Australian Government

BUILDING OUR FUTURE

NSW GOVERNMENT

M12 Motorway Environmental Impact Statement

Appendix E Biodiversity assessment report

Roads and Maritime Services | October 2019

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Executive summary

Background

Roads and Maritime Services (Roads and Maritime) is seeking approval under Part 5, Division 5.2 of the *Environmental Planning and Assessment Act 1979* (EP&A Act) to construct and operate the M12 Motorway project to provide direct access between the Western Sydney Airport at Badgerys Creek and Sydney's motorway network (the project). The project has been determined to be a controlled action under Section 75 of the *Environment Protection and Biodiversity Conservation Act 1999* (Commonwealth) (EPBC Act) (EPBC 2018/8286) for significant impact to threatened species and communities (Section 18 and Section 18A of the EPBC Act). As such, the project requires assessment and approval from the Commonwealth Government.

The M12 Motorway would run between the M7 Motorway at Cecil Hills and The Northern Road at Luddenham for a distance of about 16 kilometres and would be opened to traffic prior to opening of the Western Sydney Airport.

Purpose of this report

This report has been prepared to support the Environmental Impact Statement (EIS) for the project. The Environmental Impact Statement has been prepared to address the Secretary's Environmental Assessment Requirements (SEARs) for the project (SSI 9364), which include the Commonwealth assessment requirements under the *Environment Protection and Biodiversity Conservation Act 1999*. The Environmental Impact Statement provides sufficient information to enable the NSW Minister for Planning and Public Spaces and the Commonwealth Minister for the Environment to make a determination on whether the project can proceed. This report presents an assessment of the construction and operational activities for the project that have the potential to impact biodiversity.

Biodiversity matters in NSW are currently assessed under the *Biodiversity Conservation Act 2016* (NSW) (BC Act) which came into effect in August 2017. Roads and Maritime applied to have the project defined as a 'pending or interim planning application' under Clause 27(1) of the Biodiversity Conservation (Savings and Transitional) Regulation 2017 based on having undertaken 'substantial environmental assessment' prior to the commencement of that Act. This application was granted by a delegate of the Secretary of the Department of Planning, Industry and Environment (DPIE) (Planning and Assessment) on 5 April 2018. Accordingly, the former planning provisions (being the *Threatened Species Conservation Act 1995* (NSW) (TSC Act), the NSW Biodiversity Offsets Policy for Major Projects (2014) and the *Framework for Biodiversity Assessment 2014* (FBA; OEH, 2014b) continue to apply.

On 19 October 2018, the delegate for the Commonwealth Minister for the Environment confirmed that the project would be a controlled action under Section 75 of the *Environment Protection and Biodiversity Conservation Act 1999*. Matters of National Environmental Significance (MNES) of relevance to the project were listed threatened species and communities (Section 18 and Section 18A of the *Environment Protection and Biodiversity Conservation Act 1999*). As such, the project requires assessment and approval under the *Environment Protection and Biodiversity Conservation Act 1999*.

Study area

The study area for biodiversity investigations is about 300 metres wide and 16 kilometres long. The construction footprint is completely contained within the study area and averages about 150 metres wide. The study area is comprised predominantly of cleared agricultural land, rural residential, modified remnant vegetation and public open space. The project crosses 10 permanent or ephemeral waterways including four major waterways (Cosgroves Creek, Badgerys Creek, South Creek, Kemps Creek) and Ropes Creek.

Development site

Under the *Framework for Biodiversity Assessment 2014*, the area subject to impact assessment is referred to as the 'development site'. In this assessment, the development site is considered to encompass the construction footprint. For the purpose of this Biodiversity Assessment Report, the term construction footprint has been used to be consistent with the overall environmental assessment of the project.

Desktop and site investigations

Desktop assessment and field surveys were carried out from May 2017 to February 2019. Flora surveys consisted of rapid vegetation assessment, 33 detailed floristic plots and targeted surveys for threatened flora. Targeted threatened flora surveys were carried out in accordance with relevant guidelines and during peak flowering seasons, where relevant. Fauna surveys included an assessment of the fauna habitat present in addition to targeted threatened species surveys for species considered to have potential habitat within the study area. These included diurnal bird surveys, echolocation call recording and analysis for threatened microbats, amphibian surveys, targeted searches for Cumberland Plain Land Snail and Koala and nocturnal surveys for owls and non-flying arboreal mammals.

Overview of potential impacts

On 19 October 2018 the Commonwealth Minister for the Environment determined that the project was a controlled action due to potential significant impacts to Matters of National Environmental Significance listed under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC 2018/8286). In particular, the Department of Environment and Energy predicted significant impacts on the following threatened species and communities:

- *Cumberland Plain Shale Woodlands and Shale-Gravel Transition Forest (CPW)* – critically endangered ecological community
- *Sydney Bush Pea - Pultenaea parviflora – listed as vulnerable*
- *Grey-headed Flying-fox- Pteropus poliocephalus – listed as vulnerable*
- *Koala -Phascolarctos cinereus – listed as vulnerable in QLD, NSW and ACT*
- *Swift Parrot -Lathamus discolor – listed as critically endangered.*

As well as a thorough assessment of the above entities, the Department of Environment and Energy required this report to assess for potential impact to a further thirteen ecological communities or threatened species listed under the *Environment Protection and Biodiversity Conservation Act 1999.*

After further detailed assessment presented in this report, *Pultenaea parviflora* and *Cumberland Plain Shale Woodlands and Shale-Gravel Transition Forest (CPW)* were considered to be significantly impacted.

The Grey-headed Flying-fox was the only *Environment Protection and Biodiversity Conservation Act 1999* listed fauna species recorded or assumed present within the study area. No breeding or roosting habitat occurs within the study area. About 55.20 hectares of potential foraging habitat for the Grey-headed Flying-fox would be removed as part of the project. Given the availability of similar foraging resources in the surrounding areas, this is not considered likely to significantly impact this species. All other Matters of National Environmental Significance assessed were considered to have a low likelihood of occurrence and/or impact.

Eight Plant Community Types (PCTs) were identified in the study area. Seven Plant Community Types meet the criteria for six listed Threatened Ecological Communities (TECs) under the *Threatened Species Conservation Act 1995*. Of these, five Threatened Ecological Communities are located within the construction footprint and would be impacted by the project. Two of these communities are also listed as Threatened Ecological Communities under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*. In total, about 73.65 hectares of Plant Community Types would be removed as a result of the project, and an additional 12.73 hectares may be subject to indirect impacts. A summary of the native vegetation that occurs within the study area and that would be impacted by the project is provided in **Table 1a-1,** and the areas of TECs that would be impacted by the project are provided in **Table 1a-2**.

Table 1a-1 Plant Community Types recorded within the study area

PCT No.	PCT Name	Area within study area (ha)	Area within construction footprint excluding certified areas (ha)	Area of potential indirect impacts (ha)
724	Broad-leaved Ironbark - Grey Box - Melaleuca decora grassy open forest on clay/gravel soils of the Cumberland Plain, Sydney Basin Bioregion	12.82	6.91	0.52
725	Broad-leaved Ironbark - Melaleuca decora shrubby open forest on clay soils of the Cumberland Plain, Sydney Basin Bioregion	0.50	0	0
830	Forest Red Gum - Grey Box shrubby woodland on shale of the southern Cumberland Plain, Sydney Basin Bioregion	4.97	0.44	0.54
835	Forest Red Gum - Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney Basin Bioregion	20.70	3.23	0
849	Grey Box - Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin Bioregion	18.11	6.09	0.24
850	Grey Box - Forest Red Gum grassy woodland on shale of the southern Cumberland Plain, Sydney Basin Bioregion (includes revegetation within Western Sydney Parklands and derived grasslands in Low condition)	154.44	54.07	11.43
883	Hard-leaved Scribbly Gum - Parramatta Red Gum heathy woodland of the Cumberland Plain, Sydney Basin Bioregion	0.93	0.38	0
1800	Swamp Oak open forest on riverflats of the Cumberland Plain and Hunter valley	16.00	2.53	0
Total		**228.47**	**73.65**	**12.73**

Table 1a-2 Threatened Ecological Communities that would be impacted by the project

PCT No.	PCT Name	Equivalent TECs	Total area directly impacted (ha)	Area directly impacted meeting EPBC TEC criteria (ha)	Total area indirectly impacted (ha)	Area indirectly impacted meeting EPBC TEC criteria (ha)
724	Broad-leaved Ironbark - Grey Box - Melaleuca decora grassy open forest on clay/gravel soils of the Cumberland Plain, Sydney Basin Bioregion	Shale Gravel Transition Forest in the Sydney Basin Bioregion (Endangered, TSC Act) Cumberland Plain Shale Woodlands and Shale-Gravel Transition Forest (Critically Endangered, EPBC Act)	6.91	4.86	0.52	0.52
830	Forest Red Gum - Grey Box shrubby woodland on shale of the southern Cumberland Plain, Sydney Basin Bioregion	Moist Shale Woodland in the Sydney Basin Bioregion (Endangered, TSC Act; Critically Endangered, EPBC Act)	0.44	0.44	0.54	0.54
835	Forest Red Gum - Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney Basin Bioregion	River-Flat Eucalypt Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions (Endangered, TSC Act)	3.23	N/A – not listed	N/A – not listed	N/A – not listed
849	Grey Box - Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin Bioregion	Cumberland Plain Woodland in the Sydney Basin Bioregion (Critically Endangered, TSC Act) Cumberland Plain Shale Woodlands and Shale-Gravel Transition Forest (Critically Endangered, EPBC Act)	6.09	1.61	0.24	0.24
850	Grey Box - Forest Red Gum grassy woodland on shale of the southern Cumberland Plain, Sydney Basin Bioregion		54.07	32.01	11.43	11.33
1800	Swamp Oak open forest on riverflats of the Cumberland Plain and Hunter valley	Swamp oak floodplain forest of the NSW North Coast, Sydney Basin and South East Corner bioregions (Endangered, TSC Act and EPBC Act)	2.53	0	0	0
Total			**73.65**	**38.92**	**12.73**	**12.63**

Five threatened flora species were recorded within (or immediately adjacent to) the study area. The project would have direct impacts on two of these threatened flora species:

- Sydney Bush-pea (*Pultenaea parviflora*): 278 plants recorded in the study area, 90 within the construction footprint (listed as a Matter of National Environmental Significance (MNES) and Vulnerable under the *Environment Protection and Biodiversity Conservation Act 1999,* and listed as Endangered under the *Threatened Species Conservation Act 1995)*;
- *Dillwynia tenuifolia*: 464 plants within the study area, 244 within the construction footprint (listed as Vulnerable under the *Threatened Species Conservation Act 1995*).
- The project intersects the north-eastern corner of the South West Growth Centre as defined under the Growth Centres SEPP. Of the 83.5 hectares of the South West Growth Centre within the construction footprint, 66.15 hectares consists of non-certified land and 17.38 hectares consists of certified land. Areas of non-certified land within the Growth Centres SEPP area are all located within the Western Sydney Parklands and have been accounted for within impact assessment and offset calculations for the project.

Seven threatened fauna species were recorded, including five threatened microbat species, Grey-headed Flying-fox (*Pteropus poliocephalus*; listed as Vulnerable under the *Threatened Species Conservation Act 1995* and *Environment Protection and Biodiversity Conservation Act 1999*) and White-bellied Sea-Eagle (*Haliaeetus leucogaster*; listed as Vulnerable under the *Threatened Species Conservation Act 1995*). A further three species were assumed to be present. These were the Cumberland Plain Land Snail (*Meridolum corneovirens*; listed as Endangered under *Threatened Species Conservation Act 1995*), Southern Myotis (*Myotis macropus*; listed as Vulnerable under the *Threatened Species Conservation Act 1995*) and Eastern False Pipistrelle (*Falsistrellus tasmaniensis*; listed as Vulnerable under the *Threatened Species Conservation Act 1995*).

Potential impacts to additional species credit threatened fauna includes:

- Removal of about 0.92 hectares of potential breeding and about 3.69 hectares of potential foraging habitat for Southern Myotis;
- Removal of about 1.86 hectares of potential habitat for Cumberland Plain Land Snail.

Potential impacts to ecosystem credit threatened fauna includes:

- Removal of about 55.58 hectares of potential foraging habitat for five threatened microbat species;
- Removal of about 3.69 hectares of potential foraging habitat and anticipated removal of one active nest for White-bellied Sea-Eagle.

No threatened fish or ecological communities, listed under the *Fisheries Management Act 2004* (NSW) (FM Act), are considered likely to occur within the study area or likely to be impacted by the project. Bridges would be constructed at all major waterway crossings and permanent creek adjustments would be required for Badgerys Creek, South Creek and Kemps Creek. Fish passage would be maintained throughout construction and operation and the design would allow for the retention of fauna movement corridors along all four major creeks (Cosgroves Creek, Badgerys Creek, South Creek and Kemps Creek) as well as Ropes Creek in the north-eastern extent of the corridor.

Avoidance and minimisation of impacts have been considered at several project stages, including the route options analysis stage and through selection of the preferred option. Details about the route options development and preferred option are summarised in Section 4.2 and Chapter 5 of the Environmental Impact Statement. The guidelines for the avoidance and minimisation of biodiversity impacts during the site selection phase and planning phase are outlined in Sections 8.3.2.2 to 8.3.2.8 of the *Framework for Biodiversity Assessment 2014* (OEH, 2014b). Where it is not possible to avoid impacts, ecological input during the remainder of the design process would focus on minimising impacts to biodiversity as far as possible, especially minimising the clearing of Cumberland Plain Woodland. The current design also provides bridges for all creek crossings which would assist in maintaining wildlife connectivity. Road design would incorporate suitably placed fauna fencing to reduce mortality risks from motor vehicles, which would further reduce impacts to wildlife.

Under the *Framework for Biodiversity Assessment 2014*, certain impacts on biodiversity values require further consideration by the relevant consent authority. Impacts associated with the project that would require further consideration by the DPIE (Planning and Assessment) include:

- Impacts to a critically endangered ecological community because of a significant reduction of the viability of that community;
- Impacts that would substantially reduce the width of vegetation in the riparian buffer zone bordering watercourses classified as 4th order or greater.

Summary of biodiversity offset requirements

Under the *Framework for Biodiversity Assessment 2014*, where residual impacts occur after all efforts to avoid, minimise and mitigate impacts have been applied, they must be offset. Offsets are determined by allocating ecosystem and species credits. A summary of the credits required for the project is shown in **Table 2a-1, Table 2a-2** and **Table 2a-3** below.

Table 2a-1 Summary of ecosystem credit offset requirements for direct impacts

PCT name	Total area directly impacted (ha)	Area impacted meeting EPBC TEC criteria (ha)	Total ecosystem credits required	Ecosystem credits required for EPBC TEC impacts
Broad-leaved Ironbark - Grey Box - Melaleuca decora grassy open forest on clay/gravel soils of the Cumberland Plain, Sydney Basin Bioregion	6.91	4.86	372	276
Forest Red Gum - Grey Box shrubby woodland on shale of the southern Cumberland Plain, Sydney Basin Bioregion	0.44	0.44	15	15
Forest Red Gum - Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney Basin Bioregion	3.23	N/A – not listed	107	N/A
Grey Box - Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin Bioregion	6.09	1.61	203	65
Grey Box - Forest Red Gum grassy woodland on shale of the southern Cumberland Plain, Sydney Basin Bioregion	54.07	32.01	1,650	1,469
Swamp Oak open forest on riverflats of the Cumberland Plain and Hunter valley	2.53	0	67	0

Table 2a-2 Summary of ecosystem credit offset requirements for indirect impacts

PCT name	Total area indirectly impacted (ha)	Area indirectly impacted meeting EPBC TEC criteria (ha)	Total ecosystem credits required	Ecosystem credits required for EPBC TEC impacts
Broad-leaved Ironbark - Grey Box - Melaleuca decora grassy open forest on clay/gravel soils of the Cumberland Plain, Sydney Basin Bioregion	0.52	0.52	7	7
Forest Red Gum - Grey Box shrubby woodland on shale of the southern Cumberland Plain, Sydney Basin Bioregion	0.54	0.54	5	5
Grey Box - Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin Bioregion	0.24	0.24	3	3
Grey Box - Forest Red Gum grassy woodland on shale of the southern Cumberland Plain, Sydney Basin Bioregion	11.43	11.33	139	138

Table 2a-3 Summary of species credit offset requirements

Species name	TSC Act status	EPBC Act status	Threatened species offset multiplier	Loss of habitat (ha) or individuals	Species credits required
Dillwynia tenuifolia	Vulnerable	Not listed	1.8	244 individuals	4,392
Pultenaea parviflora Sydney Bush-pea	Endangered	Vulnerable	1.5	90 individuals	1,350
Meridolum corneovirens Cumberland Plain Land Snail	Endangered	Not listed	1.3	1.86 ha	24
Myotis macropus Southern Myotis	Vulnerable	Not listed	2.2	0.92 ha	20

A Biodiversity Offset Strategy (BOS) has been prepared to detail how biodiversity credits identified above are to be retired. This document is provided as **Annexure D** to the current report.

Contents

Annexures

Glossary of terms and abbreviations for this report

Definitions

Assessment circles	Two circles (the inner and outer assessment circle) in which the per cent of native vegetation cover in the landscape is assessed, taking into account both cover and condition of vegetation (OEH, 2014b).
Bilateral agreement	The bilateral agreement made under Section 45 of the *Environment Protection and Biodiversity Conservation Act 1999* (Commonwealth) relating to environmental assessment.
Biodiversity credit report	The report produced by the Credit Calculator that sets out the number and type of biodiversity credits required to offset the remaining adverse impacts on biodiversity values at a development site or sets out the number and type of biodiversity credits that are created at an offset site (OEH, 2014b).
Construction footprint	The construction footprint is the area required to build the project. This includes the area required for temporary work such as sedimentation basins, drainage channels, access roads and construction ancillary facilities.
Credit Calculator	Spreadsheet developed as part of Biobanking scheme to calculate offset requirements for impact assessment.
Cumulative impact	The impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time. Refer to the project SEARs for cumulative impact assessment requirements.
Direct impact	Where a primary action is a substantial cause of a secondary event or circumstance which has an impact on a protected matter (CoA, 2012).
Ecosystem credit	Ecosystem or species credits (OEH, 2014b).
Ecosystem credit species	A measurement of the value of EECs, CEECs and threatened species habitat for species that can be reliably predicted to occur with a PCT. Ecosystem credits measure the loss in biodiversity values at a development site and the gain in biodiversity values at an offset site (OEH, 2014b).
Habitat	An area or areas occupied, or periodically or occasionally occupied, by a species, population or ecological community, including any biotic or abiotic component (OEH, 2014).
Indirect impact	Where an event or circumstance is a direct consequence of the action (CoA, 2012).
Matters for further consideration	Impacts that are considered to be complicated or severe that would require further consideration by the consent authority (OEH, 2014b). The assessment is based on thresholds detailed in Section 9 of the FBA. These can also be included as part of the project SEARs.
MNES	A matter of national environmental significance protected by a provision of Part 3 of the EPBC Act.
Mitchell landscape	Landscapes with relatively homogeneous geomorphology, soils and broad vegetation types, mapped at a scale of 1: 250,000 (OEH, 2014b).
Mitigation	Action to reduce the severity of an impact (OEH, 2014b).
Mitigation measure	Any measure that facilitates the safe movement of wildlife and/or prevents wildlife mortality.
M12 Motorway	The proposed M12 Motorway which is the subject of this document (also known as 'the project').
M7 Motorway	A major connecting road on Sydney's orbital motorway network. It runs for 40 kilometres and links the M5 Motorway with the M4 Motorway, and the M2 Motorway.
Operational footprint	Generally includes the M12 Motorway and additional areas required for operation and maintenance of the project.
Population	All the individuals that interbreed within a given area.
Project area/ Project site	The area of land that is directly impacted on by a proposed Major Project that is under the EP&A Act, including access roads, and areas used to store construction materials (OEH, 2014b).

RIAR	Regions, Industry, Agriculture and Resources Group of the Department of Planning, Industry and Environment
Species credit species	Threatened species and populations that are assessed according to Section 6.4 of the FBA (OEH, 2014b).
Study area	The study area for biodiversity investigations is about 300 metres wide and 16 kilometres long and is shown on **Figure 2-2**.
Target species	A species that is the focus of a study or intended beneficiary of a conservation action or connectivity measure.
The project	M12 Motorway.
Western Sydney Aerotropolis	As defined in the Western Sydney Aerotropolis Stage 1 Plan, the Aerotropolis surrounds the Western Sydney Airport site at Badgerys Creek and will comprise industrial, commercial and residential development.
Western Sydney Airport	The future Western Sydney International Airport at Badgerys Creek.
Western Sydney Parklands Biobank Site	Biobanking Agreement Site ID 199 and shown on **Figure 1.4**.

Abbreviations

BAR	Biodiversity assessment report
BBCC	BioBanking credit calculator
BC Act	*Biodiversity Conservation Act 2016* (NSW)
BVT	Biometric vegetation type
CAMBA	China-Australia Migratory Bird Agreement
CEMP	Construction environmental management plan
DECCW	Department of Environment, Climate Change and Water NSW
DoE	Department of the Environment
DoEE	Department of the Environment and Energy
DPE	Department of Planning and Environment
DPI	Department of Primary Industries
DPIE	Department of Planning, Industry and Environment
EEC	Endangered ecological community
EESG	Environment, Energy and Science Group of the DPIE (former NSW Office of Environment and Heritage)
EIS	Environmental impact statement
EP&A Act	*Environmental Planning and Assessment Act 1979* (NSW)
EPBC Act	*Environmental Protection and Biodiversity Conservation Act 1999* (Commonwealth)
FBA	Framework for Biodiversity Assessment
FM Act	*Fisheries Management Act 1994* (NSW)
GDE	Groundwater dependent ecosystems
IBRA	Interim Biogeographically Regionalisation of Australia
JAMBA	Japan-Australia Migratory Bird Agreement
LEP	Local environmental plan
LGA	Local government area
MNES	Matters of national environmental significance
NPW Act	*National Parks and Wildlife Act 1974* (NSW)
NSW	New South Wales
OEH	Office of Environment and Heritage
PCT	Plant community type
Roads and Maritime Services	Roads and Maritime
ROKAMBA	Republic of Korea-Australia Migratory Bird Agreement
SEARs	Secretary's environmental assessment requirements
SEPP	State environmental planning policy
SSI	State significant infrastructure
TECs	Threatened ecological community
TSPD	Threatened species profile database
TSC Act	*Threatened Species Conservation Act 1995* (NSW)
VIS	Vegetation information system

1 Introduction

1.1 Project background

Roads and Maritime Services (Roads and Maritime) is seeking approval under Part 5, Division 5.2 of the *Environmental Planning and Assessment Act 1979* (EP&A Act) to construct and operate the M12 Motorway project to provide direct access between the Western Sydney Airport at Badgerys Creek and Sydney's motorway network (the project). In addition, the project has been determined to be a controlled action under Section 75 of the *Environment Protection and Biodiversity Conservation Act 1999* (Commonwealth) (EPBC Act) (EPBC 2018/8286) for significant impact to threatened species and communities (Section 18 and Section 18A of the EPBC Act). As such, the project requires assessment and approval from the Commonwealth Government.

The M12 Motorway would run between the M7 Motorway at Cecil Hills and The Northern Road at Luddenham for a distance of about 16 kilometres and would be opened to traffic prior to opening of the Western Sydney Airport. The project would commence about 30 kilometres west of the Sydney central business district, at its connection with the M7 Motorway. The project traverses the local government areas of Fairfield, Liverpool and Penrith. The suburbs of Cecil Park and Cecil Hills are found to the east of the M12 Motorway, with Luddenham to the west.

The project is predominately located in greenfield areas. The topography in and around the project comprises rolling hills and small valleys between generally north–south ridge lines. The existing land uses are semi-rural residential, recreational, agricultural, commercial and industrial. The main residential areas are Kemps Creek, Mount Vernon and Cecil Hills.

The project is required to support the opening of the Western Sydney Airport by connecting Sydney's motorway network to the airport. The project would also serve and facilitate the growth and development of the Western Sydney which is expected to undergo significant development and land use change over the coming decades. The motorway would provide increased road capacity and reduce congestion and travel times in the future and would also improve the movement of freight in and through western Sydney.

The project location is shown in **Figure 1-1** in relation to its regional context.

1.2 Project overview

The project would include the following key features:

- A new dual-carriageway motorway between the M7 Motorway and The Northern Road with two lanes in each direction with a central median allowing future expansion to six lanes
- Motorway access via three interchanges/intersections:
  - A motorway-to-motorway interchange at the M7 Motorway and associated works (extending about four kilometres within the existing M7 Motorway corridor)
  - A grade separated interchange referred to as the Western Sydney Airport interchange, including a dual-carriageway four lane airport access road (two lanes in each direction for about 1.5 kilometres) connecting with the Western Sydney Airport Main Access Road
  - A signalised intersection at The Northern Road with provision for grade separation in the future
- Bridge structures across Ropes Creek, Kemps Creek, South Creek, Badgerys Creek and Cosgroves Creek
- Bridge structure across the M12 Motorway into Western Sydney Parklands to maintain access to the existing water tower and mobile telephone/other service towers on the ridgeline in the vicinity of Cecil Hills, to the west of the M7 Motorway
- Bridge structures at interchanges and at Clifton Avenue, Elizabeth Drive, Luddenham Road and other local roads to maintain local access and connectivity

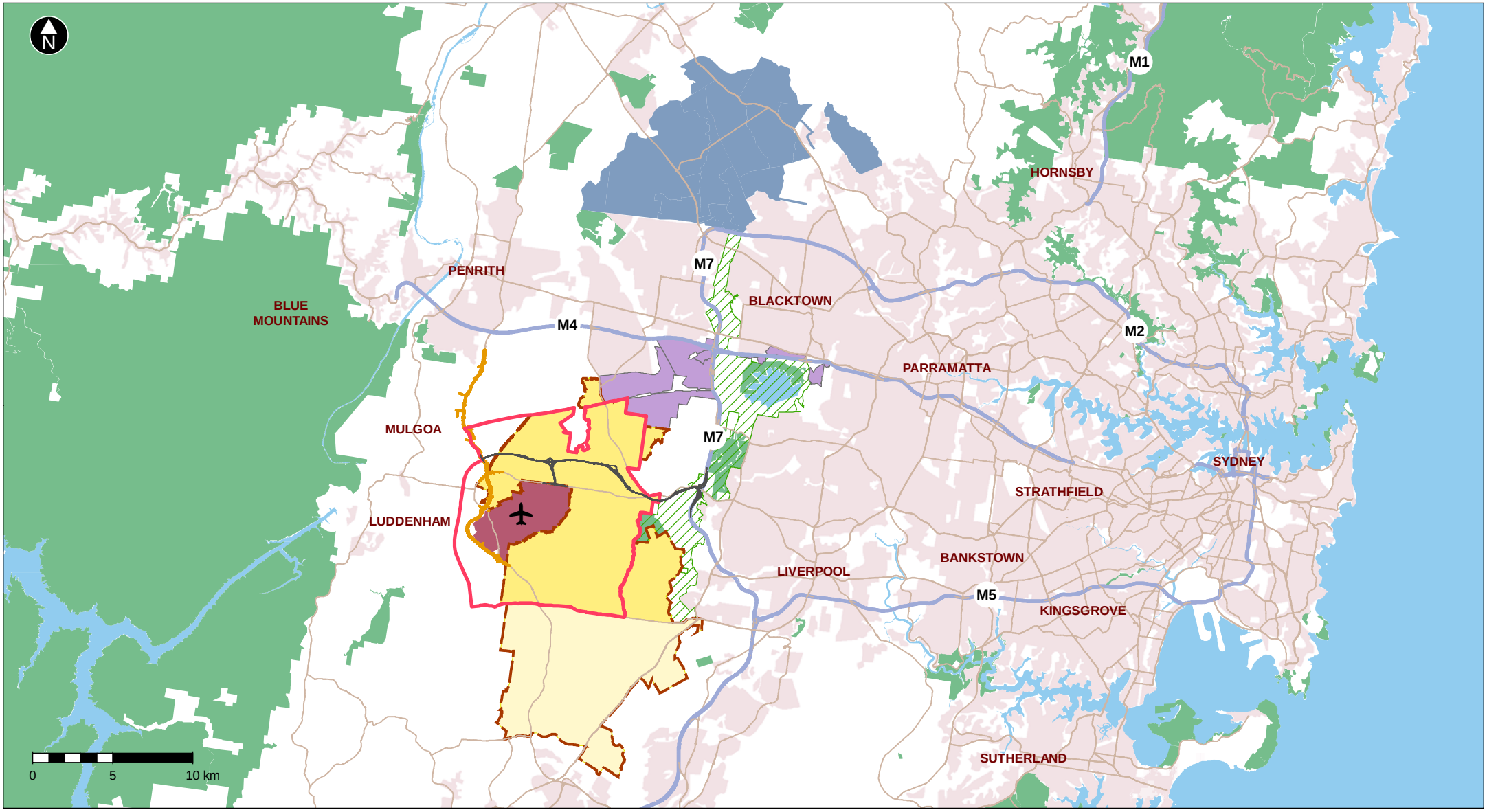

Figure 1-1 Project location (regional context)

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- Inclusion of active transport (pedestrian and cyclist) facilities through provision of pedestrian bridges and an off-road shared user path including connections to existing and future shared user path networks
- Modifications to the local road network, as required, to facilitate connections across and around the M12 Motorway including:
  - Realignment of Elizabeth Drive at the Western Sydney Airport, with Elizabeth Drive bridging over the airport access road and future passenger rail line to the airport
  - A realignment of Clifton Avenue over the M12 Motorway, with associated adjustments to nearby property access
  - Relocation of Salisbury Avenue cul-de-sac, on the southern side of the M12 Motorway
  - Realignment of Wallgrove Road north of its intersection with Elizabeth Drive to accommodate the M7 Motorway northbound entry ramp
- Adjustment, protection or relocation of existing utilities
- Ancillary facilities to support motorway operations, smart motorways operation in the future and the existing M7 Motorway operation, including gantries, electronic signage and ramp metering
- Other roadside furniture including safety barriers, signage and street lighting
- Adjustments of waterways, where required, including Kemps Creek, South Creek and Badgerys Creek
- Permanent water quality management measures including swales and basins
- Establishment and use of temporary ancillary facilities, temporary construction sedimentation basins, access tracks and haul roads during construction
- Permanent and temporary property adjustments and property access refinements as required.

The project overview presented in this document represents the design outlined in the M12 Motorway EIS. If the project is approved, a further detailed design process would follow, which may include variations to the design. Flexibility has been provided in the design to allow for refinement of the project during detailed design, in response to any submissions received following the exhibition of the environmental impact statement (EIS), or if opportunities arise to further minimise potential environmental impacts.

The key features of the project are shown on **Figure 1-2**.

1.3 Purpose and scope of this report

This report has been prepared to support the EIS for the project. The EIS has been prepared to address the Secretary's Environmental Assessment Requirements (SEARs) for the project (SSI 9364), as well as the Australian Government assessment requirements under the EPBC Act. The EIS for the project provides sufficient information to enable the NSW Minister for Planning and Public Spaces and the Commonwealth Minister for the Environment to make a determination on whether the project can proceed. This report presents an assessment of the construction and operational activities for the project that have the potential to impact biodiversity.

Policy and planning including NSW and Commonwealth legislative requirements, as well as the Bilateral Agreement, are discussed in detail in **Section 1.4** below.

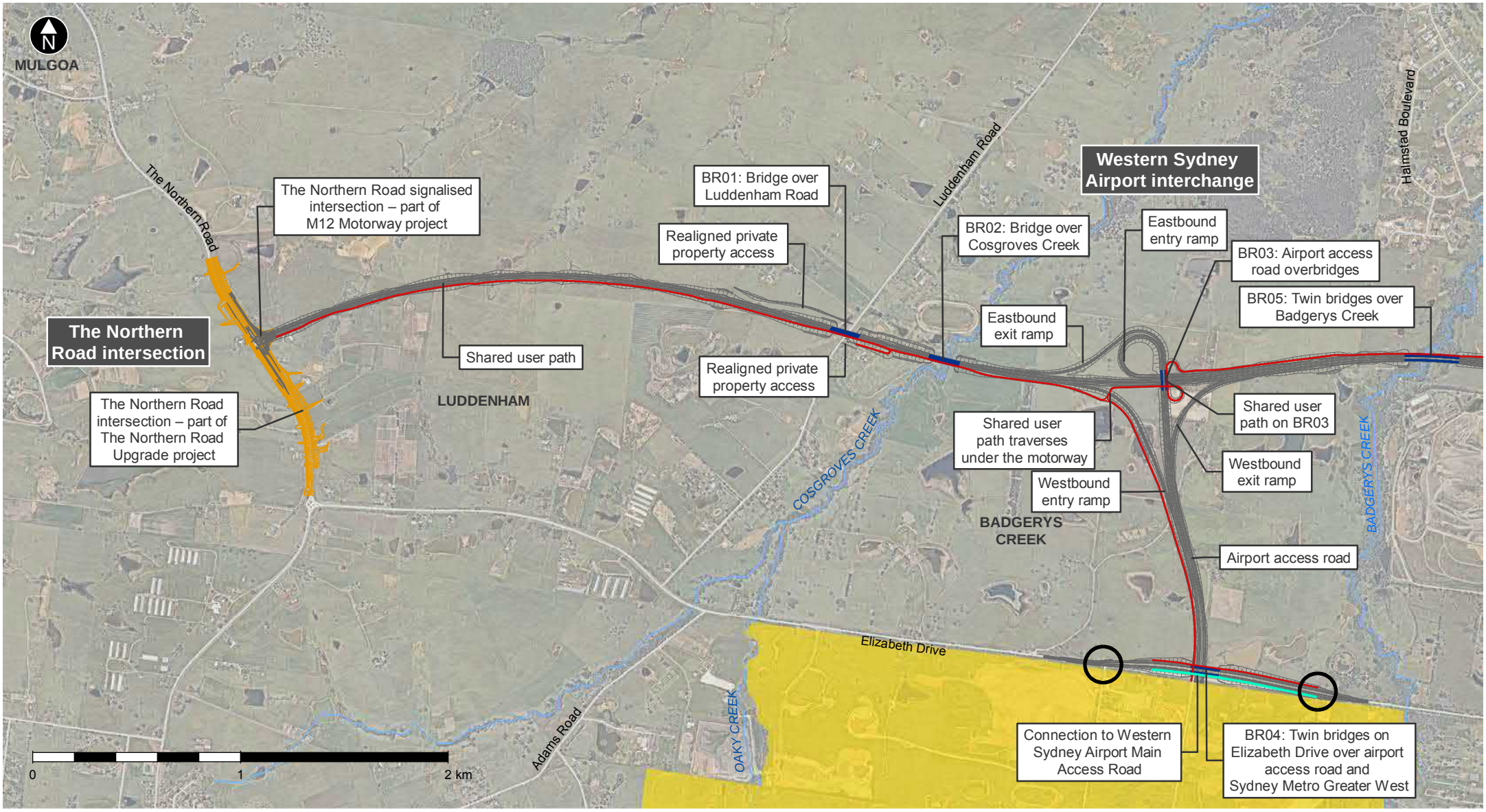

Figure 1-2 Key features of the project

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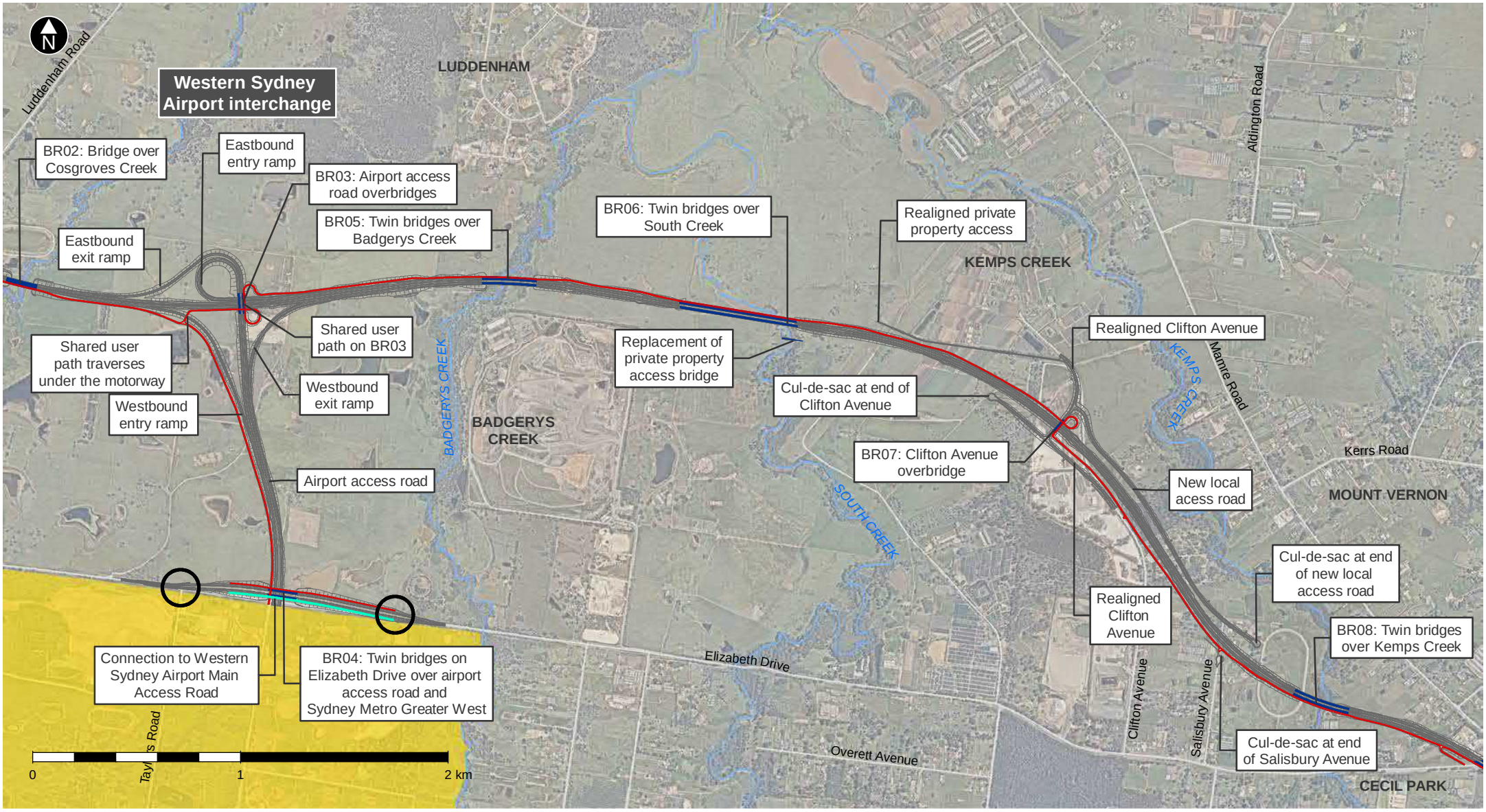


The project

Part of The Northern Road upgrade project

Shared user path

Future shared user path (by others)

Existing roads

Waterways

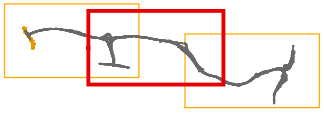
Bridges

Western Sydney Airport

Note. The roads within this zone are being removed as part of airport construction.

Potential future intersections (by others)

Note: Locations to be confirmed



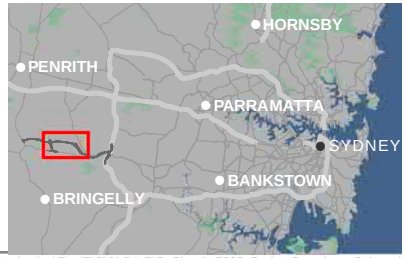


Figure 1-2 Key features of the project

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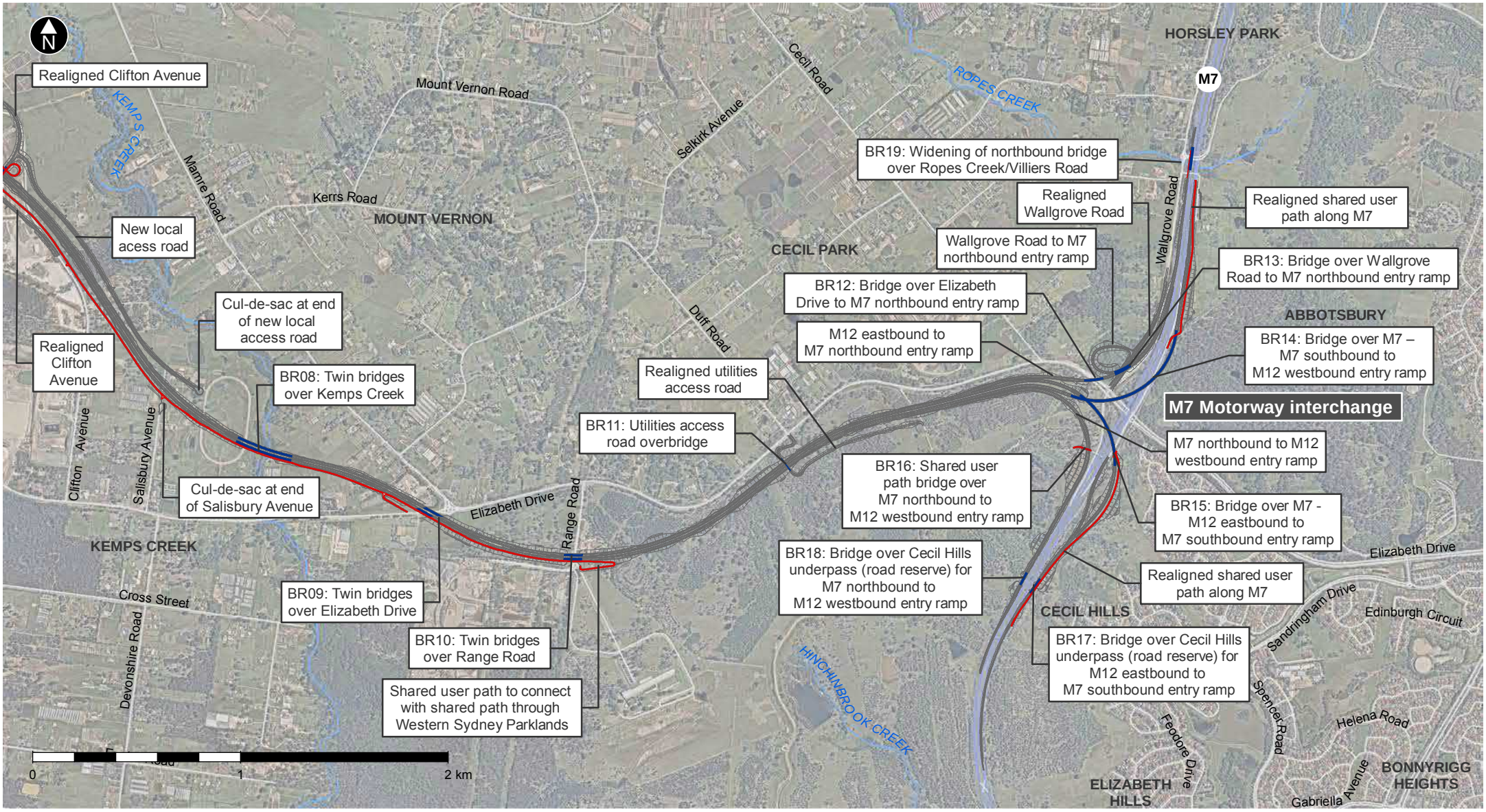
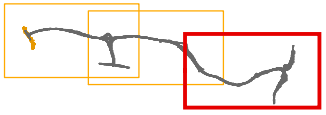


The project
Part of The Northern Road upgrade project
Shared user path
Future shared user path (by others)
Existing roads
Waterways
Bridges



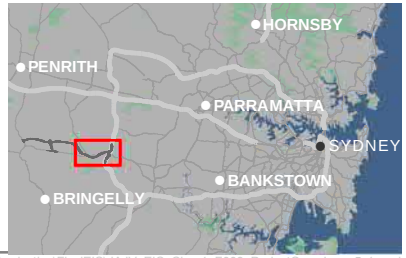


Figure 1-2 Key features of the project

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1.4 Policy and planning setting

1.4.1 NSW legislative requirements

An EIS has been prepared to assess the impacts of State Significant Infrastructure (SSI) projects, under Part 5.1 of the EP&A Act. This Biodiversity Assessment Report (BAR) forms part of the EIS being prepared for the project and assesses the biodiversity impacts of the project.

EIS's are subject to a range of legislative and policy requirements as set out in the SEARs. The project SEARs that are relevant to biodiversity are discussed in **Section 1.4.2** and presented in **Table 1-1**.

On 25 August 2017, the *Biodiversity Conservation Act 2016* (NSW) (BC Act) came into effect, repealing the former *Threatened Species Conservation Act 1995* (NSW) (TSC Act). The Biodiversity Conservation (Savings and Transitional) Regulation 2017 (BC (Savings and Transitional) Reg) provides the criteria under which a project would be saved, meaning the former planning provisions would continue to apply.

Part 7 (Clause 27) of BC (Savings and Transitional) Reg defines a pending or interim planning application as:

> *An application for planning approval (or for the modification of a planning approval) made after the commencement of the new Act if an environmental impact statement is to be submitted in connection with the application and the Secretary of the Department of Planning and Environment determines in writing that the proponent had undertaken substantial environmental assessment in connection with the statement before the commencement of the new Act (but only if the application is made within 18 months after that determination).*

An application was made to the Secretary of the DPIE (Planning and Assessment) to consider whether substantial environmental assessment had been undertaken by Roads and Maritime. This application was granted on 5 April 2018. Accordingly, the project can be assessed under the TSC Act and in accordance with the NSW Biodiversity Offsets Policy for Major Projects (2014) which is underpinned by the *Framework for Biodiversity Assessment 2014* (FBA).

1.4.2 Bilateral agreement

The Commonwealth Government and NSW Government have signed an agreement under Section 45 of the EPBC Act to establish a 'One-stop Shop' for environmental approvals, removing duplication of assessment and approval processes while maintaining appropriate environmental standards. The Agreement between the Commonwealth of Australia and the State of New South Wales relating to Environmental Assessment was signed by both governments in February 2015.

Under clause 4.1 of this agreement, if an action meets the specific criteria outlined in Schedule 1 of the agreement, then it does not require assessment under Part 8 of the EPBC Act. The project is classified as SSI development and as such meets the criteria in Schedule 1, clause (x):

> *Actions that are assessed under Part 5 (other than Division 5 of Part 5) of the Environmental Planning and Assessment Act 1979, and which includes an environmental impact statement, where the assessment has been undertaken in accordance with the requirements of Item 3 of this Schedule 1.*

Item 3 of Schedule 1 of the agreement includes general requirements for assessment of controlled actions subject to the Bilateral Agreement. This item outlines guidelines or directions for assessments covering the level of information required to be reported, need for public comment and requirements to provide sufficient information on the controlled action that the Commonwealth Minister can make an informed decision whether or not to approve the controlled action under the EPBC Act.

There is also a requirement under Schedule 3.2(iii) to address matters outlined in Schedule 4 of the Environment Protection and Biodiversity Conservation Regulations 2000 (Commonwealth). This schedule has a detailed list of requirements, similar to the questions required in a referral under Section 75 of the EPBC Act. It includes:

- The detail required for relevant impacts on MNES
- Proposed safeguards and mitigation measures
- Environmental record of the person proposing to take the action.

Section 5 and **Section 8.4** of this document, and the information from the referral for the project (2018/8286) provide this level of detail to satisfy these requirements.

1.4.3 SEARs

On 18 June 2018, the Secretary of the DPIE (Planning and Assessment) issued to Roads and Maritime the draft SEARs for the M12 Motorway EIS. The SEARs were finalised and reissued on 12 July 2018. The project was then determined to be a controlled action under the EPBC Act, and updated SEARs were issued on 30 October 2018 that include the Commonwealth assessment requirements under the EPBC Act. **Table 1-1 and Table 1-2** lists those requirements relating specifically to the assessment of the project's potential impacts on biodiversity, with a reference to the chapter or section of this report where each requirement is addressed.

Table 1-1 SEARs for the project (biodiversity)

Secretary's requirement	Where addressed in this report
5. Biodiversity	
1. The Proponent must assess biodiversity impacts in accordance with the current guidelines including the Framework for Biodiversity Assessment (FBA).	**Chapter 6** **Chapter 8**
2. The proponent must assess any impacts on biodiversity values not covered by the FBA as specified in s2.3. OEH[1] will provide specific assessment requirements for any such impacts during agency consultation on the SEARs.	**Section 6.2** **Chapter 8**
3. The Proponent must assess impacts on the following (EECs, threatened species and/populations) and provide the information specified in s9.2 of the FBA. OEH[1] will provide this list of species during agency consultation on the SEARs.	**Chapter 4** **Chapter 6** **Chapter 8**
4. The Proponent must identify whether the project as a whole, or any component of the project, would be classified as a Key Threatening Process (KTP) in accordance with the listings in the *Threatened Species Conservation Act 1997* (TSC Act), *Fisheries Management Act 1994* (FM Act) and *Environmental Protection and Biodiversity Conservation Act 2000* (EPBC Act).	**Chapter 8**
16. Protected and sensitive lands	
1. The Proponent must assess the impacts of the project on environmentally sensitive land and processes (and the impact of processes on the project) including, but not limited to: a) Key Fish Habitat as mapped and defined in accordance with the *Fisheries Management Act 1994* (FM Act);	**Chapter 4**
b) waterfront land as defined in the *Water Management Act 2000*;	**Section 8.5.1** **Chapter 10**
c) land or waters identified as Critical Habitat under the TSC Act, FM Act or EPBC Act; and	**Section 8.5.1**
d) biobank sites, private conservation lands and other lands identified as offsets.	**Chapter 11**

Note 1 = NSW Office of Environment and Heritage (OEH) now known as Environment, Energy and Science Group (EESG) of the DPIE

1.4.4 Commonwealth assessment requirements

A referral under Section 75 and Section 87 of the EPBC Act was submitted to the Department of the Environment and Energy (DoEE) in July 2018 (EPBC Referral Number: 2018/8286). The project was determined to be a controlled action on 19 October 2018 and would be assessed under the Bilateral Agreement between the Commonwealth and NSW governments. While the project is subject to assessment under the Bilateral Agreement, approval from the Commonwealth is needed before the project can commence.

Additional requirements listed in the re-issued SEARs, as outlined by the Commonwealth, are listed in **Table 1-2** with specific MNES to be assessed "in accordance with clauses 11-15 of these guidelines" (clauses 11-15 are detailed in **Table 1-2**. **Table 1-3** contains the entities to be assessed).

Table 1-2 SEARs Attachment A: Guidelines for preparing Assessment Documentation relevant to the EPBC Act

Secretary's requirement	Where addressed in this report
1. On 19 October 2018 it was determined that the M12 Motorway Project will impact upon the following matters of national environmental significance (MNES) protected under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act): • Threatened species and communities The project will be assessed in accordance with the *NSW Assessment Bilateral Agreement 2015* (the Agreement) and as such is required to be assessed in the manner specified in Schedule 1 to that Agreement. These requirements are a supplement to the Secretary's Environmental Assessment Requirements issued on 12 July 2018 and should be addressed in conjunction with those requirements.	**Chapter 2** **Chapter 3** **Chapter 4** **Chapter 5** **Chapter 8** **Section 8.4**
2. Assessment documentation prepared for the purposes of approval under the EPBC Act must, in addition to providing sufficient information for a decision in accordance with the Agreement, address the matters outlined in Schedule 4 of the Environment Protection and Biodiversity Conservation Regulations 2000 (Commonwealth). Proponents are advised to check that requirements in Schedule 4 of the EPBC Regulations have been appropriately addressed.	Refer to Appendix D of the EIS
3. The requirements are intended such that there is sufficient information in the assessment report relevant to MNES such that the Commonwealth decision-maker may make a determination on whether or not to approve the action. The proponent must undertake an assessment of all the protected matters that may be impacted by the development under the controlling provision identified in paragraph 1. A list of protected matters that are considered likely to be significantly impacted is provided in Attachment A to these Guidelines. Note that this may not be a complete list and it is the responsibility of the proponent to ensure any protected matters under this controlling provision, likely to be significantly impacted, are assessed for the Commonwealth decision-maker's consideration.	**Section 1.4.4** **Section 1.4.6** **Chapter 5** **Chapter 8** **Section 8.4**
Project description	
4. The title of the action, background to the development and current status.	**Chapter 1**
5. The precise location and description of all works to be undertaken (including associated offsite works and infrastructure), structures to be built or elements of the action that may have impacts on matters of national environmental significance (MNES).	**Chapter 1** **Chapter 7** **Chapter 8** **Section 8.4**
6. How the action relates to any other actions that have been, or are being taken, in the region affected by the action.	**Section 8.5**

Secretary's requirement	Where addressed in this report
7. How the works are to be undertaken and design parameters for those aspects of the structures or elements of the action that may have relevant impacts on MNES.	**Chapter 1** **Chapter 5** **Section 8.4**
Impacts	
8. The EIS must include an assessment of the relevant impacts of the action on threatened species and communities; including • a description and detailed assessment of the nature and extent of the likely direct, indirect and consequential impacts, including short term and long term relevant impacts;	**Chapter 8**
• a statement whether any relevant impacts are likely to be known, unpredictable or irreversible; analysis of the significance of the relevant impacts;	**Chapter 8** **Annexure G**
• any technical data and other information used or needed to make a detailed assessment of the relevant impacts; and	**Chapter 8** **Annexure G**
• a comparative description of the impacts of alternatives, if any, on the threatened species and communities.	**Chapter 8**
Avoidance, mitigation and offsetting	
9. For each of the relevant matters protected that are likely to be significantly impacted by the development, the EIS must provide information on proposed avoidance and mitigation measures to deal with the relevant impacts of the action, including: • a description and an assessment of the expected or predicted effectiveness of the mitigation measures;	**Chapter 7** **Chapter 10**
• any statutory policy basis for the mitigation measures;	**Chapter 8** **Chapter 10**
• the cost of the mitigation measures;	**Chapter 11**
• a description of the outcomes that the avoidance and mitigation measures will achieve;	**Chapter 7** **Chapter 10**
• an outline of an environmental management plan that sets out the framework for continuing management, mitigation and monitoring programs for the relevant impacts of the action;	Refer to Chapter 9 of the EIS
• the name of any agency responsible for endorsing or approving a mitigation measure or monitoring program;	Refer to Chapter 9 of the EIS **Annexure D**
• a description of the offsets proposed to address the residual adverse significant impacts and how these offsets will be established.	**Chapter 11** **Annexure D**
10. Where a significant residual adverse impact to a threatened species or community is considered likely, the EIS must provide information on the proposed offset strategy, including discussion of the conservation benefit associated with the proposed offset strategy. Paragraphs 13 & 14 provide further requirements in relation to offsets.	**Chapter 11** **Annexure D**

Secretary's requirement	Where addressed in this report
Key issues – biodiversity	
11. The EIS must address the following issues in relation to Biodiversity including separate: • identification of each EPBC Act listed threatened species and community likely to be impacted by the development. Provide evidence why other EPBC Act listed threatened species and communities likely to be located in the project area or in the vicinity will not be impacted.	**Chapter 3** **Chapter 4** **Chapter 5** **Chapter 6** **Chapter 7** **Chapter 8**
12. For each of the relevant EPBC Act listed threatened species and communities likely to be impacted by the development the EIS must provide a separate: • description of the habitat and habits (including identification and mapping of suitable breeding habitat, suitable foraging habitat, important populations and habitat critical for survival), with consideration of, and reference to, any relevant Commonwealth guidelines and policy statements including listing advice, conservation advice and recovery plans, threat abatement plans and wildlife conservation plans; and	**Chapter 3** **Chapter 4**
• details of the scope, timing and methodology for studies or surveys used and how they are consistent with (or justification for divergence from) published Australian Government guidelines and policy statements.	**Chapter 4**
• description of the impacts of the action having regard to the full national extent of the species or community's range.	**Chapter 8**
13. For each of the relevant EPBC Act listed threatened species and communities likely to be significantly impacted by the development the EIS must provide a separate: • identification of significant residual adverse impacts likely to occur after the proposed activities to avoid and mitigate all impacts are taken into account.	**Chapter 8**
• details of how the current published NSW Framework for Biodiversity Assessment (FBA) has been applied in accordance with the objects of the EPBC Act to offset significant residual adverse impacts;	**Chapter 11** **Annexure D**
• details of the offset package to compensate for significant residual impacts including details of the credit profiles required to offset the development in accordance with the FBA and/or mapping and descriptions of the extent and condition of the relevant habitat and/or threatened communities occurring on proposed offset sites.	**Chapter 11** **Annexure D**
Note: For the purposes of approval under the EPBC Act, it is a requirement that offsets directly contribute to the ongoing viability of the specific protected matter impacted by a proposed action ie 'like for like'. In applying the FBA, residual impacts on EPBC Act listed threatened ecological communities must be offset with Plant Community Type(s) (PCT) that are ascribed to the specific EPBC listed ecological community. PCTs from a different vegetation class will not generally be acceptable as offsets for EPBC listed communities.	**Chapter 11** **Annexure D**
14. Any significant residual impacts not addressed by the FBA may need to be addressed in accordance with the Environment Protection and *Biodiversity Conservation Act 1999* Environmental Offset Policy. *[Note if the EPBC Act Environmental Offset Policy is used to calculate proposed offsets for a threatened species or community you may wish to seek further advice from the Department of Planning and Environment.]*	**Annexure D**
15. For each threatened species and community likely to be significantly impacted by the development, the EIS must provide reference to, and consideration of, relevant approved conservation advice or recovery plan for the species or community.	**Annexure G**

Secretary's requirement	Where addressed in this report
Note: the relevant guidelines and policy statement for each species and community are available from the Department of the Environment Species Profiles and Threats Database. http://www.environment.gov.au/cgi-bin/sprat/public/sprat.pl	**Annexure G**
Environmental Record of person proposing to take the action	
16. Information in relation to the environmental record of a person proposing to take action must include details as prescribed in Schedule 4 Clause 6 of the EPBC Regulations 2000.	Refer to Appendix Q of the EIS
Information sources	
For information given in the EIS, the EIS must state the source of the information, how recent the information is, how the reliability of the information was tested; and what uncertainties (if any) are in the information.	**Section 3.1** **Section 4.2** **Section 4.2.3** **Chapter 12**

Table 1-3 Threatened species and communities listed under the EPBC Act that may occur within 5 kilometres of the proposed action as identified by DoEE in Attachment A to the SEARs

Title of MNES/Scientific Name	Common name (if applicable)	Status under the EPBC Act	Where addressed in this report
Entities for which significant impacts are expected (Attachment A of the SEARS DoEE October 2018)			
Cumberland Plain Shale Woodlands and Shale-Gravel Transition Forest (CPW) – critically endangered	N/A	Critically Endangered	**Section 5.4.1** and **Section 8.4.3**
Pultenaea parviflora	Sydney Bush-pea	Vulnerable	**Section 5.4.2** and **Section 8.4.1**
Pteropus poliocephalus	Grey-headed Flying-fox	Vulnerable	**Section 5.4.2** and **Section 8.4.2**
Phascolarctos cinereus	Koala	Vulnerable	
Lathamus discolor	Swift Parrot	Critically Endangered	
Entities for which significant impacts may occur and require further investigation			
Western Sydney Dry Rainforest and Moist Woodland on Shale	N/A	Critically Endangered	**Section 5.4.1** and **Section 8.4.3**
Castlereagh Scribbly Gum and Agnes Banks Woodlands of the Sydney Basin Bioregion	N/A	Endangered	**Section 5.4.1** and **Section 8.4.3**
Coastal Swamp Oak (*Casuarina glauca*) Forest of the South-east Queensland and New South Wales	N/A	Endangered	**Section 5.4.1** and **Section 8.4.3**
Pimelea spicata	Spiked Rice-flower	Endangered	**Section 5.4.2** and **Section 8.4.1**
Acacia pubescens	Downy Wattle	Vulnerable	
Acacia bynoeana	Bynoe's Wattle	Vulnerable	

Title of MNES/Scientific Name	Common name (if applicable)	Status under the EPBC Act	Where addressed in this report
Allocasuarina glareicola		Endangered	
Cynanchum elegans	White-flowered Wax Plant	Endangered	
Grevillea parviflora subsp. *parviflora*	Small-flower Grevillea	Vulnerable	
Persoonia nutans	Nodding Geebung	Endangered	
Anthochaera phrygia	Regent Honeyeater	Critically Endangered	**Section 5.4.2** and **Section 8.4.2**
Litoria aurea	Green and Golden Bell Frog	Vulnerable	
Chalinolobus dwyeri	Large-eared Pied Bat	Vulnerable	

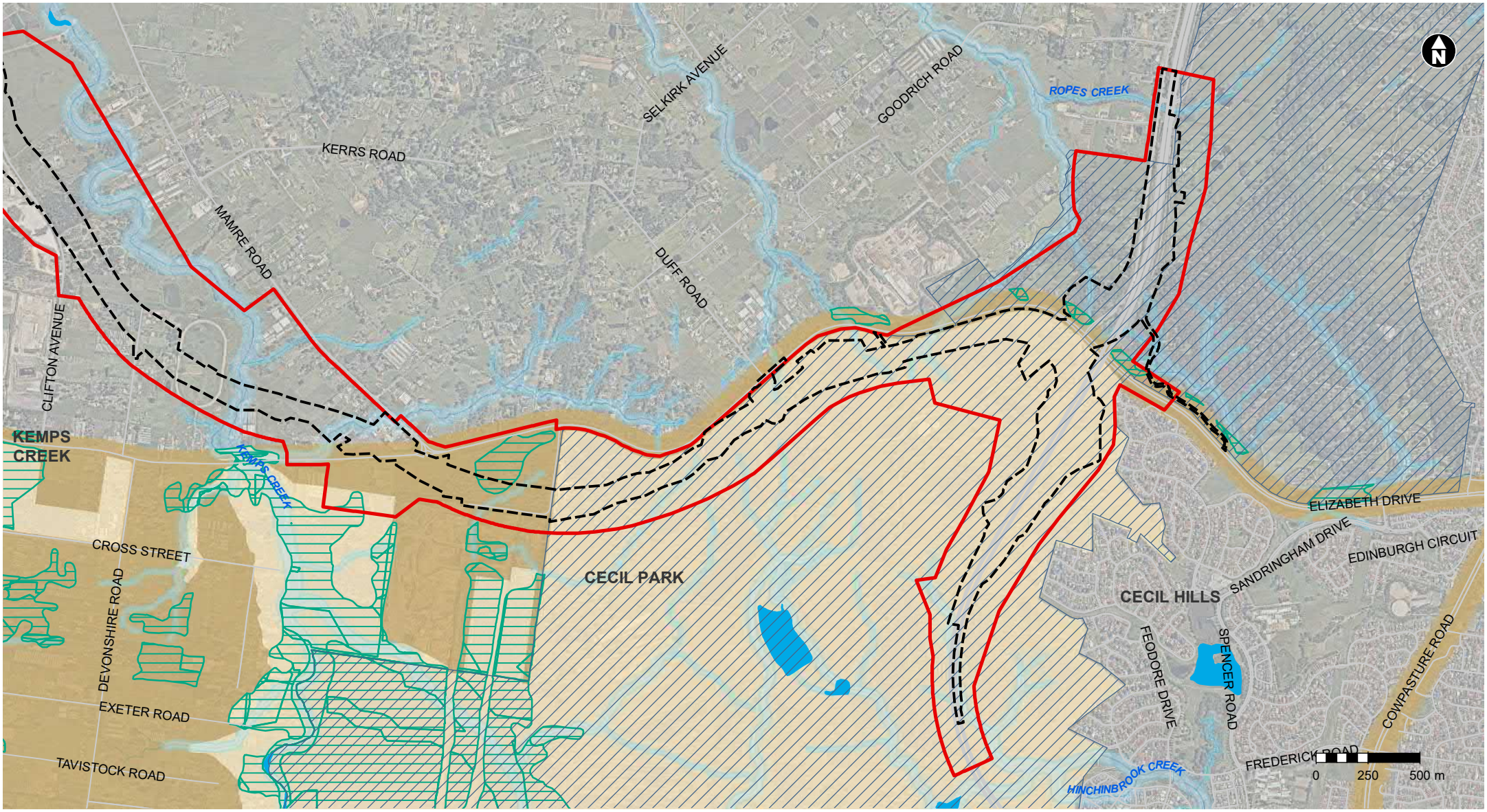
1.4.5 Sydney growth centres SEPP and biodiversity certification

The State Environmental Planning Policy (Sydney Region Growth Centres 2006) (Growth Centres SEPP) aims to co-ordinate the release of land for residential, employment and other urban development in the North West and South West Growth Centres of the Sydney region.

On 11 December 2007, an order conferring biodiversity certification on the Sydney Growth Centres SEPP was made by the Commonwealth Minister for the Environment under Section 126G of the TSC Act. Under the terms of the Biodiversity Certification Order, any developments or activities proposed to be undertaken within certified areas do not need to undertake assessment of impacts on threatened species, populations and ecological communities, or their habitats, that would normally be required by Parts 3, 4 or 5 of the EP&A Act. Development within non-certified land within the Growth Centres requires assessment under normal legislative requirements. Non-certified areas in the Growth Centres are identified on the maps in Schedule 2 of the Biodiversity Certification Order.

The Growth Centres SEPP requires proponents to implement an ‘avoid, minimise, mitigate and offset’ hierarchy during project development. Offsets within certified areas in the Growth Centres SEPP are offset at about 1:1 (GCC, 2007).

The project intersects the north-eastern corner of the South West Growth Centre as defined under the Growth Centres SEPP. Of the 83.5 hectares of the South West Growth Centre within the construction footprint, 66.15 hectares consists of non-certified land and 17.38 hectares consists of certified land (see **Figure 1-3**). The areas of non-certified land within the construction footprint are all located in Western Sydney Parklands. The areas of certified land within the construction footprint consist of a linear corridor adjoining Elizabeth Drive, as well as the land south of Elizabeth Drive and west of Range Road.



Study area corridor
The project construction footprint
Waterways
Western Sydney Parklands
Existing Native Vegetation (ENV)
South West Growth Centre Biodiversity Certification
Certified areas
Non-certified areas

*Entire map extent is covered by the IBRA 7 Region - Sydney Basin,and IBRA 7 Subregion - Cumberland. No SEPP 14 Coastal Wetlands or Ramsar Wetlands are present in the entire map extent.

Figure 1-3 Location of project in relation to South West Growth Centre Biodiversity Certification

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The study area is also likely to fall within the Cumberland Plain Conservation Plan (CPCP) area which is currently being developed. This is a strategic conservation planning tool designed to strike a balance between delivering positive environmental outcomes and supporting appropriate development over the next 38 years. At time of writing, the Terms of Reference for this plan are currently being developed based on community consultation completed in January 2019. The M12 Motorway falls within the geographic area of the CPCP but is not part of the activities assessed by it.

1.4.6 Commonwealth strategic assessment

The DPIE (Planning and Assessment) in consultation with the DoEE, undertook a strategic assessment under the EPBC Act of the Sydney Growth Centres Program (the Program) (DoP, 2010). The Commonwealth Minister endorsed the Program document in December 2011, and subsequently approved all actions associated with the development of the Western Sydney Growth Centres as described in the Strategic Assessment Program Report on 28 February 2012. The Strategic Assessment relies on the information in the Growth Centres Draft Conservation Plan (ELA, 2007) to evaluate the impacts to native vegetation in the Growth Centres.

The Program builds upon the Biodiversity Certification for the Growth Centres SEPP conferred in 2007 under the TSC Act and specifies a range of additional measures that specifically target MNES listed under the EPBC Act. In particular, the program requires the NSW Government to ensure that:

- A minimum of 998 hectares of Cumberland Plain Shale Woodlands and Shale Gravel Transition Forest (CPW) will be retained and protected within the Growth Centres, including a minimum of 363 hectares of high management viability (HMV) CPW
- At least 2,400 hectares of either CPW, or other grassy woodland communities which are similar to CPW in floristic structure, will be protected outside of the Growth Centres. As part of this commitment at least 205 hectares of additional HMV CPW will be protected outside of the Growth Centre.

High management viability (HMV) vegetation is defined in the Growth Centres Draft Conservation Plan as areas that are endangered ecological community (EEC), in good condition based on existing regional mapping, greater than four hectares in size, with good landscape connectivity and less likely to be impacted by surrounding land use threats.

1.4.7 Western Sydney Parklands

The State Environmental Planning Policy (Western Sydney Parklands) 2009 (Parklands SEPP) establishes planning controls for the Western Sydney Parklands so it can be developed into a multi-use urban parkland for the region of western Sydney.

In determining a development application for development on land in the Western Parklands, the consent authority must consider a number of matters as identified in Clause 12 of the Parklands SEPP. The matters relevant to biodiversity assessment, and the section of the BAR where each matter is addressed, are listed in **Table 1-4**.

Table 1-4 Matters to be considered by the consent authority under Clause 12 of the Parklands SEPP

Matters to be considered by the consent authority	Where addressed in this report
(d) the impact of carrying out the development on environmental conservation areas and the natural environment, including endangered ecological communities,	**Section 8**
(e) the impact on the continuity of the Western Parklands as a corridor linking core habitat such as the endangered Cumberland Plain Woodland,	**Section 8**
(i) consistency with: (i) any plan of management for the parklands, that includes the Western Parklands, prepared and adopted under Part 4 of the Western Sydney Parklands Act 2006, or (ii) any precinct plan for a precinct of the parklands, that includes the Western Parklands, prepared and adopted under that Part,	**This section (see below)**

Matters to be considered by the consent authority	Where addressed in this report
(l) the effect on drainage patterns, ground water, flood patterns and wetland viability,	**Section 8**

Clause 14 of the Parkland SEPP specifies that development consent must not be granted to development on land in the Western Sydney Parklands that is in, or adjoins, a nature reserve or any environmental conservation area shown on the Environmental Conservation Areas Map attached to the SEPP, unless the consent authority has considered the following:

(a) whether the development is compatible with and does not detract from the values of the nature reserve or environmental conservation area,

(b) any management plans applicable to the nature reserve or environmental conservation area,

(c) whether the development has been designed and sited to minimise visual intrusion when viewed from vantage points in the nature reserve or environmental conservation area.

The Environmental Conservation Areas Map shows the area to the north-east of the intersection of the M7 and Elizabeth Drive as mapped within an Environmental Conservation Area; the construction footprint overlaps about 1.87 hectares within the mapped Environmental Conservation Area (**Figure 1-4**).

The Western Sydney Parklands Plan of Management 2030 (WSP PoM) (Western Sydney Parklands Trust, 2018) provides a framework for the operation and development of the Western Sydney Parklands. The WSP PoM identifies 16 precincts within the Western Sydney Parklands, with boundaries defined by each precinct's character, context, land use and functions. The construction footprint overlaps four precincts:

- Precinct 10 (Abbotsbury – located north-east of the intersection of the M7 Motorway and Elizabeth Drive
- Precinct 11 (Cecil Park North) – located north-west of the intersection of Wallgrove Road and Elizabeth Drive
- Precinct 12 (Cowpasture) – located to the south-east of the intersection of the M7 Motorway and Elizabeth Drive
- Precinct 14 (Cecil Park) – located to the south-west the intersection of the M7 Motorway and Elizabeth Drive.

Most of Precincts 10 and 12 are mapped as bushland corridor, with the central portion of Precinct 11 and the easternmost part of Precinct 14 also mapped as a bushland corridor. The construction footprint contains about 17.2 hectares mapped as bushland corridor within the Western Sydney Parklands (**Figure 1-4**). Bushland corridor is defined in the WSP PoM as (p84):

> *Bushland and waterways set aside to improve biodiversity, create habitat, link habitat and enhance the viability of gazetted conservation lands. The Corridor can include both unstructured and structured recreation activities.*

The project is acknowledged in the WSP PoM, within sections on Precinct 11 (Cecil Park North) and Precinct 14 (Cecil Park).

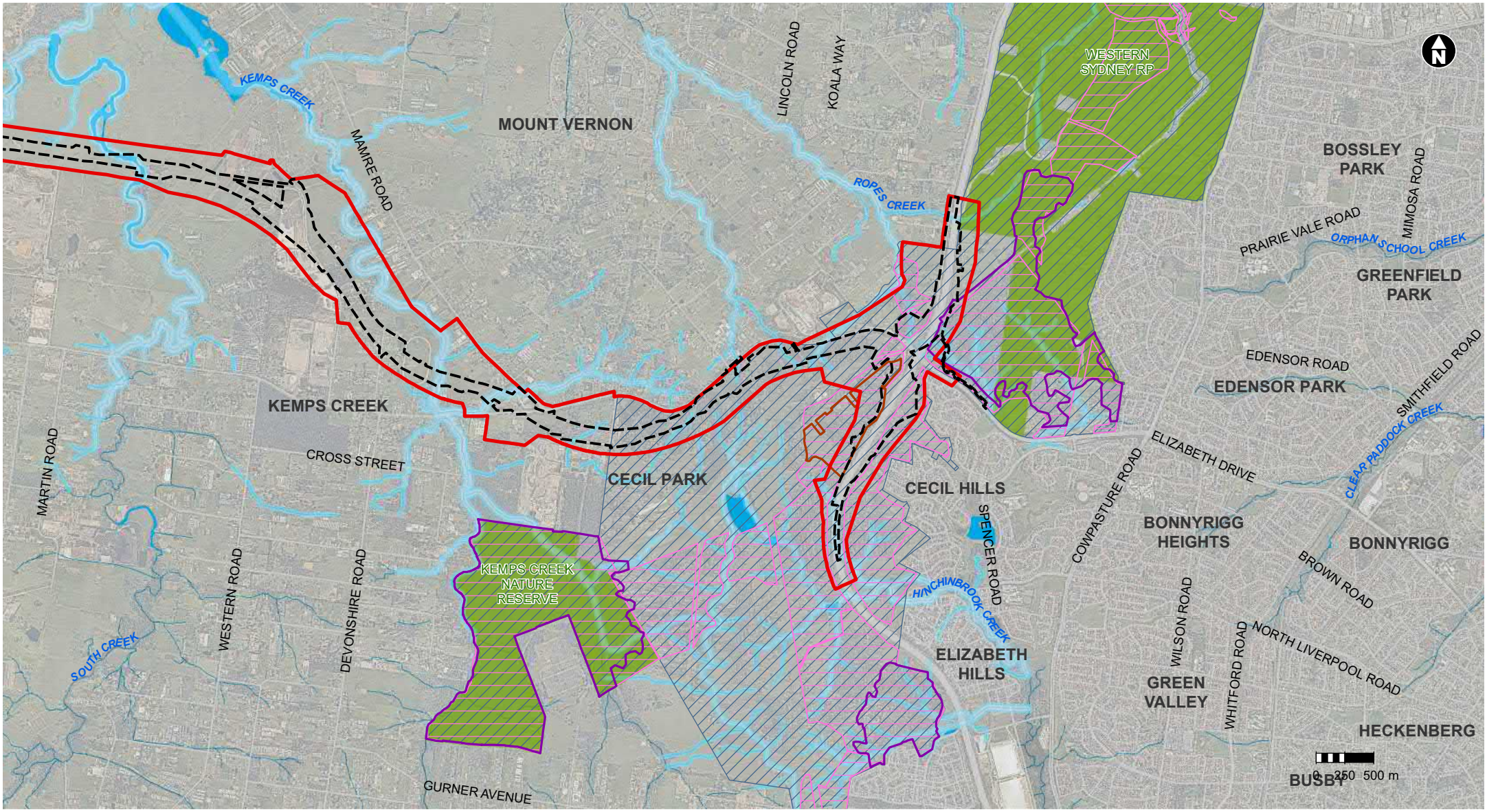
The 'desired future character' description for Precinct 11 states:

> *Allowance will be made for the future M12 Motorway corridor and associated infrastructure, if required.*

The objectives for Precinct 14 include:

> *Minimise impacts on the natural and recreational qualities of the precinct when providing future service infrastructure such as the M12 Motorway corridor.*

The impacts of the project on areas of native vegetation within the Western Sydney Parklands are assessed and offset in accordance with the FBA, as documented in this BAR.



Study area corridor
The project construction footprint
Waterways
Western Sydney Parklands
Biobank site
Environmental Conservation Area (Parklands SEPP)
Bushland Corridor (Western Sydney Parklands PoM)
Riparian buffer area
NPWS Reserves

*Entire map extent is covered by the IBRA 7 Region - Sydney Basin,and IBRA 7 Subregion - Cumberland. No SEPP 14 Coastal Wetlands or Ramsar Wetlands are present in the entire map extent.

Figure 1-4 Location of project in relation to Western Sydney Parklands

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2 Landscape features

2.1 Study area

The study area for field survey purposes and subject to this assessment is shown on **Figure 2-1**. The study area used for database searches and desktop landscape assessment is broader than this and included an area up to about 10 kilometres from the project. This broader study area is used for the purposes of review of regional vegetation mapping and searches for previously recorded threatened species.

The study area is located about 30 kilometres west of the Sydney central business district (CBD). The study area falls within three local government areas (LGAs), Penrith and Fairfield to the north of Elizabeth Drive and Liverpool to the south of Elizabeth Drive. It extends west from the M7 Motorway and Western Sydney Parklands, and traverses the suburbs of Abbotsbury, Cecil Park, Cecil Hills, Kemps Creek, Badgerys Creek and Luddenham.

The study area is predominately located in greenfield areas. The topography in and around the study area comprises rolling hills and small valleys between generally north–south ridge lines. Existing land uses in the study area are semi-rural residential, recreational and community facilities, agricultural, commercial and industrial. The Western Sydney Employment Area (WSEA) is located around six kilometres north-north-east of the study area.

A portion of Western Sydney Parklands located to the south-west of the M7 Motorway and Elizabeth Drive intersection is the subject of a Biobanking agreement under Part 7A Division 2 of the TSC Act. This Biobank site (ID number 119) is about 32.2 hectares in area, of which the eastern 17.06 hectares is within the study area. Of that 17.06 hectares, about 2.89 hectares is within the construction footprint, directly impacting a strip along the eastern boundary of the Biobank site, ranging from about 10 metres to 80 metres wide (**Figure 2-1**).

2.2 Development site

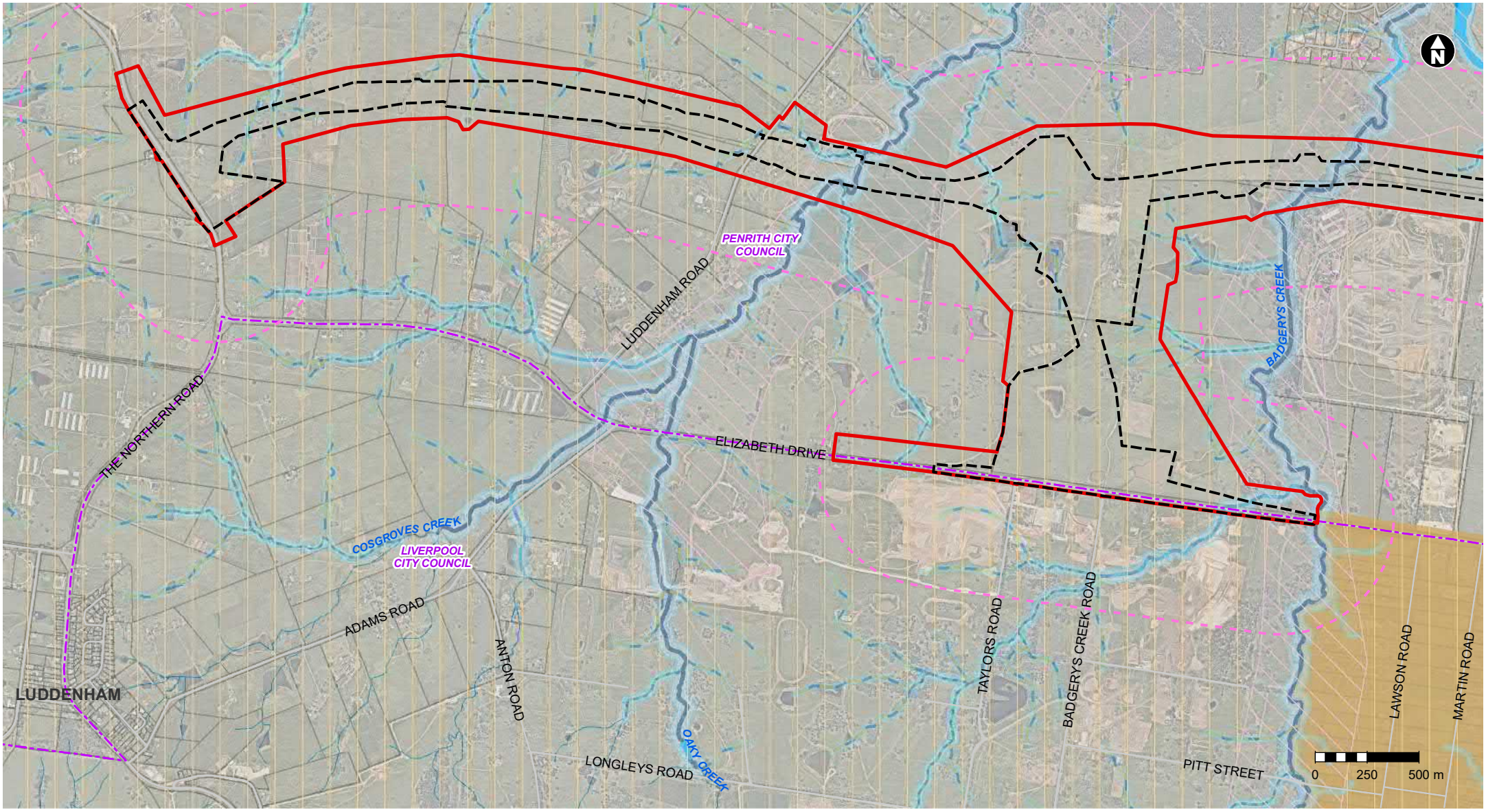
Under the FBA (OEH, 2014b), the area subject to impact assessment is referred to as the ‘development site’. In this assessment, the development site is considered to encompass the construction footprint (**Figure 2-2**). For the purpose of this BAR, the term construction footprint has been used to be consistent with the overall environmental assessment of the project.

2.3 Identified features

2.3.1 Interim Biogeographic Rationalisation for Australia bioregions and subregions

The study area is located within the Cumberland sub-region of the Sydney Basin Interim Biogeographic Regionalisation for Australia (IBRA) Bioregion.

Morgan (2001) describes the Cumberland sub-region as situated in a rain shadow area between the Blue Mountains and east coast on low rolling hills and valleys. The geology is dominated by Triassic Wianamatta groups shales and sandstones with Quaternary alluvium present along the main streams. Soils consist of red and yellow texture contrast soils on slopes, becoming harsher and salt affected in tributary valley floors. The soil landscapes within the study area include South Creek, Luddenham, Picton and Blacktown (Hazelton, et al., 1989). Vegetation associated with the Cumberland sub-region include woodlands dominated by *Eucalyptus moluccana*, *E. tereticornis* and *E. crebra* on the shale hills and *Angophora subvelutina, E. amplifolia* and *E. tereticornis* with abundant *Casuarina glauca* on river flats. Lagoons and swamps in this area are often dominated by *Eleocharis sphacelata* with *Eucalyptus parramattensis* (Morgan, 2001).



Study area corridor
The project construction footprint
550m landscape assessment buffer
Local government area
Riparian buffer area
Cadastre

Mitchell Landscapes (OEH, 2016)
Cumberland Plain
Georges River Alluvial Plain
Hawkesbury - Nepean Channels and Floodplains

Western Sydney Parklands
Biodiversity certified land
NPWS Reserves

Waterways (Strahler)
First order
Second order
Third order
Fourth order, and above

*Entire map extent is covered by the IBRA 7 Region - Sydney Basin,and IBRA 7 Subregion - Cumberland. No SEPP 14 Coastal Wetlands or Ramsar Wetlands are present in the entire map extent.

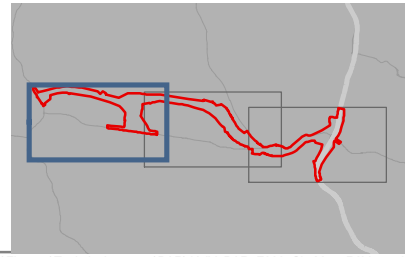


Figure 2-1 Site map

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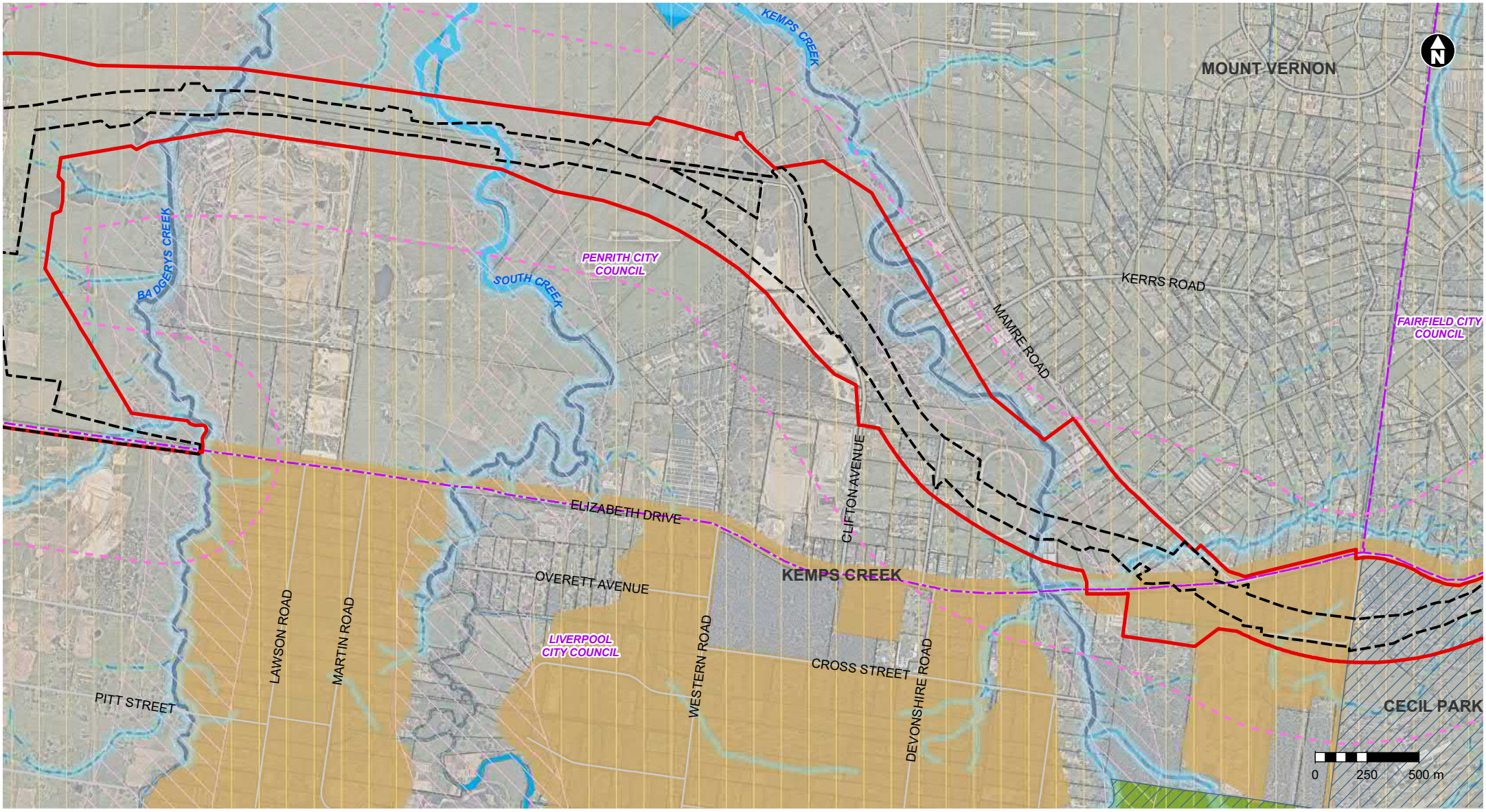

Study area corridor
The project construction footprint
550m landscape assessment buffer
Local government area
Riparian buffer area
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Mitchell Landscapes (OEH, 2016)
Cumberland Plain
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Western Sydney Parklands
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NPWS Reserves

Waterways (Strahler)
First order
Second order
Third order
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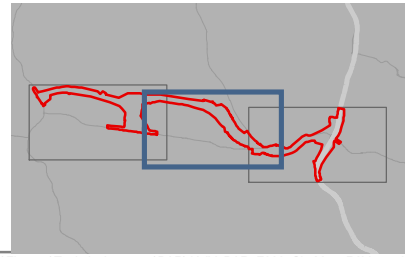

Figure 2-1 Site map

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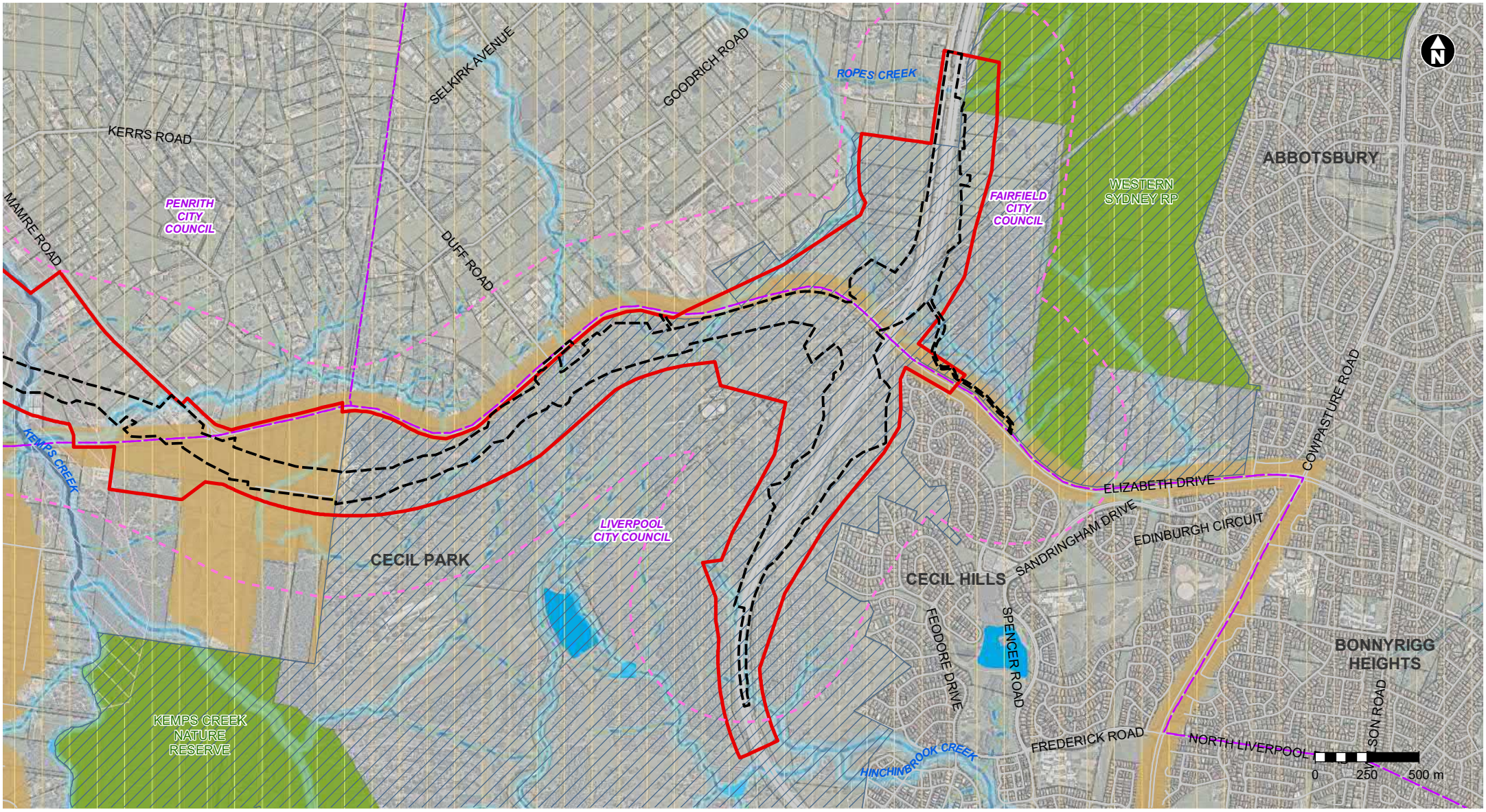

Study area corridor
The project construction footprint
550m landscape assessment buffer
Local government area
Riparian buffer area
Cadastre

Mitchell Landscapes (OEH, 2016)
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Biodiversity certified land
NPWS Reserves

Waterways (Strahler)
First order
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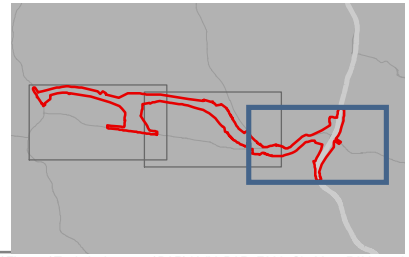

Figure 2-1 Site map

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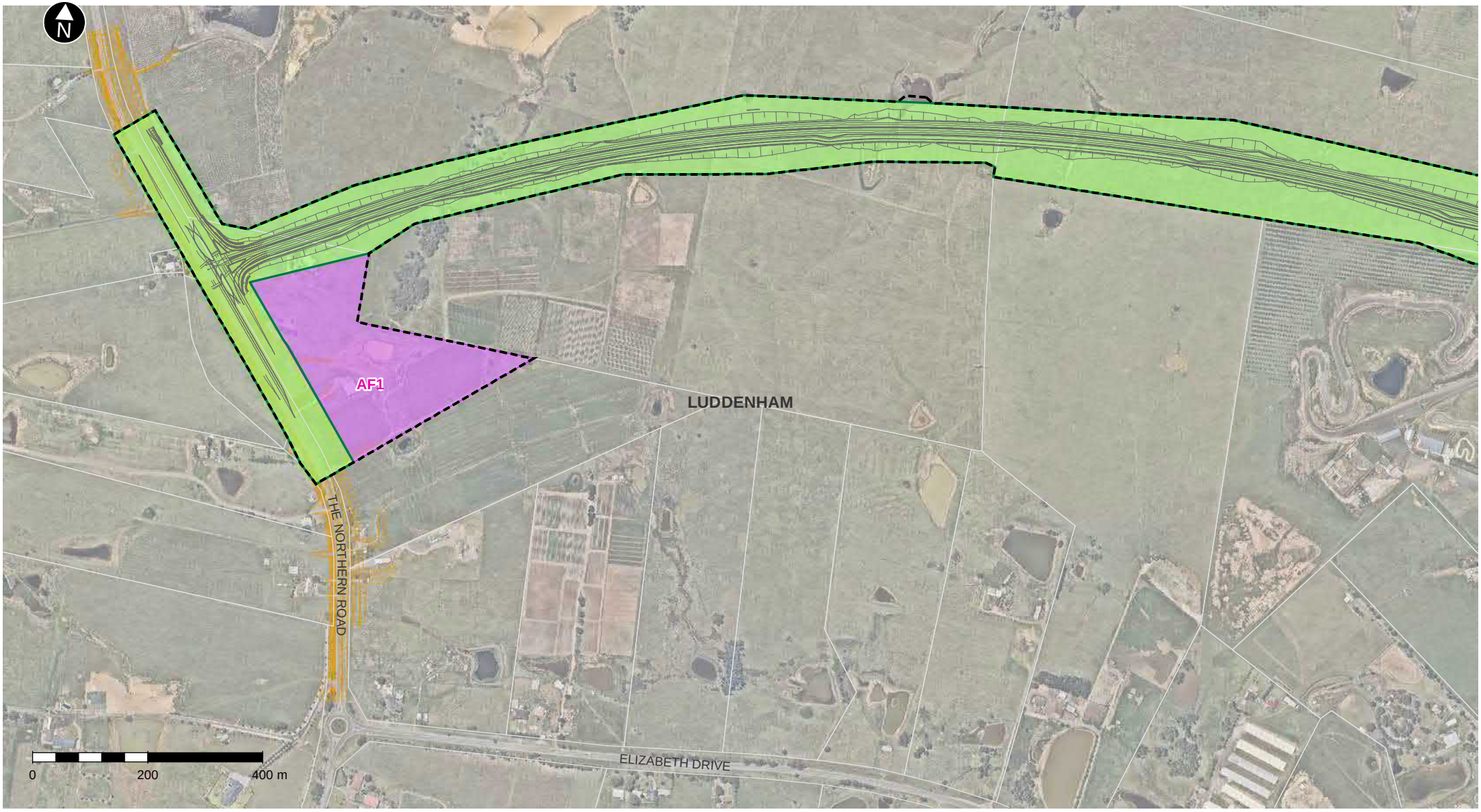

Figure 2-2 Operational and construction footprints

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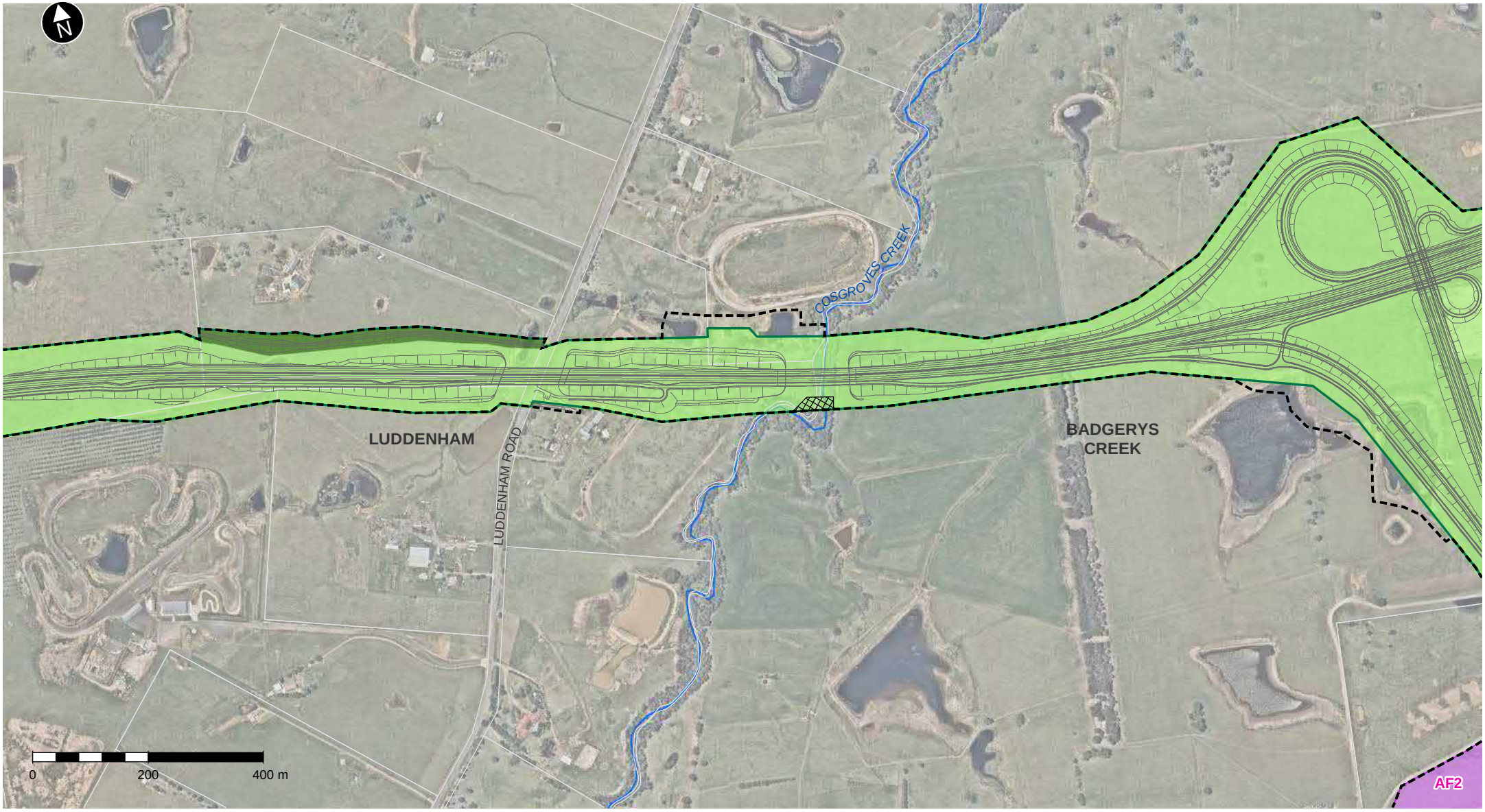

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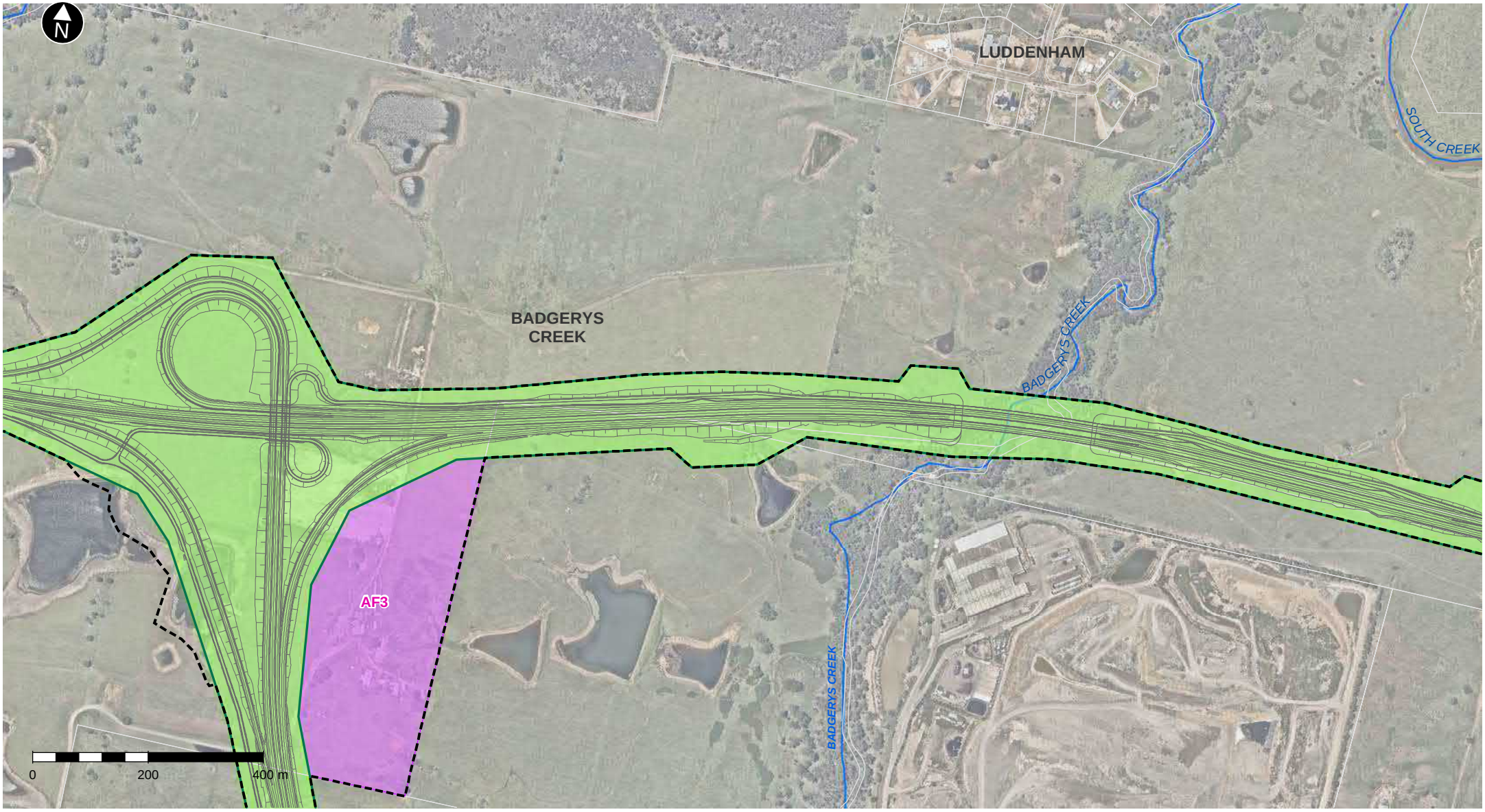

Figure 2-2 Operational and construction footprints

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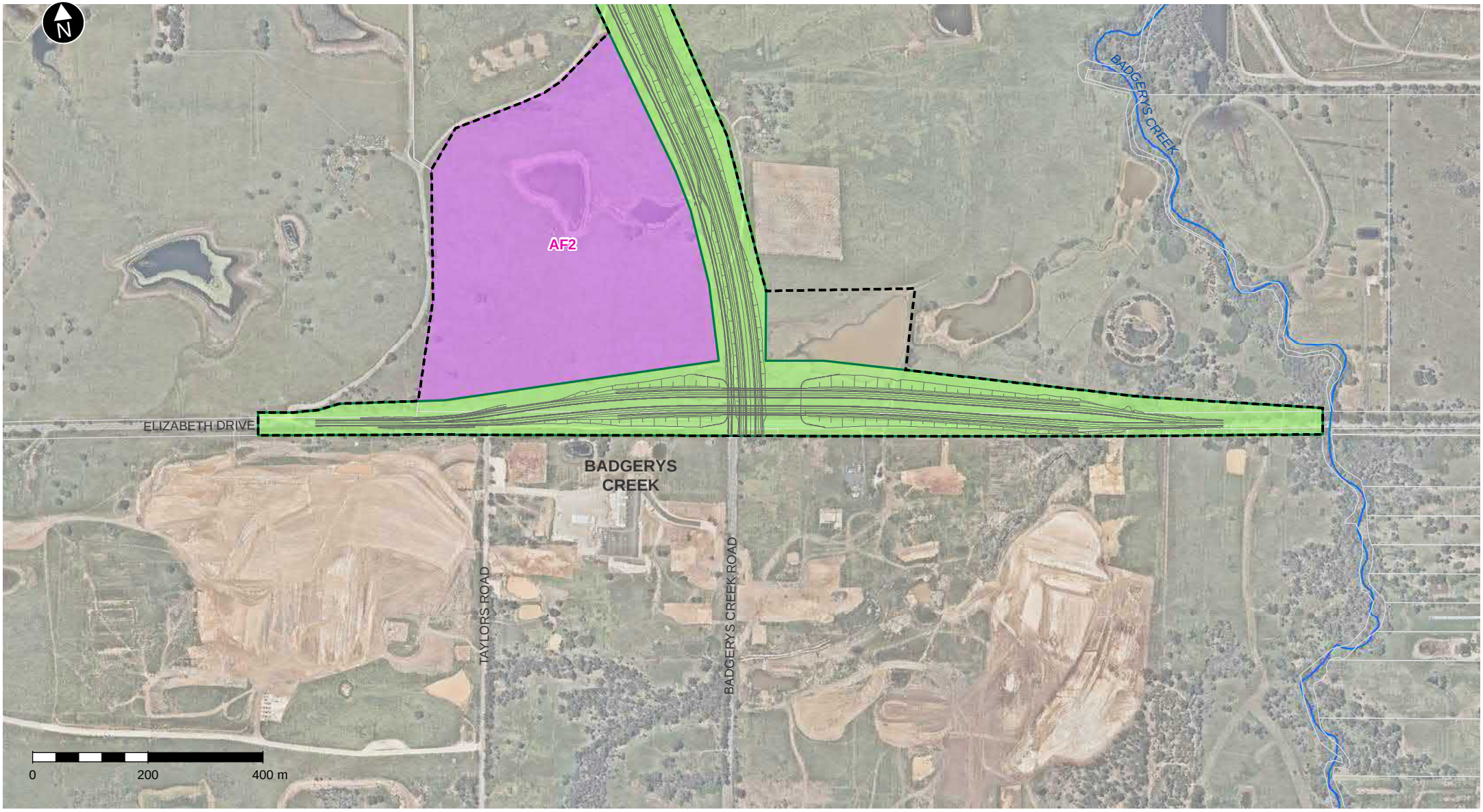

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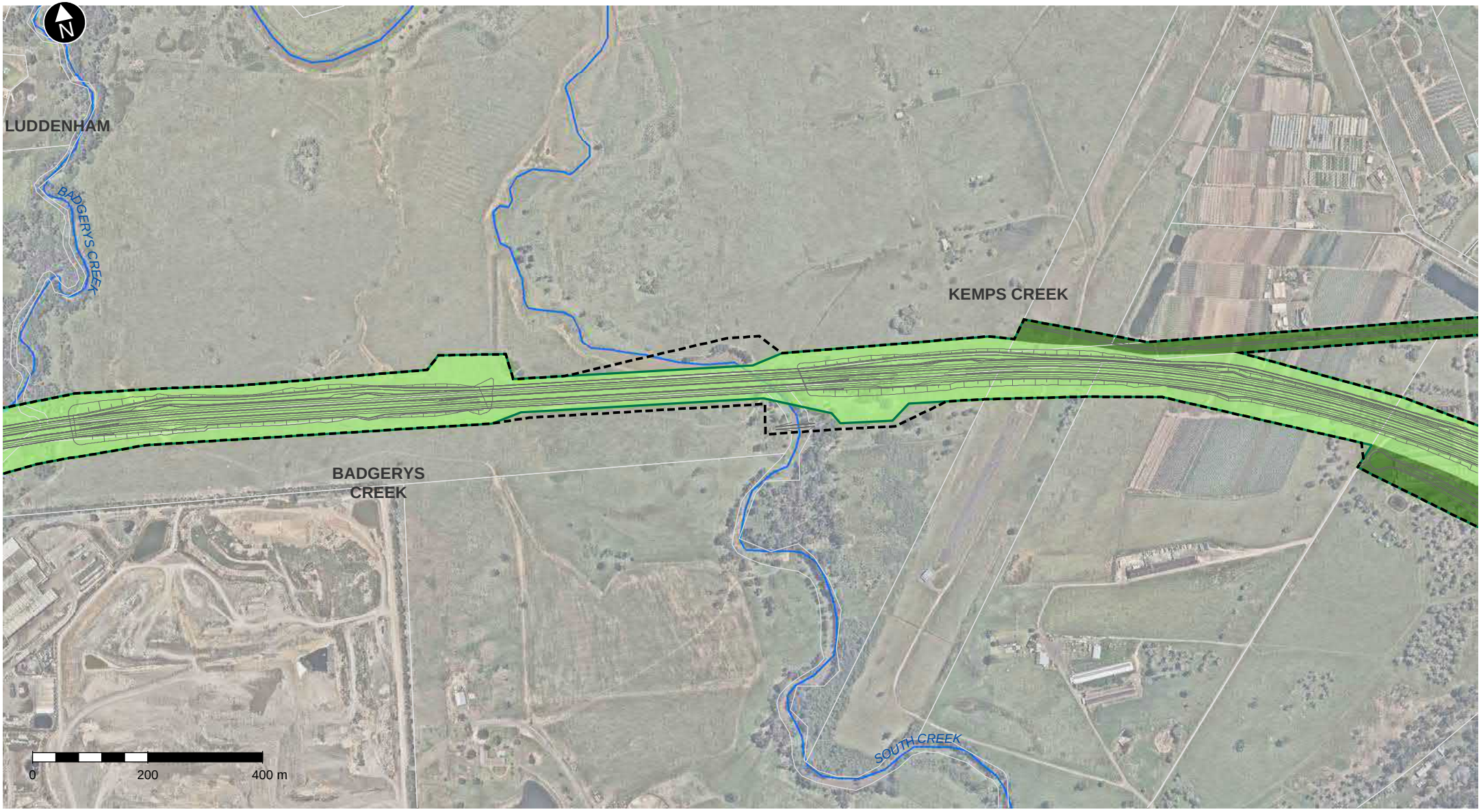

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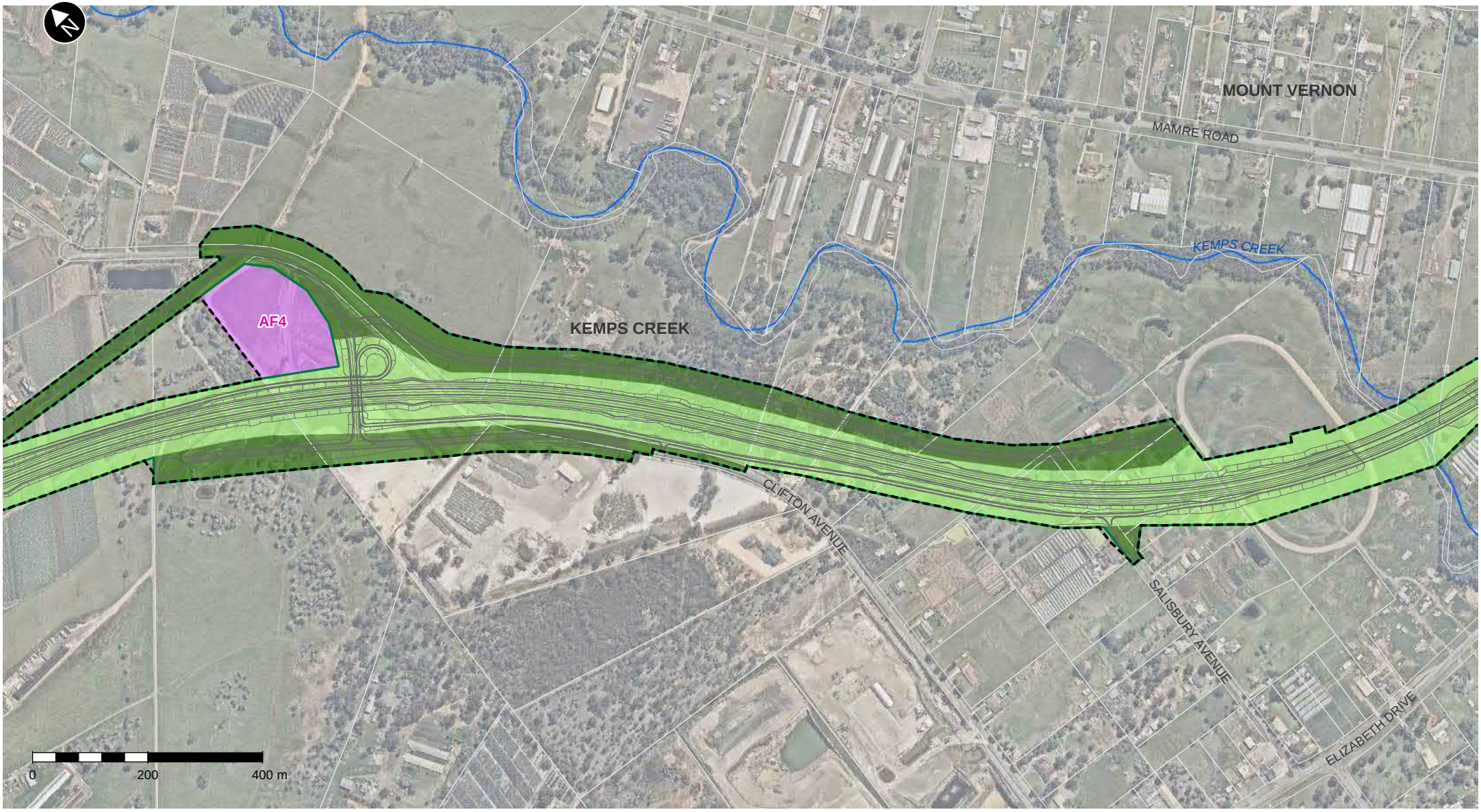

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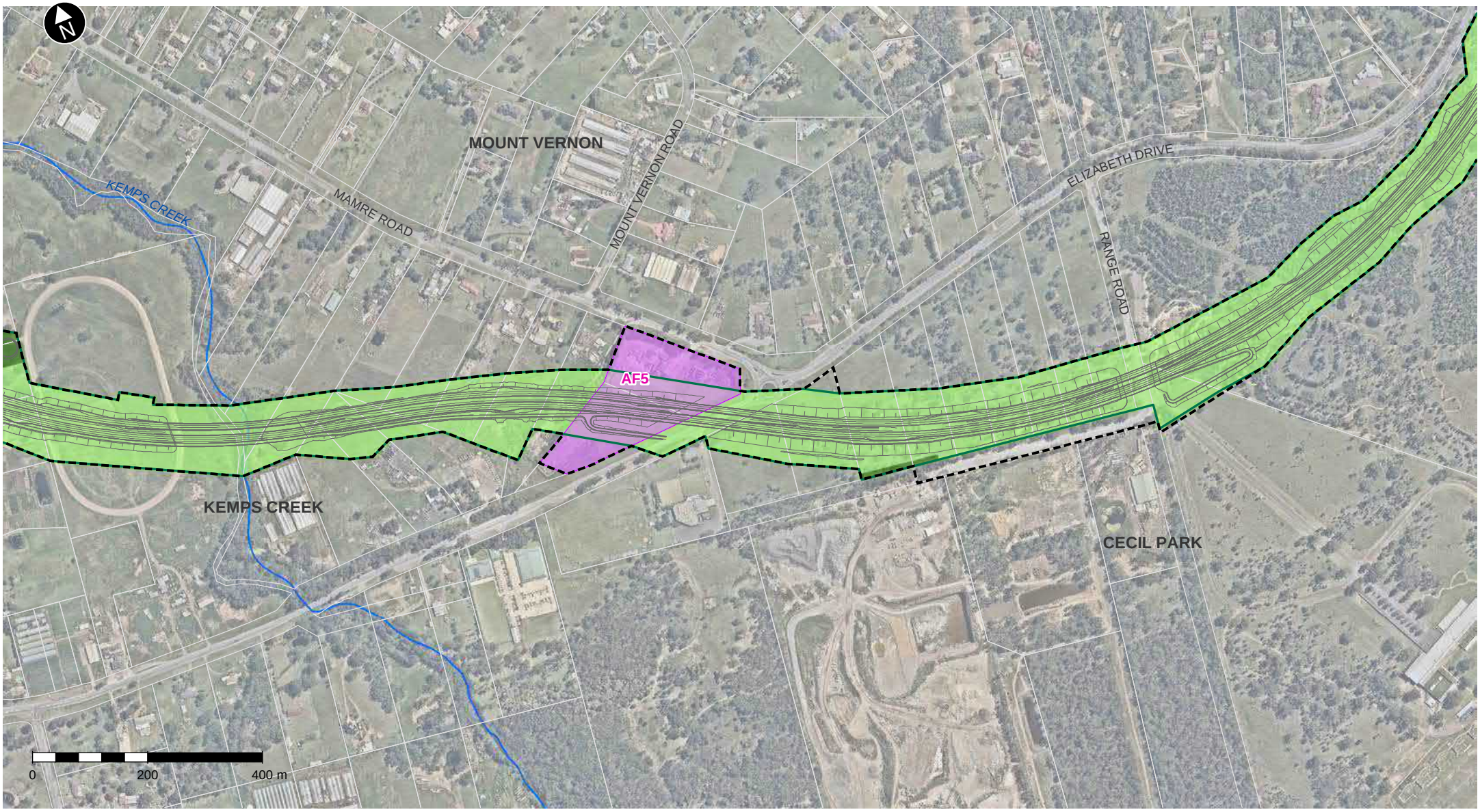

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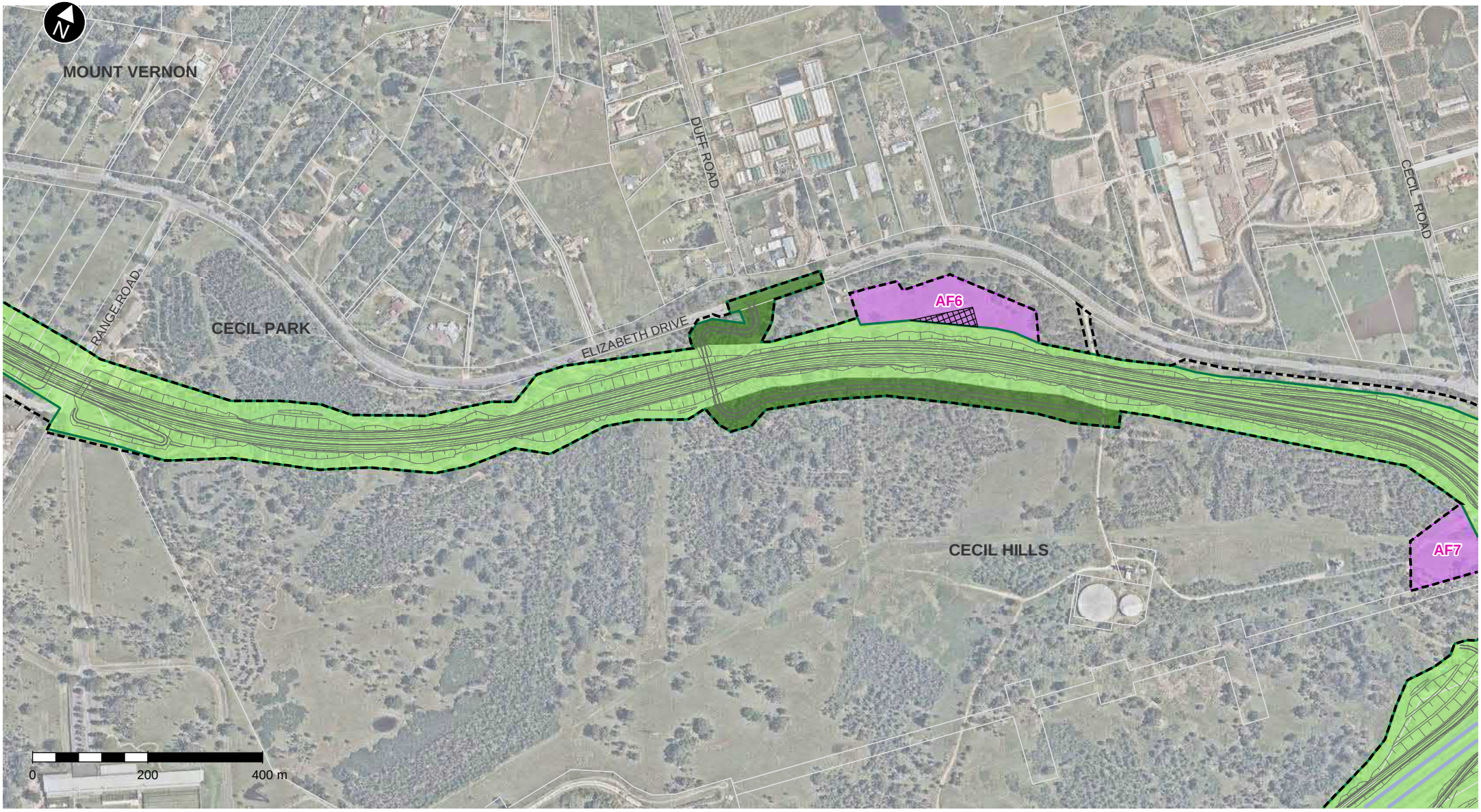

The project
Cadastre

Construction footprint
The project construction footprint
Ancillary facilities
Exclusion zones

Operational footprint
The project operational footprint
RMS road reserve
Proposed permanent work areas

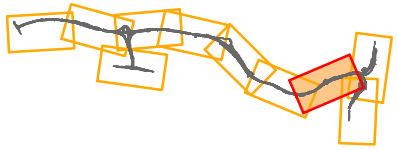

Figure 2-2 Operational and construction footprints

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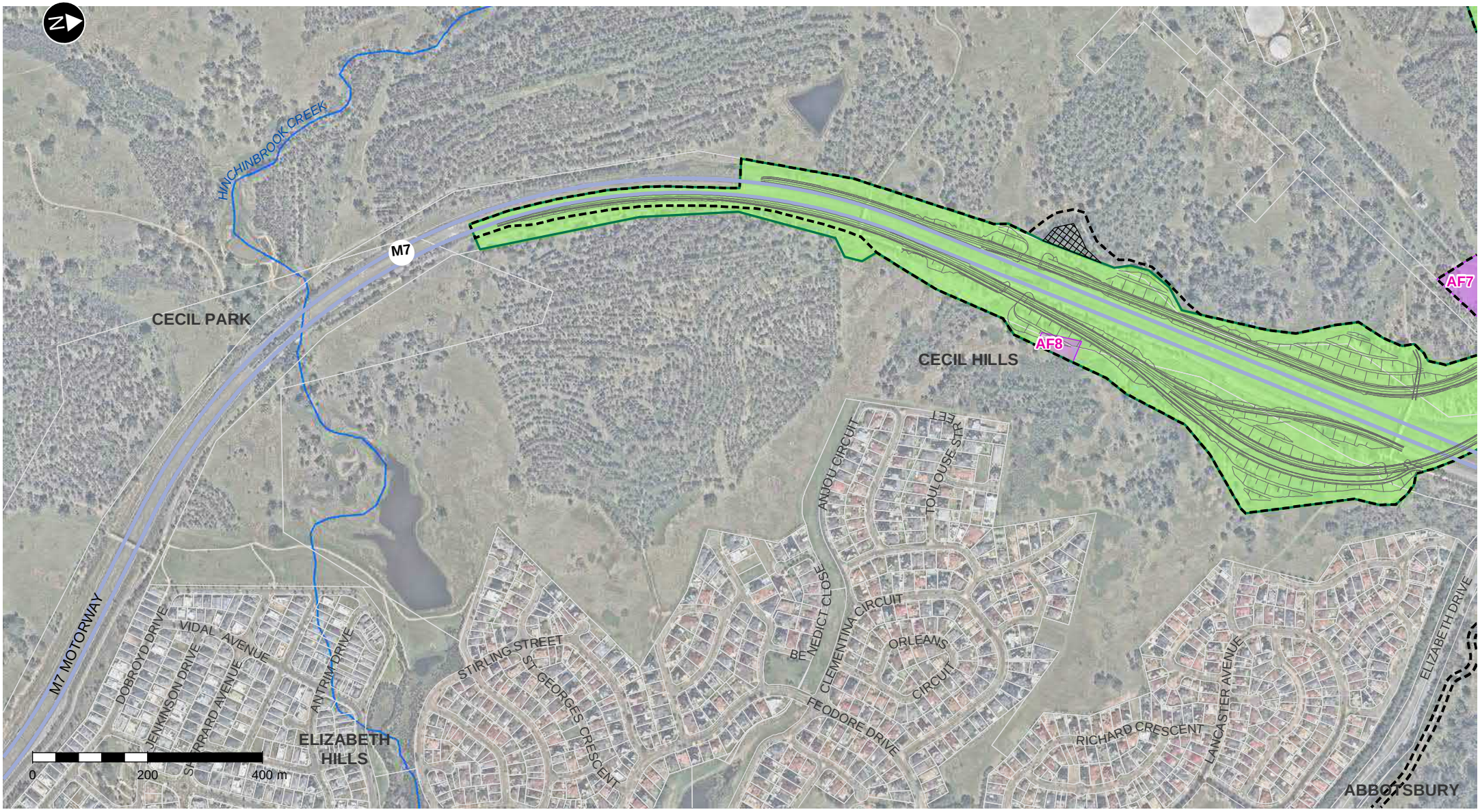


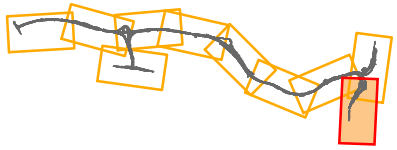
The project
Waterways
Cadastre

Construction footprint

The project construction footprint
Ancillary facilities
Exclusion zones

Operational footprint

The project operational footprint
RMS road reserve



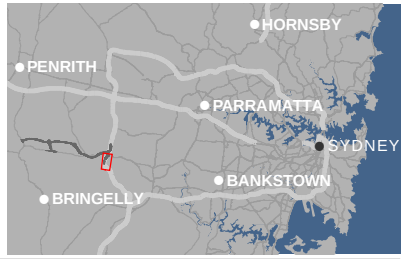


Figure 2-2 Operational and construction footprints

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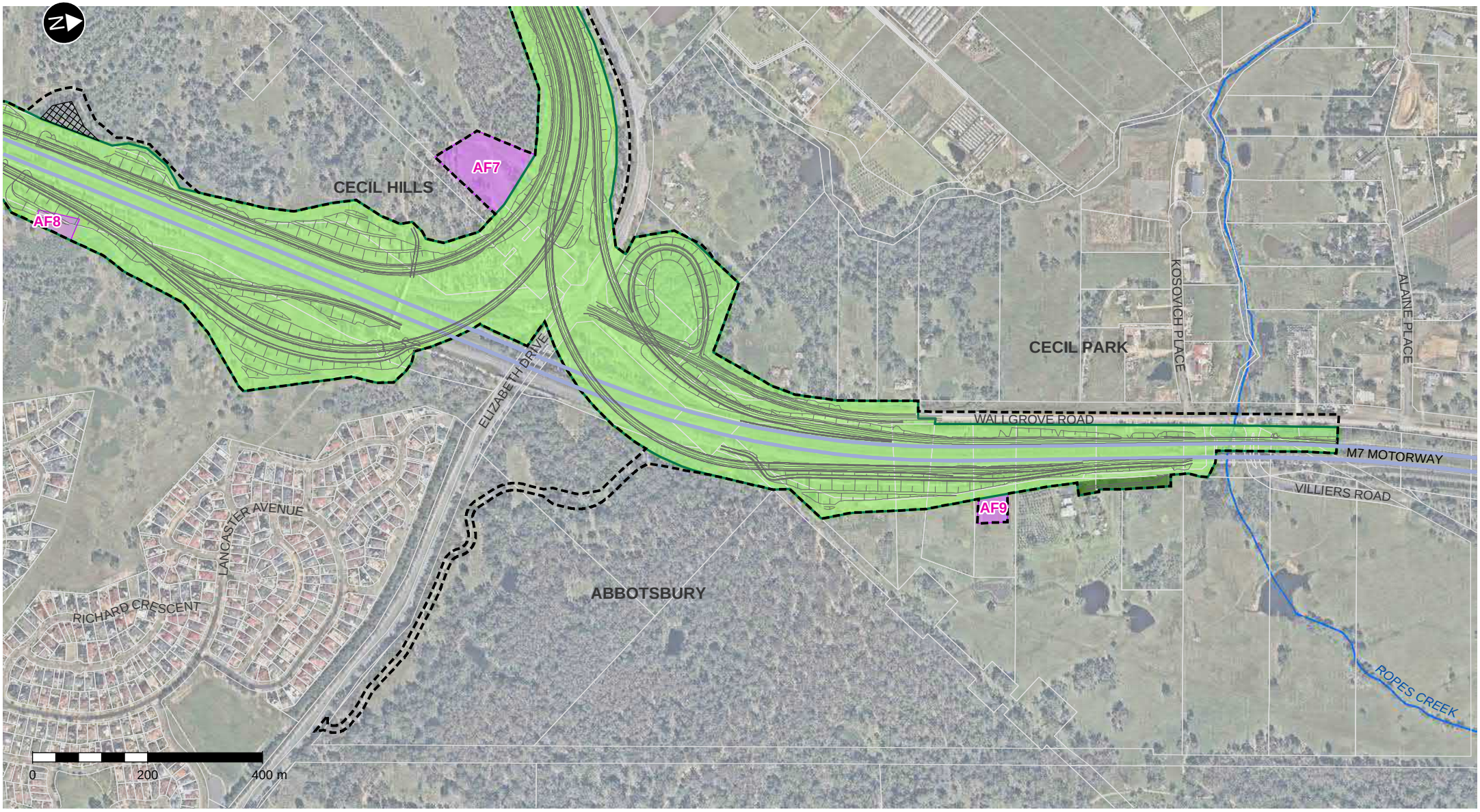


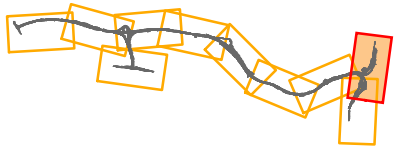
The project
Waterways
Cadastre

Construction footprint

The project construction footprint
Ancillary facilities
Exclusion zones

Operational footprint

The project operational footprint
RMS road reserve
Proposed permanent work areas



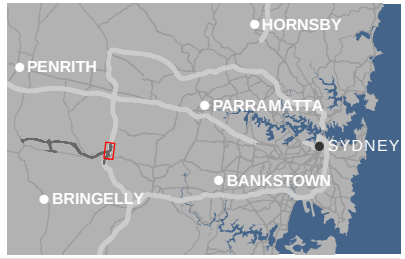


Figure 2-2 Operational and construction footprints

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2.3.2 NSW Landscape Regions (Mitchell landscapes)

The study area is largely situated within the Cumberland Plain Mitchell Landscape with sections of the study area also situated on the Hawkesbury – Nepean Channels and Floodplains as mapped by the NSW National Parks and Wildlife Service (NSW NPWS, 2002).

The Cumberland Plain Mitchell Landscape is an over-cleared landscape with 89 per cent of the landscape currently cleared. It is situated in a rain shadow area between the coast and the Blue Mountains on Triassic shales and lithic sandstones. The landscape consists of low rolling hills and valleys with woodlands and open forests dominated by *Eucalyptus tereticornis* Forest Red Gum, *E. moluccana* Grey Box, *E. crebra* Narrow-leaved Ironbark and *E. amplifolia* Cabbage Gum. The understory is grassy to shrubby and often dominated by *Bursaria spinosa* Australian Boxthorn while valley floors are poorly drained, and salt affected, with *Casuarina glauca* Swamp Oak abundant.

The Hawkesbury – Nepean Channels and Floodplains Mitchell Landscape is an over-cleared landscape with 79 per cent of the landscape currently cleared. It consists of the meandering channel and wide floodplain of the Hawkesbury and Nepean rivers on Quaternary sand and gravel. On the river flats, forests are present with the tree species *Eucalyptus baueriana* Blue Box*, E. viminalis* Ribbon Gum and *Angophora subvelutina* Broad-leaved Apple*.* River flat forests are present on floodplains with a canopy of *Eucalyptus saligna* Sydney Blue Gum*, E. deanei* Mountain Blue Gum*, E. tereticornis* Forest Red Gum and *E. amplifolia* Cabbage Gum (NSW NPWS, 2002).

2.3.3 Soils and geology

Four soil landscapes are mapped across the study area; Luddenham, Picton, Blacktown and South Creek (OEH, 2018b). There is also a small patch of Disturbed Terrain near the corner of Mamre Road and Elizabeth Drive. The study area is evenly split between three soil types: Luddenham, Blacktown and South Creek. South Creek and Blacktown occur together throughout the central portion of the study area and Luddenham occurs at the western and eastern end of the study area. A small area of Picton soil landscape occurs in the east of the study area, adjoining Elizabeth Drive, to the east of the M7 Motorway.

The Luddenham soil landscape is associated with undulating to rolling low hills on Wianamatta Group shales, often associated with Minchinbury Sandstone. Soils are shallow to moderately deep (greater than 100 centimetres) hardsetting mottled texture contrast soils, red and brown podzolic soils on crests grading to yellow podzolic soils on lower slopes and in drainage lines (Hazelton, et al., 1989) (Clarke & Jones, 1991).

The Blacktown soil landscape is associated with gently undulating rises on Wianamatta Group shales (Ashfield Shale consisting of laminite and dark grey siltstone, Bringelly Shale which consists of shale with occasional calcareous claystone, laminite and infrequent coal, and Minchinbury Sandstone consisting of fine to medium-grained quartz lithic sandstone). Soils are shallow to moderately deep (greater than 100 centimetres) hardsetting mottled texture contrast soils, red and brown podzolic soils on crests grading to yellow podzolic soils on lower slopes and in drainage lines (Hazelton, et al., 1989) (Clarke & Jones, 1991).

The South Creek soil landscape is associated with floodplains, valley flats and drainage depressions of the channels on the Cumberland Plain. South Creek landscape is usually flat with incised channels; mainly cleared. Soils are often very deep layered sediments over bedrock or relict soils. Where pedogenesis has occurred, structured plastic clays or structured loams in and immediately adjacent to drainage lines; red and yellow podzolic soils are most common terraces with small areas of structured grey clays, leached clay and yellow solodic soils (Hazelton, et al., 1989) (Clarke & Jones, 1991).

The Picton soil landscape is associated with steep low hills on fine textured Wianamatta Group shales and shale colluvial materials usually with a southerly aspect. Soils are shallow to deep (50-200 cm) red and brown podzolic soils on upper slopes, brown and yellow podzolic soils on colluvial material, and yellow podzolic soils on lower slopes and in drainage lines (Hazelton, et al., 1989) (Clarke & Jones, 1991).

2.3.4 Rivers and streams

The project traverses a large part of the Lower Nepean River Management Zone of the Hawkesbury and Lower Nepean Rivers Water Source. The catchment covers much of the Cumberland Plain, generally flowing from south to north, towards the Hawkesbury River. The catchment is relatively flat with rolling shale hills.

The project would cross a number of major creeks (major permanently or intermittently flowering waterways), first order streams (top of a catchment with headwater flow paths), second order streams (downstream of the junction of two first order streams), unnamed tributaries and drainage lines (sometimes associated with farm dams) including:

- Unnamed tributary of Cosgroves Creek – second order stream
- Cosgroves Creek – fourth order stream
- Unnamed tributary of Badgerys Creek – first order stream
- Badgerys Creek – fourth order stream
- South Creek – fifth order stream
- Unnamed tributary of South Creek – first order stream
- Kemps Creek – fourth order stream
- Unnamed tributary of Kemps Creek – third order stream
- Ropes Creek – first order stream
- Unnamed tributary of Ropes Creek – first order stream.

Two additional creeks lie within the study area or directly downstream (but outside the construction footprint) as follows:

- Hinchinbrook Creek – fourth order stream
- Unnamed tributary of Hinchinbrook Creek – second order stream.

Key fish habitat

Table 2-1 outlines the habitat types and sensitivity classes used by Regions, Industry, Agriculture and Resources Group (RIAR) of the DPIE (DPI, 2013) for assessing potential impacts of certain activities and developments on key fish habitat types. These descriptions have formed the basis for classifying the key fish habitats that have been mapped as occurring within the study area.

Table 2-1 Key fish habitat types and descriptions (adapted from the DPI, 2013 guidelines)

Habitat type	Description
TYPE 1 – Highly sensitive key fish habitat	• Posidonia australis (strapweed) • Zostera, Heterozostera, Halophila and Ruppia species of seagrass beds >5m^2 in area • Coastal saltmarsh >5m^2 in area • Coral communities • Coastal lakes and lagoons that have a natural opening and closing regime (ie are not permanently open or artificially opened or are subject to one off unauthorised openings) • Marine park, an aquatic reserve or intertidal protected area • SEPP coastal wetlands, wetlands recognised under international agreements (eg Ramsar, JAMBA, CAMBA, ROKAMBA wetlands), wetlands listed in the Directory of Important Wetlands of Australia • Freshwater habitats that contain in-stream gravel beds, rocks greater than 500 mm in two dimensions, snags greater than 300 mm in diameter or 3 m in length, or native aquatic plants • Any known or expected protected or threatened species habitat or area of declared ‘critical habitat’ under the FM Act

Habitat type	Description
TYPE 2 – Moderately sensitive key fish habitat	• Zostera, Heterozostera, Halophila and Ruppia species of seagrass beds <5m^2 in area • Mangroves • Coastal saltmarsh <5m^2 in area • Marine macroalgae such as Ecklonia and Sargassum species • Estuarine and marine rocky reefs • Coastal lakes and lagoons that are permanently open or subject to artificial opening via agreed management arrangements (eg managed in line with an entrance management plan) • Aquatic habitat within 100 m of a marine park, an aquatic reserve or intertidal protected area • Stable intertidal sand/mud flats, coastal and estuarine sandy beaches with large populations of in-fauna • Freshwater habitats and brackish wetlands, lakes and lagoons other than those defined in TYPE 1 • Weir pools and dams up to full supply level where the weir or dam is across a natural waterway
TYPE 3 – Minimally sensitive key fish habitat	• Unstable or unvegetated sand or mud substrate, coastal and estuarine sandy beaches with minimal or no in-fauna • Coastal and freshwater habitats not included in TYPES 1 or 2 • Ephemeral aquatic habitat not supporting native aquatic or wetland vegetation
Not fish habitat	• First and second order streams on gaining streams (based on the Strahler method of stream ordering) • Farm dams on first and second order streams or unmapped gullies • Agricultural and urban drains • Urban or other artificial ponds (eg evaporation basins, aquaculture ponds) • Sections of stream that have been concrete-lined or piped (not including a waterway crossing) • Canal estates

In addition to the habitat type, the waterway class is also used to assess the functionality and determine the requirement to maintain long term fish passage. The criteria by which the waterway class is derived are outlined in **Table 2-2**.

Table 2-2 Classification of waterways for fish passage (DPI, 2013)

Class type	Description
CLASS 1: Major key fish habitat	Marine or estuarine waterway or permanently flowing or flooded freshwater waterway (eg river or major creek), habitat of a threatened or protected fish species or 'critical habitat'.
CLASS 2: Moderate key fish habitat	Non-permanently flowing (intermittent) stream, creek or waterway (generally named) with clearly defined bed and banks with semi-permanent to permanent waters in pools or in connected wetland areas. Freshwater aquatic vegetation is present. TYPE 1 and 2 habitats present.
CLASS 3: Minimal key fish habitat	Named or unnamed waterway with intermittent flow and sporadic refuge, breeding or feeding areas for aquatic fauna (eg fish, yabbies). Semi-permanent pools form within the waterway or adjacent wetlands after a rain event. Otherwise, any minor waterway that interconnects with wetlands or other CLASS 1-3 fish habitats.
CLASS: 4 Unlikely key fish habitat	Waterway (generally unnamed) with intermittent flow following rain events only, little or no defined drainage channel, little or no flow or free-standing water or pools post rain events (eg dry gullies or shallow floodplain depressions with no aquatic flora present).

The waterways mapped as key fish habitat by RIAR (DPI, 2018) which meet the definition of key fish habitat under the Policy and Guidelines for Fish Habitat Conservation and Management (DPI, 2013) are outlined in **Table 2-3**.

Table 2-3 Waterways identified as key fish habitat within the study area

Waterway name	Key Fish Habitat Type	Waterway Classification
Cosgroves Creek	Type 2	Class 2
Badgerys Creek	Type 2	Class 2
South Creek	Type 1	Class 2
Kemps Creek	Type 1	Class 2
Unnamed tributary of Hinchinbrook Creek	Type 3	Class 3

An additional three of the waterways (Unnamed tributary of South Creek, Unnamed tributary of Kemps Creek and Unnamed tributary of Ropes Creek) are also mapped as key fish habitat by RIAR (DPI, 2018) but do not meet the definition of key fish habitat in accordance with the Policy and Guidelines for Fish Habitat Conservation and Management (DPI, 2013) as they are first order streams (see **Table 2-1**). Key fish habitats are mapped in **Figure 4-4.**

2.3.5 Wetlands

Artificial wetlands (ie farm dams, detention basins, roadside drains, effluent treatment systems) are scattered throughout the study area (see **Figure 2-1**). A total of 28 dams occur within the study area. A wetland listed under the State Environmental Planning Policy (Coastal Management SEPP) 2018 and identified as a Coastal Wetland (ID 117) is located about 500 metres east of the Elizabeth Drive and M7 Motorway intersection, within Western Sydney Parklands. This wetland is about 110 metres long and 30 metres wide and occurs within a large area of intact vegetation. At the time of surveys (see **Section 3.1**), the wetland was at about 10 per cent capacity and emergent and fringing vegetation was dry.

The Unnamed tributary of Hinchinbrook Creek passes through the southern extent of the study area and flows into a Coastal Wetland (ID 276) about 1.8 kilometres to the southeast of the study area. Hinchinbrook Creek, about 330 metres south of the construction footprint, also flows into this Coastal Wetland. Doujon Lake and two other Coastal Wetlands (ID 113 and ID 114) lie in proximity to the study area on a tributary of Hinchinbrook Creek.

2.3.6 State or regionally significant biodiversity links

A State significant biodiversity link is defined as:

- An area identified as being part of a State significant biodiversity link and in a plan approved by the Chief Executive, EESG; or
- A riparian buffer 50 metres either side of a 6th order stream or higher; or
- A riparian buffer 50 metres around an important wetland or an estuarine area.

Table 17 of the FBA (OEH, 2014b) provides definitions of local, large and very large regionally significant and State significant biodiversity links.

A regionally significant biodiversity link is defined as:

- An area identified by the assessor as being part of a regionally significant biodiversity link and in a plan approved by the Chief Executive, EESG; or
- A riparian buffer 20 metres either side of a 4th or 5th order stream; or
- A riparian buffer 30 metres around a regionally significant wetland.

There are no State significant biodiversity links in the study area. Four 4th order streams (Badgerys Creek, Kemps Creek, Cosgroves Creek and Hinchinbrook Creek), one 5th order stream (South Creek), and one 1st order stream (Ropes Creek) intersect the study area. The riparian buffers 20 metres either side of these streams meet the criteria for regionally significant biodiversity links as defined under the FBA.

Further detail regarding the presence of biodiversity links is provided in **Section 8.5.4**.

2.4 Landscape values

The landscape value of the study area has been calculated from the methodology for assessing landscape value for linear shaped developments outlined in Annexure 5 of the FBA. As part of applying the methodology, the following information is examined:

- Per cent native vegetation cover in the landscape – percentage of all land within the 550 metres landscape buffer from the centre line of the construction footprint that contains native vegetation, for the current extent of cover and future extent of cover once clearing for the project has occurred
- Connectivity value – the value determined by identifying impacts to connecting links and State or regional biodiversity links. Where the project would impact on more than one connecting link, a connectivity value must be determined for each link based on the linkage widths and conditions
- Patch size score – determined from the percentage of native vegetation that has been cleared within the Mitchell landscapes which the project intersects and the patch size class. The patch size class considers the largest patch of native vegetation occurring within or connecting to the study area within each Mitchell landscape, and attributes a size class between nil or small to extra-large, dependent on the size of the patch in hectares and the percentage of native vegetation cleared
- Change in area to perimeter ratio – determined by comparing the area to perimeter ratio of the patch size areas within the 550 metre landscape buffer before and after the project impact.

A discussion of each of these factors and how they relate to the construction footprint is provided below.

2.4.1 Native vegetation assessment

The native vegetation cover in the landscape was determined with reference to two regional vegetation mapping projects, including:

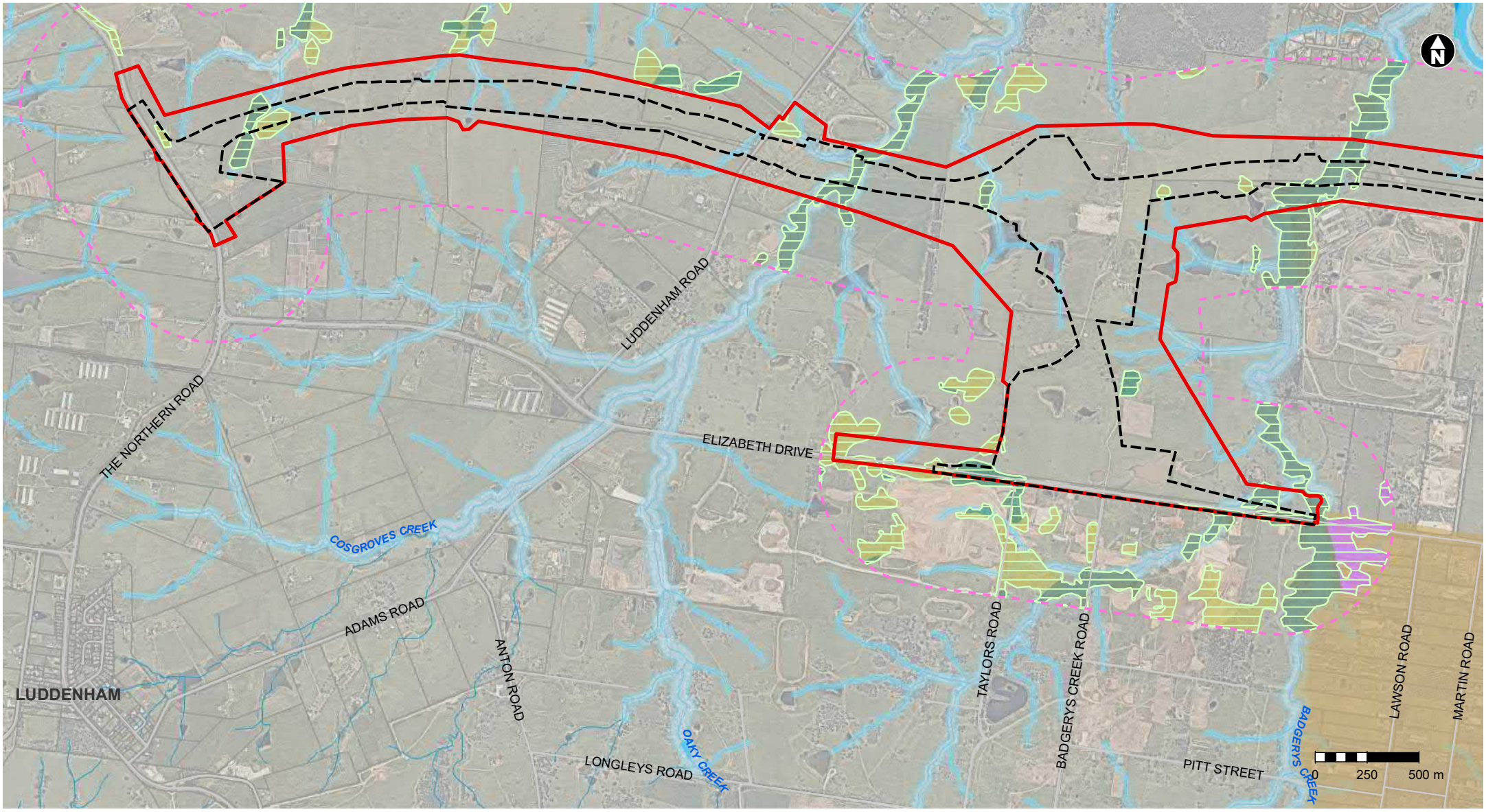
- Remnant Vegetation Mapping of the Cumberland Plain (OEH, 2015) (VIS_ID 2221, 2222 and 2223)
- The Native Vegetation of the Sydney Metropolitan Area – Version 3 (OEH, 2016) (VIS_ID 4489).

Revegetation in the Western Sydney Parklands as mapped by Western Sydney Parklands (n.d.) was also included. All native vegetation types mapped within the 550 metre landscape buffer were considered to represent the current native vegetation cover.

The future native vegetation cover was determined by subtracting the area of native vegetation to be cleared for the project from the current summed native vegetation cover in the landscape buffer. Native vegetation cover percentages were calculated as a proportion of all land within the 550 metre landscape buffer that contains native vegetation. The current (before development) and future (after development) percentage of native vegetation cover in the landscape buffer has been provided in **Table 2-4**. Scores for each per cent cover were then determined using the score criteria in Table 9, Annexure 4 of the FBA (OEH, 2014b). Regional vegetation mapping is shown below in **Figure 2-3.**

Table 2-4 Native vegetation cover in the landscape

Assessment buffer	Before development		After development		Native vegetation cover score
	Remnant vegetation cover	Cover class	Remnant vegetation cover	Cover class	
550 m from centre line (2471 ha)	581 ha	21-25% (score 5)	506 ha	16-20% (score 3.75)	1.25%



Study area corridor
The project construction footprint
550m landscape assessment buffer
Riparian buffer area
Biodiversity certified land
Native vegetation
Western Sydney Parklands
NPWS Reserves
Cadastre

Regional Plant Community Types
(OEH, 2016; OEH, 2011; Western Sydney Parklands, n.d.)

Broad-leaved Ironbark - Grey Box - Melaleuca decora grassy open forest on clay/gravel soils of the Cumberland Plain, Sydney Basin Bioregion (724)

Broad-leaved Ironbark - Melaleuca decora shrubby open forest on clay soils of the Cumberland Plain, Sydney Basin Bioregion (725)

Coastal freshwater lagoons of the Sydney Basin Bioregion and South East Corner Bioregion (781)

Forest Red Gum - Grey Box shrubby woodland on shale of the southern Cumberland Plain, Sydney Basin Bioregion (830)

Forest Red Gum - Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney Basin Bioregion (835)

Grey Box - Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin Bioregion (849)

Grey Box - Forest Red Gum grassy woodland on shale of the southern Cumberland Plain, Sydney Basin Bioregion (850)

Grey Myrtle dry rainforest of the Sydney Basin Bioregion and South East Corner Bioregion (877)

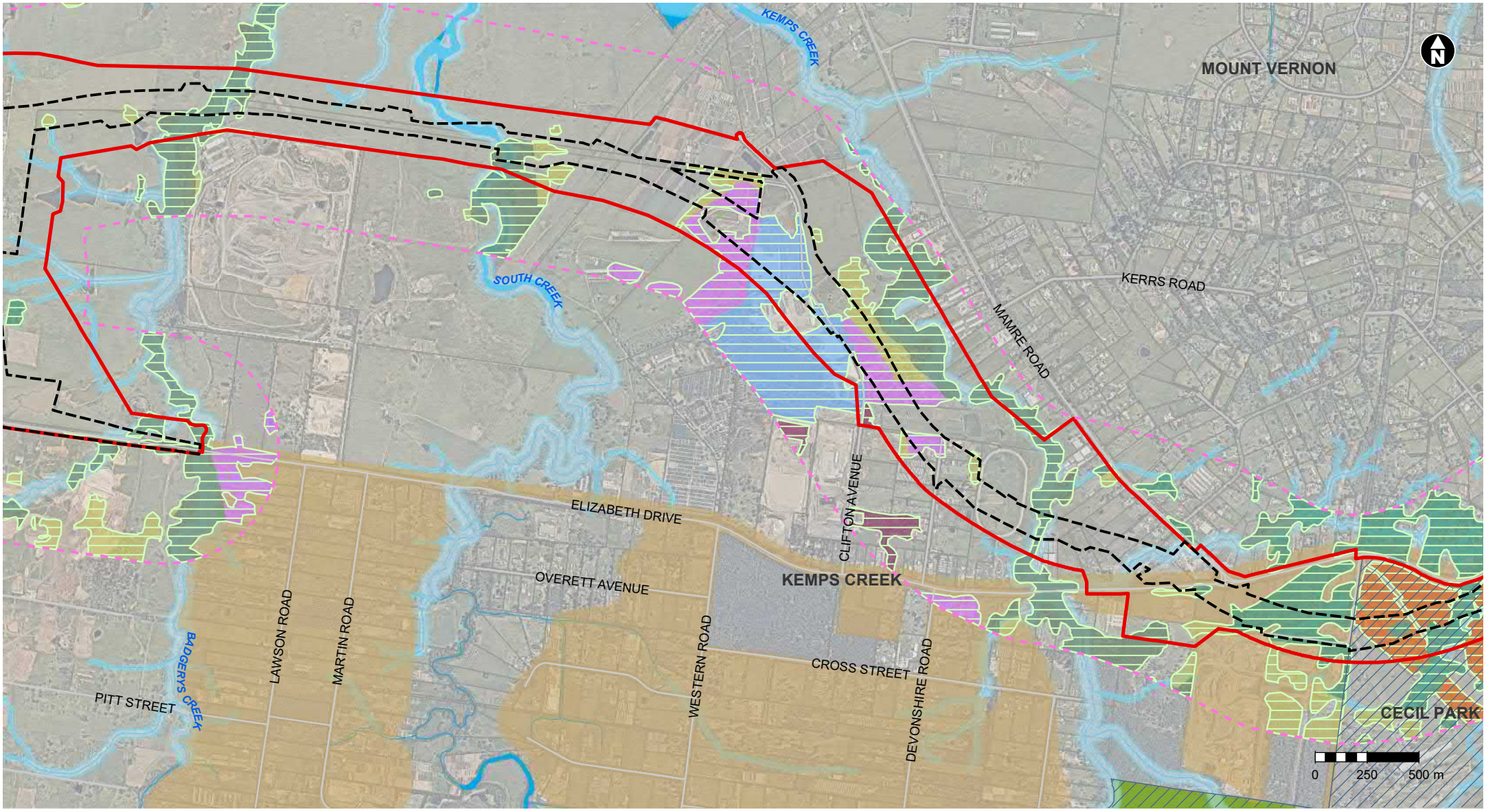
Hard-leaved Scribbly Gum - Parramatta Red Gum heathy woodland of the Cumberland Plain, Sydney Basin Bioregion (883)

Revegetation

*Entire map extent is covered by the IBRA 7 Region - Sydney Basin, and IBRA 7 Subregion - Cumberland. No SEPP 14 Coastal Wetlands or Ramsar Wetlands are present in the entire map extent.

Figure 2-3 Regional vegetation mapping (OEH 2013, OEH 2016)

Date: 27/06/2019 Path: \\10.10.25.32\data\GIS\MXDs\Figures\Technical_reports\BAR\JAJV_BAR_F004_NativeVegetation_R5V4.mxd
Created by : RB | QA by : NS



Study area corridor
The project construction footprint
550m landscape assessment buffer
Riparian buffer area
Biodiversity certified land
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Revegetation

*Entire map extent is covered by the IBRA 7 Region - Sydney Basin, and IBRA 7 Subregion - Cumberland. No SEPP 14 Coastal Wetlands or Ramsar Wetlands are present in the entire map extent.

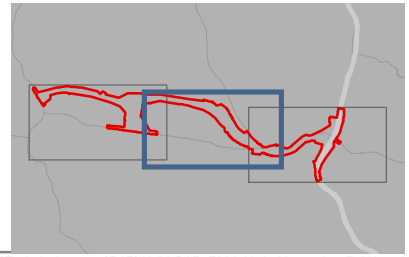
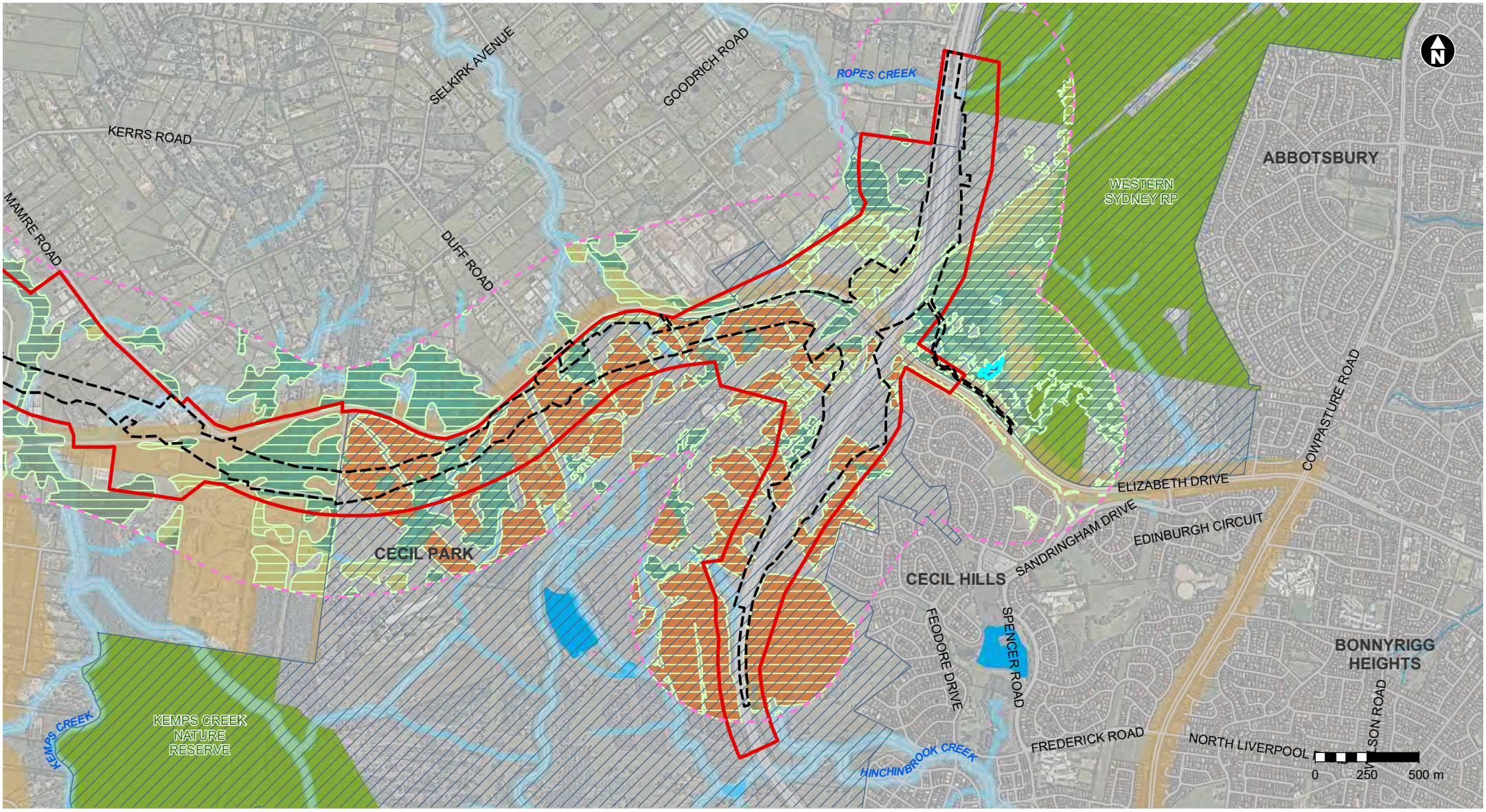


Figure 2-3 Regional vegetation mapping (OEH 2013, OEH 2016)

Date: 27/06/2019 Path: \\10.10.25.32\data\GIS\MXDs\Figures\Technical_reports\BAR\JAJV_BAR_F004_NativeVegetation_R5V4.mxd
Created by : RB | QA by : NS



Study area corridor
The project construction footprint
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Figure 2-3 Regional vegetation mapping (OEH 2013, OEH 2016)

Date: 27/06/2019 Path: \\10.10.25.32\data\GIS\MXDs\Figures\Technical_reports\BAR\JAJV_BAR_F004_NativeVegetation_R5V4.mxd
Created by : RB | QA by : NS

2.4.2 Connectivity value

A connecting link, as defined in Annexure 7 of the FBA (OEH, 2014), is present when native vegetation on the construction footprint adjoins native vegetation surrounding the construction footprint, and the native vegetation:

- Is in moderate to good condition
- Has a patch size less than one hectare
- Is separated by a distance of less than 100 metres (or less than 30 metres for non-woody ecosystems ie grasslands)
- Is not separated by a large water body, dual carriageway, wider highway or similar hostile link.

Section 2.3.6 refers to State and regionally significant biodiversity links in the study area. No State significant biodiversity links were identified; however, four streams within the study area meet the criteria for regionally significant biodiversity links as defined under the FBA. Table 17 of the FBA (OEH, 2014b) provides definitions of local, large and very large area, regional and State significant connectivity links. A comparison of the definitions of connectivity links in Table 17 of the FBA and the vegetation on and adjoining the construction footprint is provided in **Table 2-5**.

The M7 Motorway and Elizabeth Drive already create significant barriers to habitat connectivity and impact regional habitat corridors in the study area. Further detail on biodiversity links and habitat corridors, including existing barriers to connectivity and fragmentation, are discussed in **Section 8.5.4**.

Table 2-5 Comparison of vegetation on and adjoining construction footprint with criteria for connectivity links in EESG (OEH, 2014)

Categories of connecting links	Definitions of connecting link	Presence in construction footprint	Connectivity score
State significant biodiversity link	• An area identified as being part of a State significant biodiversity link and in a plan approved by the Chief Executive, EESG; or • A riparian buffer 50 m either side of a 6th order stream or higher; or • A riparian buffer 50 m around an important wetland or an estuarine area.	No. No State significant biodiversity links have been identified on or adjacent to the construction footprint. No 6th order streams or important wetlands occur on or adjacent to the construction footprint.	12.5
Regionally significant biodiversity link	• An area identified by the assessor as being part of a regionally significant biodiversity link and in a plan approved by the Chief Executive, EESG; or • A riparian buffer 20 m either side of a 4th or 5th order stream; or • A riparian buffer 30 m around a regionally significant wetland.	Yes. Three 4th order streams (Badgerys Creek, Kemps Creek and Cosgroves Creek) and one 5th order stream (South Creek) intersect the construction footprint. These creeks meet the criteria for regionally significant biodiversity links. No regionally significant biodiversity links have been identified on or adjacent to the construction footprint. There are no regionally significant wetlands identified on or adjacent to the construction footprint.	10

Categories of connecting links	Definitions of connecting link	Presence in construction footprint	Connectivity score
Very large area biodiversity link	• Links areas of native vegetation in moderate to good condition that are >5000 ha in total; and • Width of vegetation in moderate to good condition that is connecting the area is >500 m.	No. No areas of native vegetation >5000 ha on or adjacent to the construction footprint.	7.5
Large area biodiversity link	• Links areas of native vegetation in moderate to good condition that are ≥1000 ha and ≤5000 ha in total, or areas >5000 ha in total; and • Width of vegetation in moderate to good condition that is connecting the area is >100 m and <500 m.	No. No areas of native vegetation >1000 ha on or adjacent to the construction footprint.	5
Local area biodiversity link	• Links areas of native vegetation in moderate to good condition that are ≥250 ha and <1000 ha in total, or areas greater than 1000 ha in total; and • Width of vegetation in moderate to good condition that is connecting the area is >30 m and <100 m.	Yes. Vegetation in moderate to good condition that is ≥250 ha and <1000 ha in and adjoining the construction footprint. Width of vegetation connecting the area within the construction footprint is >30m and <100m.	2.5

2.4.3 Patch size

For a linear development, the FBA (OEH, 2014b) requires assessment of the patch size for each Mitchell Landscape in which the construction footprint occurs.

The Cumberland Plain Mitchell landscape covers most of the construction footprint, with the Hawkesbury – Nepean Channels and Floodplains Mitchell Landscape also mapped adjoining drainage lines. The Cumberland Plain Mitchell landscape is 89 per cent cleared and the Hawkesbury – Nepean Channels and Floodplains Mitchell Landscape is 79 per cent cleared. Both Mitchell Landscapes fall within the more than 70 per cent to ninety per cent vegetation cleared category for assessing patch size specified in Table 18 of the FBA (OEH, 2014b).

The largest patch of native vegetation intersecting the construction footprint comprises a network of mostly fragmented vegetation across the east of the construction footprint, but to the west of the M7 Motorway which forms a hostile barrier. This vegetation connects to the Kemps Creek Nature Reserve and areas further south in the Western Sydney Parklands. This patch is greater than 100 hectares, placing it in the 'extra-large' patch size class in accordance with Table 18 of the FBA (OEH, 2014b) and attributing it a patch size score of 12.5.

2.4.4 Area to perimeter ratio

Linear projects are also required to assess the change in area to perimeter ratio of vegetation patch size areas that are impacted by the project. The current and future area to perimeter ratios of each patch of native vegetation within the 550 metre landscape buffer area were calculated using a Geographic Information System (GIS). The proportional change in area to perimeter ratio was determined to be 8.6, with a corresponding score of 1. The relatively small change in area to perimeter ratio is due to the highly fragmented nature of the existing vegetation in and adjoining the construction footprint.

The area and perimeter ratios before and after development, the proportional change in area to perimeter ratio and the resultant score are shown in **Table 2-6**.

Table 2-6 Change in area to perimeter ratio of vegetation patches

Before development			After development			Proportional change (%)	Score
Vegetation area (m^2)	Vegetation perimeter (m)	Area to perimeter ratio	Vegetation area (m^2)	Vegetation perimeter (m)	Area to perimeter ratio		
5,819,968	164,123	35:1	5,076,056	157,481	32:1	9	1

2.4.5 Landscape value score

A summary of the scores for each landscape component and the final landscape value score is presented in **Table 2-7**.

Table 2-7 Landscape value summary

Landscape component	Score
Per cent native vegetation cover	1.25
Connectivity value	10
Patch size	12.5
Area to perimeter ratio	1
Landscape value score	**24.75**

3 Native vegetation and habitat

The following section documents the methodology used to identify and map the extent of vegetation within the study area. Plant Community Types (PCTs) are classified based on the BioNet Vegetation Classification data collection (OEH, 2018).

3.1 Methods

3.1.1 Background research

Database searches

Database searches were undertaken in mid-2017, updated in August 2018, and re-updated in April 2019 to identify State and Commonwealth records of threatened entities and Commonwealth MNES that occur or have the potential to occur within 10 kilometres of the study area. Databases and reports interrogated for this purpose are listed in **Table 3-1**.

Table 3-1 Database interrogations carried out

Database	Purpose of search	Date of database search
NSW BioNet Species Sightings data collection, managed by EESG	Used to compile a list of threatened species records listed under the TSC Act to within 10 km of the study area.	5 April 2019 (updated)
Protected Matters Search Tool, managed by the Commonwealth Department of the Environment (DoE)	Used to compile a list of potentially occurring Matters of National Environmental Significance (MNES) listed under the EPBC Act to within 10 km of the study area (**Annexure E**).	5 April 2019 (updated)
BioNet Vegetation Classification data collection managed by EESG	Information on PCTs and their relationship to a vegetation formation and vegetation class is managed and maintained in the BioNet Vegetation Classification data collection.	Referenced throughout
BioNet Threatened Species data collection, managed by EESG	Contains information for all listed threatened species, populations and communities.	Referenced throughout
NSW WeedWise, managed by DPI	Identifies species listed as priority weeds for a weed control area and their control requirements.	Referenced throughout
RIAR Spatial Data Portal	Maps threatened fish species distribution in NSW.	5 April 2019 (updated)

Literature review

A review of relevant, existing information was undertaken to identify the existing environment of the construction footprint and provide an understanding of ecological values occurring or potentially occurring in the study area and locality. The review focused on relevant ecological reports from the study area and wider locality, property boundaries, vegetation maps, topographic maps, aerial photography and relevant GIS layers.

Relevant literature included, but was not limited to:

- *M12 Motorway Strategic Route Options Analysis: Biodiversity working paper* (Roads and Maritime Services (Roads and Maritime), 2016a)
- *M12 Motorway Strategic Route Options Analysis: Shortlisted Options Report* (Roads and Maritime, 2016b)
- *The Northern Road Upgrade – Mersey Road, Bringelly to Glenmore Parkway, Glenmore Park Final Environmental Impact Statement* (Roads and Maritime, 2017)
- *Western Sydney Airport EIS Biodiversity Assessment* (GHD, 2016)
- *Commonwealth land at Badgerys Creek Biodiversity Report* (SMEC, 2014)
- *The native vegetation of the Cumberland Plain, Western Sydney: systematic classification and field identification of communities* (Tozer, 2003)
- *Remnant vegetation of the western Cumberland subregion, 2013 update* (OEH, 2013)
- *The Native Vegetation of the Sydney Metropolitan Catchment Management Authority Area (version 3.0)* (OEH, 2016)
- Cumberland Plain Recovery Plan (DECCW, 2011)
- *Soil landscapes of the Penrith 1:100,000 Sheet 9030* (Hazelton, et al., 1989)
- *Geology of the Penrith 1:100,000 Sheet 9030* (Clarke & Jones, 1991)
- *Terrestrial vertebrate fauna of the Greater Southern Sydney Region* (DECC, 2007)
- *Key Fish Habitat Mapping* (DPI, 2018).

Field surveys

Flora and fauna surveys were carried out across the study area by Arcadis ecologists between May 2017 and October 2018. All work was carried out under the appropriate licences, including scientific licences as required under Clause 22 of the National Parks and Wildlife Regulations 2002, Section 132C of the *National Parks and Wildlife Act 1974* (License Number: SL100646).

Field surveys and the preparation of this assessment have been undertaken in accordance with, or with reference to:

- *Threatened Biodiversity Survey and Assessment: Guidelines for Developments and Activities working draft* (DEC, 2004)
- *EPBC Act Referral Guidelines for the vulnerable koala (combined populations of Queensland, New South Wales and the Australian Capital Territory)* (DoE, 2014)
- *Threatened Species Assessment Guidelines: the assessment of significance* (DECC, 2007)
- *Significant Impact Guidelines 1.1 Matters of National Environmental Significance* (DoE, 2013)
- *NSW Guide to Surveying Threatened Plants* (OEH, 2016)
- *Environmental Impact Assessment Guidelines for the Green and Golden Bell Frog* (*Litoria aurea*) (NSW NPWS, 2003)
- *BioBanking Assessment Methodology (BBAM)* (OEH, 2014a)
- *Survey guidelines for Australia's threatened mammals: Guidelines for detecting mammals listed as threatened under the Environment Protection and Biodiversity Conservation Act 1999* (CoA, 2011)
- *The Spot Assessment Technique: a tool for determining localised levels of habitat use by Koalas Phascolarctos cinereus* (Phillips & Callaghan, 2011).

3.1.2 Vegetation surveys

Vegetation surveys were conducted in accordance with Chapter 5 of the FBA and the *Threatened Biodiversity Survey and Assessment Guidelines for Developments and Activities* (DEC, 2004). The vegetation surveys, which included rapid reconnaissance surveys, plot based surveys and site value assessments were undertaken over 13 days between May and November 2017, August and September 2018 and February 2019.

Weather conditions at the time of the flora surveys were generally warm, clear and still. The weather records from the Horsley Park Equestrian Centre AWS (station 067119), about one kilometre from the eastern edge of the study area, for the dates of vegetation surveys are detailed in **Table 3-2**.

Table 3-2 Weather conditions during vegetation survey period (BoM, 2018)

Date	Temperature		Rain	Wind Speed at 3pm	
	Min (°C)	Max (°C)	mm	Direction	Speed (km/h)
24 May 2017	11.6	22.1	3.8	W	17
25 May 2017	7.3	20.4	0	WNW	2
5 June 2017	8	18.4	0.2	ENE	2
15 June 2017	7.8	18.8	0	Calm	Calm
22 June 2017	8.3	18.1	0	N	4
2 November 2017	10.5	23.9	0	E	17
1 August 2018	7.4	21	0	SW	17
2 August 2018	6.5	19	0	NNE	9
14 August 2018	2.3	22.5	0	NNW	7
15 August 2018	7	24.8	0	WNW	30
5 September 2018	7.4	16.7	0	E	7
6 September 2018	6.3	21.8	3.0	NNE	6
26 February 2019	13	30.5	0.2	N	11

Rapid reconnaissance survey

The study area was visited numerous times during the early stages of the assessment to verify the PCTs identified from the desktop assessment. Rapid assessment points were performed at various locations across the study area.

Vegetation mapping and PCT identification

Vegetation within the study area has previously been stratified and assigned to PCTs by the Remnant vegetation mapping of the Cumberland Plain (OEH, 2013). This data source informed the current assessment of vegetation within the study area.

Vegetation was initially stratified based on the composition of the canopy and vegetation structure (key elements in PCT assignment). Ecotones between vegetation communities were investigated in more detail to determine the functional boundary of each PCT. These discrete vegetation communities were then

compared to recognised and accepted PCTs, as described in the BioNet Vegetation Classification data collection (OEH, 2018). The identification of PCTs in the study area was predominantly based on:

- Structure and species composition consistent with descriptions in the BioNet Vegetation Classification data collection and other published references
- Characteristic tree species present
- Previous regional mapping as an equivalent vegetation type
- Landscape position.

Plot based floristic survey

The extent of vegetation sampling required was established through review of regional vegetation mapping and site reconnaissance to determine the PCT and condition. Once preliminary vegetation zones were identified and mapped, the minimum number of quadrats for each zone was identified with reference to Table 3 of the FBA (OEH, 2014). Plots were established randomly within each vegetation zone, with some plots placed deliberately to sample any observed variation in vegetation structure within a vegetation zone. The quadrat locations are shown on **Figure 3-1**.

Plot surveys were undertaken in accordance with the methodology outlined by the FBA. In total, 39 plots were carried out across the study area. Each plot consists of a 20 metre x 20 metre floristic plot nested inside a 20 metre x 50 metre transect. The floristic plot measures five attributes which inform the assignment of PCTs and assess the expected environmental variation (see **Table 3-3**).

Table 3-3 Data collected from vegetation plots

Variable	Data collected
Stratum (and layer)	Stratum and layer in which each species occurs.
Growth form	Growth form for each recorded species.
Species name	Scientific name and common name (where applicable).
Cover	A measure or estimate of the appropriate cover measure for each species recorded within the 20 m x 20 m plot. Recorded from 1–5% and then to the nearest 5%. If the cover of a species is less than 1% and the species is considered important, then the estimated cover is entered (eg 0.4).
Abundance rating	A relative measure of the number of individuals or shoots of a species within the 20 m x 20 m plot using the following intervals (numbers above about 20 are estimates only): 1,2,3,4,5,6,7,8,9,10,20,50,100,500,1000 or specify a number greater than 1000 if required.

Site value assessment

The FBA plot/transect has been designed to assess the vegetation condition by measuring 10 site attributes. These attributes were measured at each FBA plot/transect (see **Table 3-4**).

Table 3-4 Site attribute data collected from vegetation plots

Site attribute	Data collected
Indigenous plant species richness	Number of indigenous plant species within 20 m x 20 m plot.
Native over-storey cover	Estimate of per cent foliage cover at 10 points (every 5 m) along the 50 m transect.
Native mid-storey cover	Estimate of per cent foliage cover at 10 points (every 5 m) along the 50 m transect.
Native ground cover (grasses)	At 50 points along the 50 m transect (every 1 m), recorded whether native grass intersects that point.

Site attribute	Data collected
Native ground cover (shrubs)	At 50 points along the 50 m transect (every 1 m), recorded whether native ground cover (shrub) intersects that point.
Native ground cover (other)	At 50 points along the 50 m transect (every 1 m), recorded whether native ground cover (other) intersects that point.
Exotic plant cover	Measured as total per cent foliage cover of all exotics in all strata; exotic cover measured using the same method as for native over-storey, mid-storey and ground cover.
Number of trees with hollows	Count of the number of living and dead trees within the 50 m x 20 m plot that have at least one hollow.
Regeneration	Measured as the proportion of over-storey species present in the zone that are regenerating (ie with diameter at breast height < 5 cm).
Total length of fallen logs	Total length of logs at least 10 cm in diameter and at least 0.5 m long.

The vegetation condition data obtained for each PCT in vegetation plots was used to obtain site attribute scores and given a weighting as per Table 2 in the FBA (OEH, 2014b). The scores were assessed against the Vegetation Type Benchmarks for the identified vegetation types in the BioNet Vegetation Classification data collection.

The number of FBA plot/transects that were completed in each of the PCTs is consistent with the minimum number as required by the FBA (see **Table 3-5**) for all but one vegetation zone:

- For vegetation zone 13 (883 – Poor), this vegetation zone could not be sampled due to the size and dimensions of the remaining fragmented patches, which range from about 0.02 hectares to about 0.27 hectares in size. The 0.27 hectare patch consists of a five metre wide x 470 metre long strip of degraded roadside vegetation in the road reserve adjoining cleared and disturbed areas. This vegetation zone is discussed in greater detail in **Section 3.2.3**.

Table 3-5 Comparison of number of transects/plots required and completed per zone area

Veg zone	Vegetation zone	Vegetation zone area (ha)	FBA plot requirements	Number of plots completed
1	Broad-leaved Ironbark - Grey Box - Melaleuca decora grassy open forest on clay/gravel soils of the Cumberland Plain, Sydney Basin Bioregion 724 – Moderate/ Good_High	3.50	2	2
2	Broad-leaved Ironbark - Grey Box - Melaleuca decora grassy open forest on clay/gravel soils of the Cumberland Plain, Sydney Basin Bioregion 724 – Moderate/ Good_Medium	2.96	2	3
3	Broad-leaved Ironbark - Grey Box - Melaleuca decora grassy open forest on clay/gravel soils of the Cumberland Plain, Sydney Basin Bioregion 724 – Moderate/ Good_Poor	0.45	1	1
4	Forest Red Gum - Grey Box shrubby woodland on shale of the southern Cumberland Plain, Sydney Basin Bioregion 830 – Moderate/ Good_Poor	0.44	1	1

Veg zone	Vegetation zone	Vegetation zone area (ha)	FBA plot requirements	Number of plots completed
5	Forest Red Gum - Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney Basin Bioregion 835 – Moderate/ Good_Poor	3.23	2	2
6	Grey Box - Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin Bioregion 849 – Moderate/ Good_Medium	3.54	2	3
7	Grey Box - Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin Bioregion 849 – Moderate/ Good_Poor	2.07	2	2
8	Grey Box - Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin Bioregion 849 – Moderate/ Good_Other (Derived Shrubland)	0.48	1	1
9	Grey Box - Forest Red Gum grassy woodland on shale of the southern Cumberland Plain, Sydney Basin Bioregion 850 – Moderate/ Good_High	3.21	2	3
10	Grey Box - Forest Red Gum grassy woodland on shale of the southern Cumberland Plain, Sydney Basin Bioregion 850 – Moderate/ Good_Medium	10.14	3	7
11	Grey Box - Forest Red Gum grassy woodland on shale of the southern Cumberland Plain, Sydney Basin Bioregion 850 – Moderate/ Good_Other (Revegetation)	22.65	4	4
12	Grey Box - Forest Red Gum grassy woodland on shale of the southern Cumberland Plain, Sydney Basin Bioregion 850 – Low	18.07	2	4
13	Hard-leaved Scribbly Gum - Parramatta Red Gum heathy woodland of the Cumberland Plain, Sydney Basin Bioregion 883 – Poor	0.38	1	0
14	Swamp Oak open forest on riverflats of the Cumberland Plain and Hunter valley 1800 – Moderate/ Good_Poor	2.53	2	3

3.1.3 Native vegetation survey limitations

Field surveys and survey effort met the requirements of the FBA and a majority of the construction footprint was able to be surveyed. However, in some areas, surveys were constrained by landowner permissions and restricted access. As such, while the location of transects/plots were stratified to the greatest extent possible, not all areas of vegetation were surveyed. Where possible, vegetation was viewed from the roadside or public areas to verify the PCT and vegetation condition. Further surveys of these areas would be undertaken during detailed design and prior to construction and new calculations performed as necessary.

Vegetation within the study area was assigned to a PCT using the BioNet Vegetation Classification data collection (OEH, 2018). Assignment to a PCT was based on the observed species composition, landscape position and underlying geology and soils recorded during field surveys.

In some instances, mapped PCTs may not directly correlate to published mapping, as mapping for the project is on a localised scale, as opposed to regional, and is supported by on ground observations and quantitative data. Further, boundaries of some PCTs may be mapped differently, as it is possible for some boundaries to change over time. Similarly, the boundaries of each vegetation zone may change over time as these are based on both the PCT and the broad condition of vegetation, which is dynamic.

Species recorded in the study area should be treated as an indication of species presence at the time of field surveys, not a fully comprehensive list, as some species are only present or apparent at certain times of the year (eg annual herbs and grasses). Further, some species require specific weather conditions for optimum detection. For example, most vegetation in the Cumberland Plain, a rainshadow coastal valley, is dependent on rainfall and as such, many plant species would not be present above ground during cooler seasons and in drier years. Vegetation surveys were undertaken during autumn, winter and spring however rainfall for the study area was below the long-term average for this period (700 - 900 millimetres per annum). Overall, conditions for flora surveys on the Cumberland Plain during the survey period were good.

The conclusions of this report are based upon available data and field surveys and are therefore indicative of the environmental condition of the study area at the time of the survey. It should be recognised that conditions, including the presence of threatened species, could change with time. To address this limitation, a precautionary approach has been used which aimed to identify the presence and suitability of the habitat for threatened species (**Annexure B**).

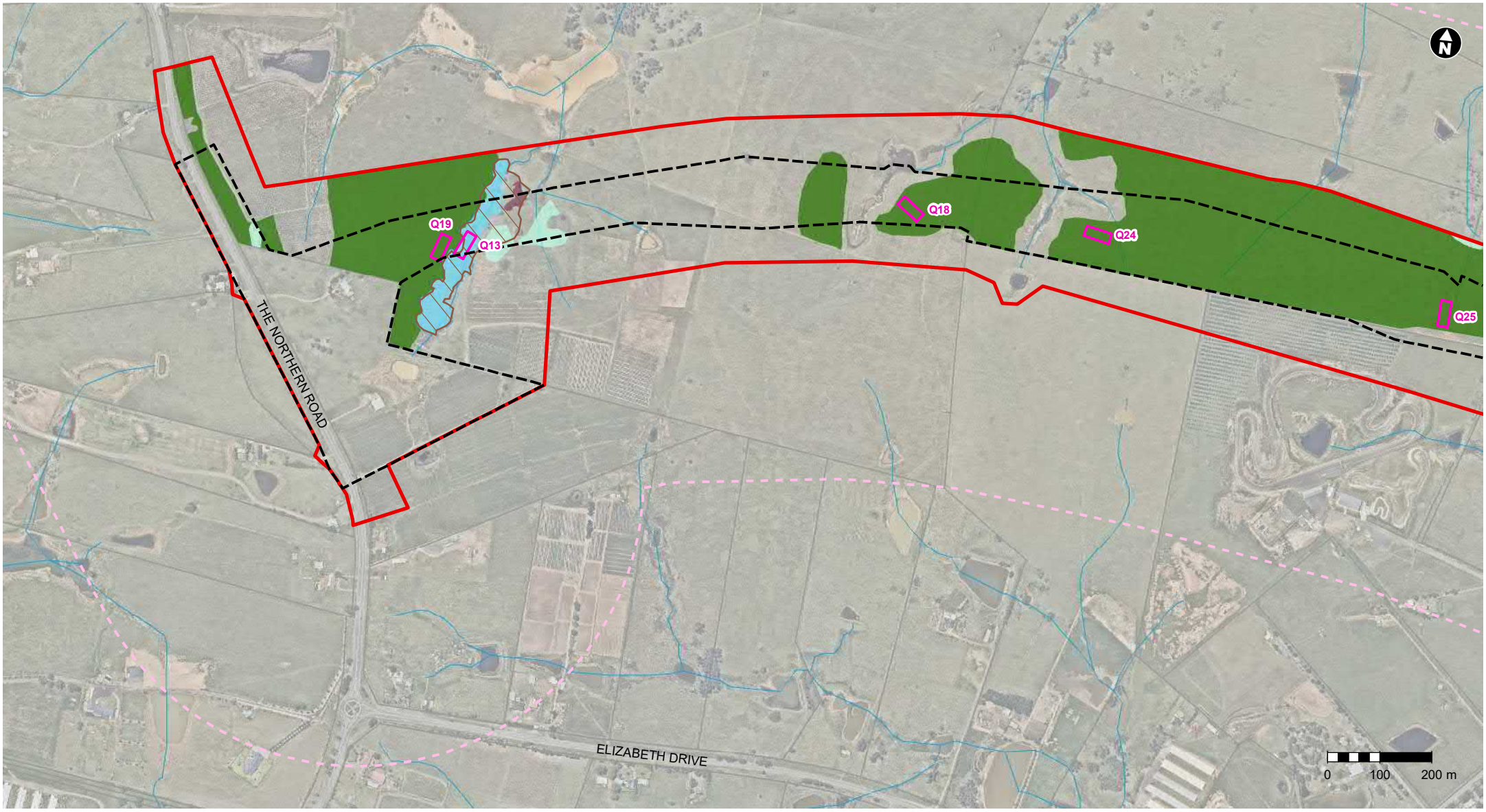
3.2 PCT descriptions

PCTs in the study area were identified and mapped based on review of existing vegetation mapping, observations made during site inspections, and analysis of data collected during field surveys.

3.2.1 Vegetation mapping

EESG (OEH, 2013) updated the western parts of the Remnant Vegetation of the Cumberland Plain GIS data layers using 2011 and 2012 imagery. The vegetation of the Cumberland Plain was previously mapped by NPWS (2002)/Tozer (2003) and updated in 2008. The 2013 (OEH, 2013) update focused on removing large areas of clearing at 1:10,000-1:15,000 scale.

EESG (OEH, 2016) mapped the vegetation of the Sydney Metropolitan Catchment Management Authority (CMA) Area. The Sydney CMA Area encompasses the eastern portions of the Sydney Metropolis, extending from the coastline to the catchments that flow to the Parramatta, Georges and Hacking River.



Study area corridor
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Flora - Targeted search

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Broad-leaved Ironbark - Melaleuca decora shrubby open forest on clay soils of the Cumberland Plain, Sydney Basin Bioregion [725]

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Hard-leaved Scribbly Gum - Parramatta Red Gum heathy woodland of the Cumberland Plain, Sydney Basin Bioregion [883]

Swamp Oak open forest on riverflats of the Cumberland Plain and Hunter valley [1800]

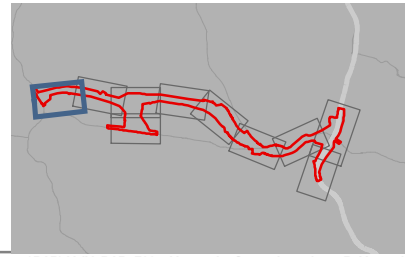

Figure 3-1 Vegetation survey locations

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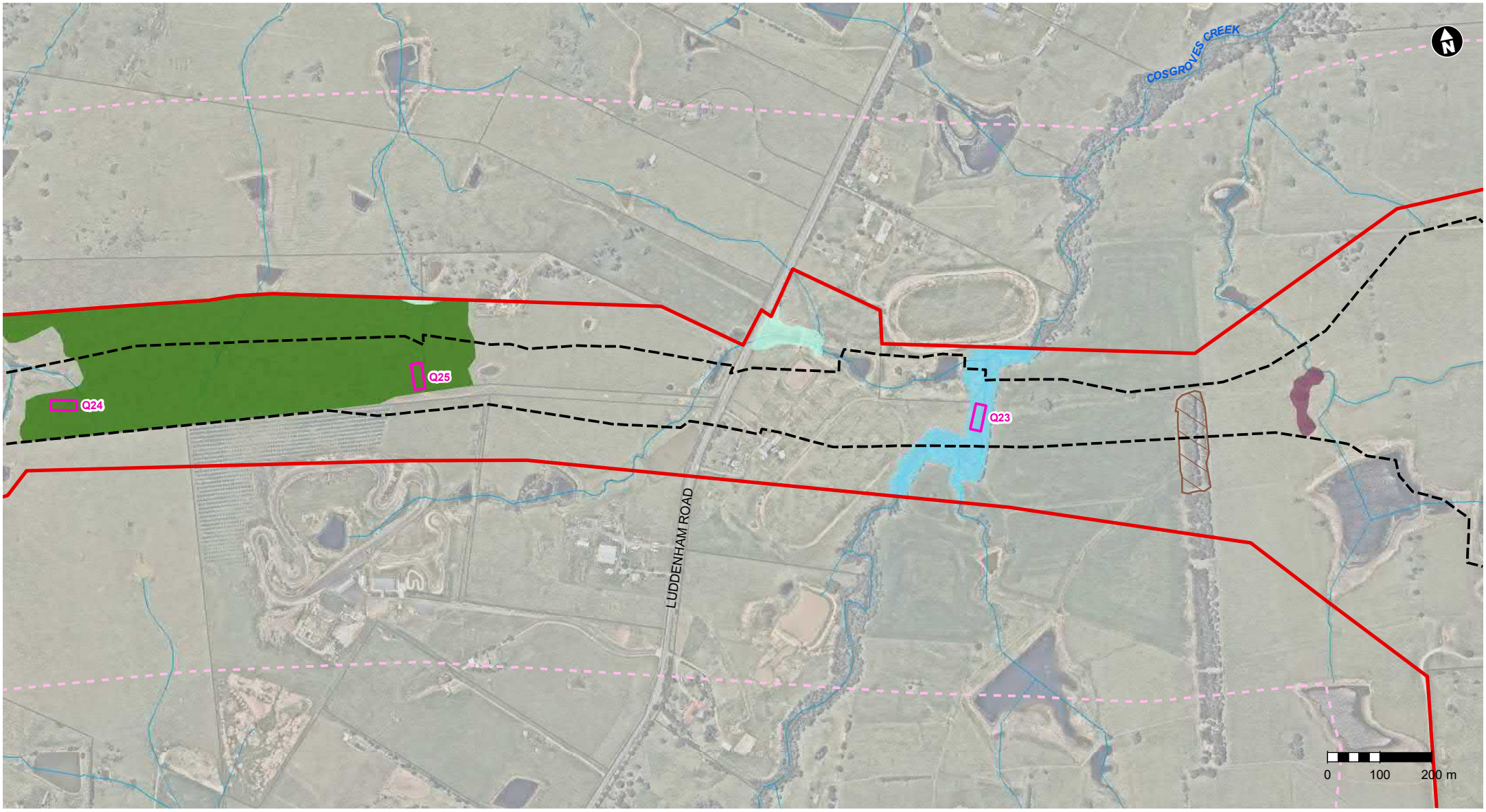

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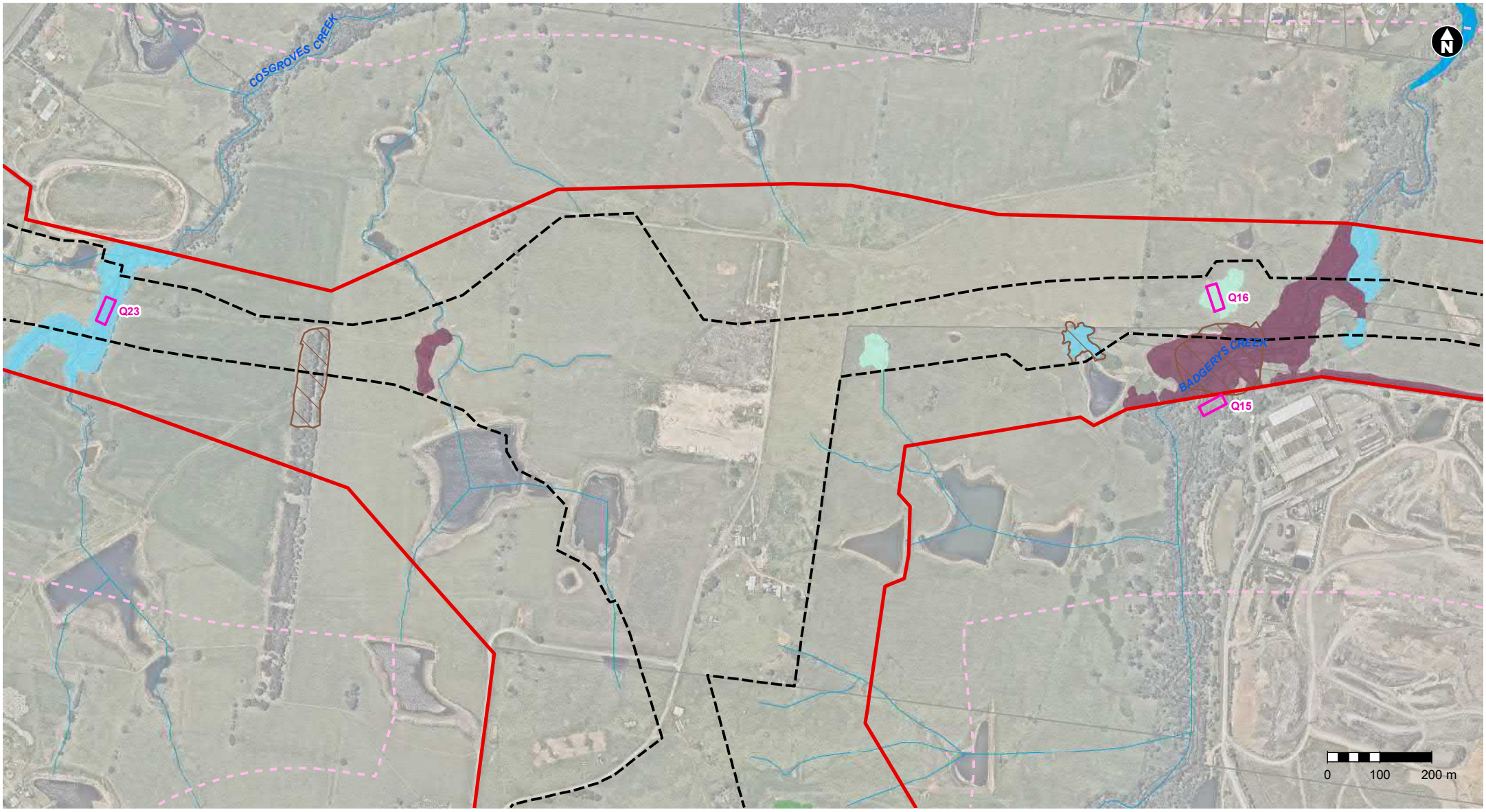

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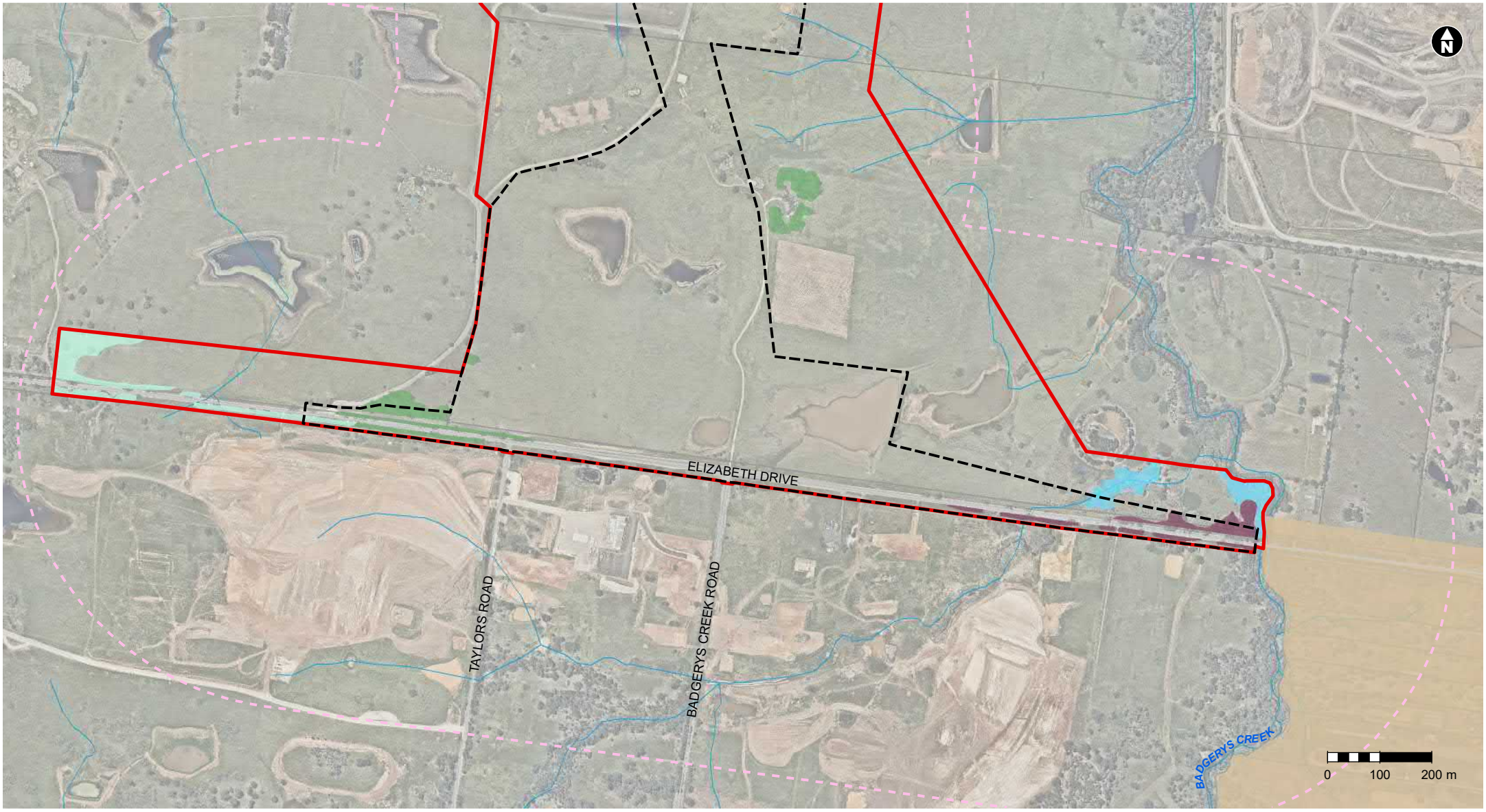

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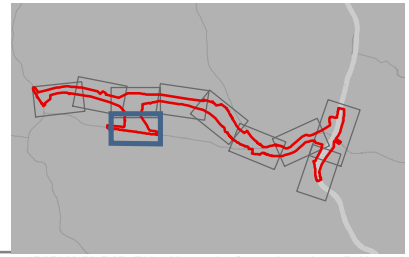

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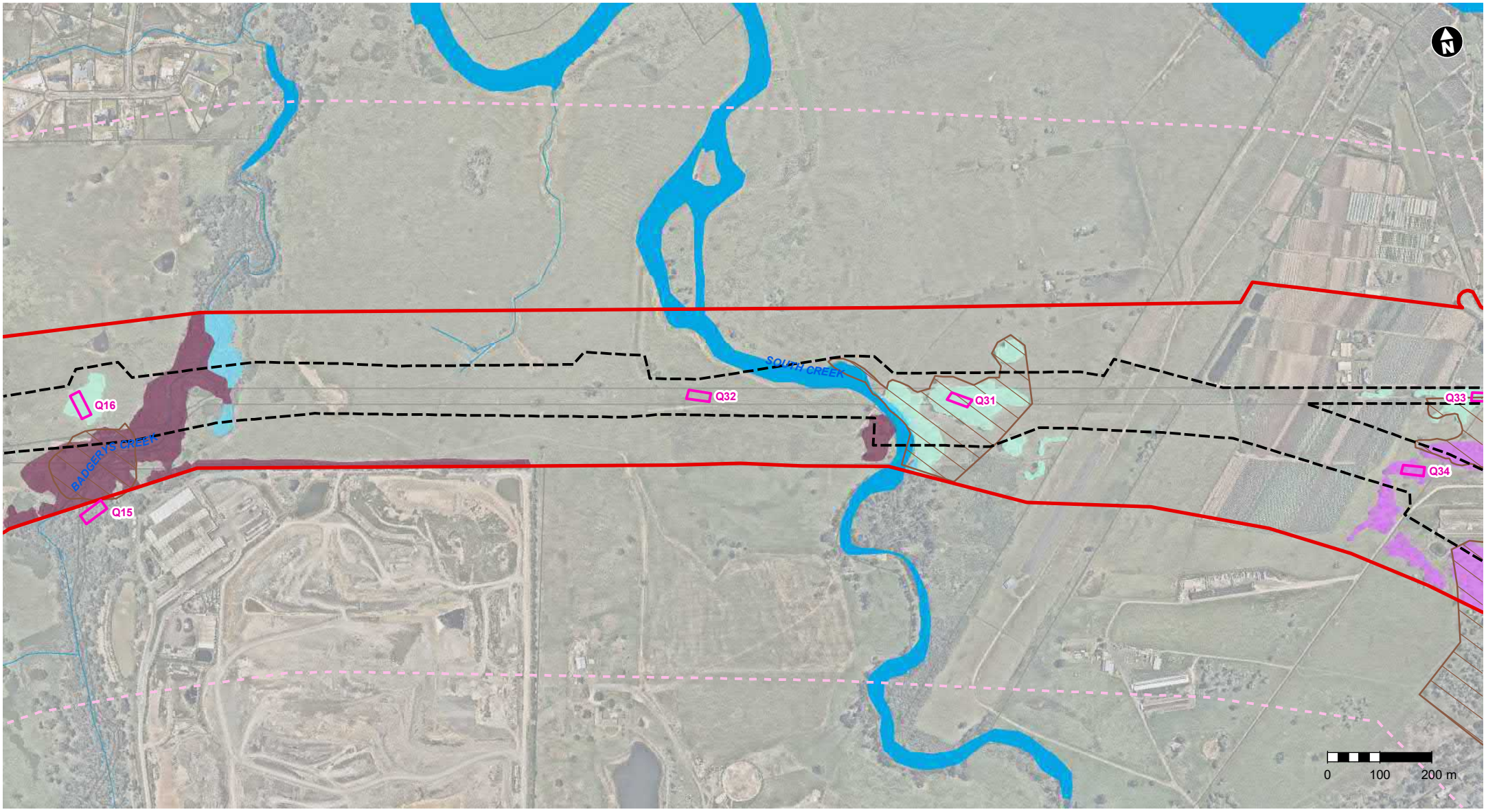

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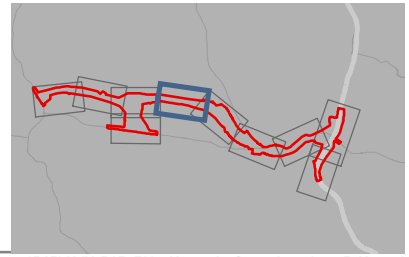

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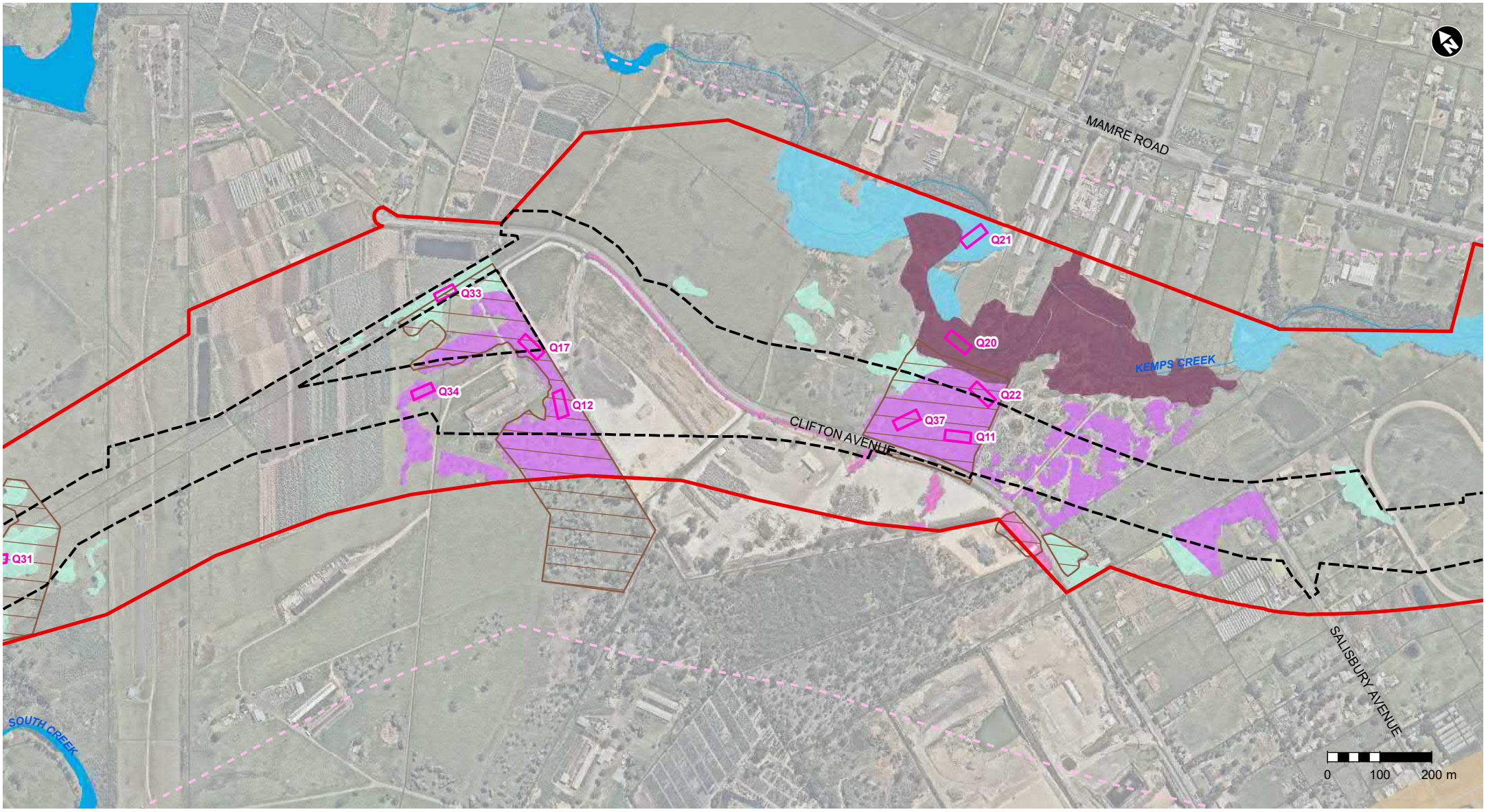

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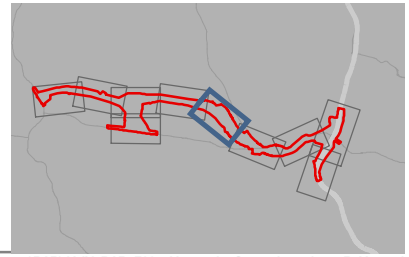

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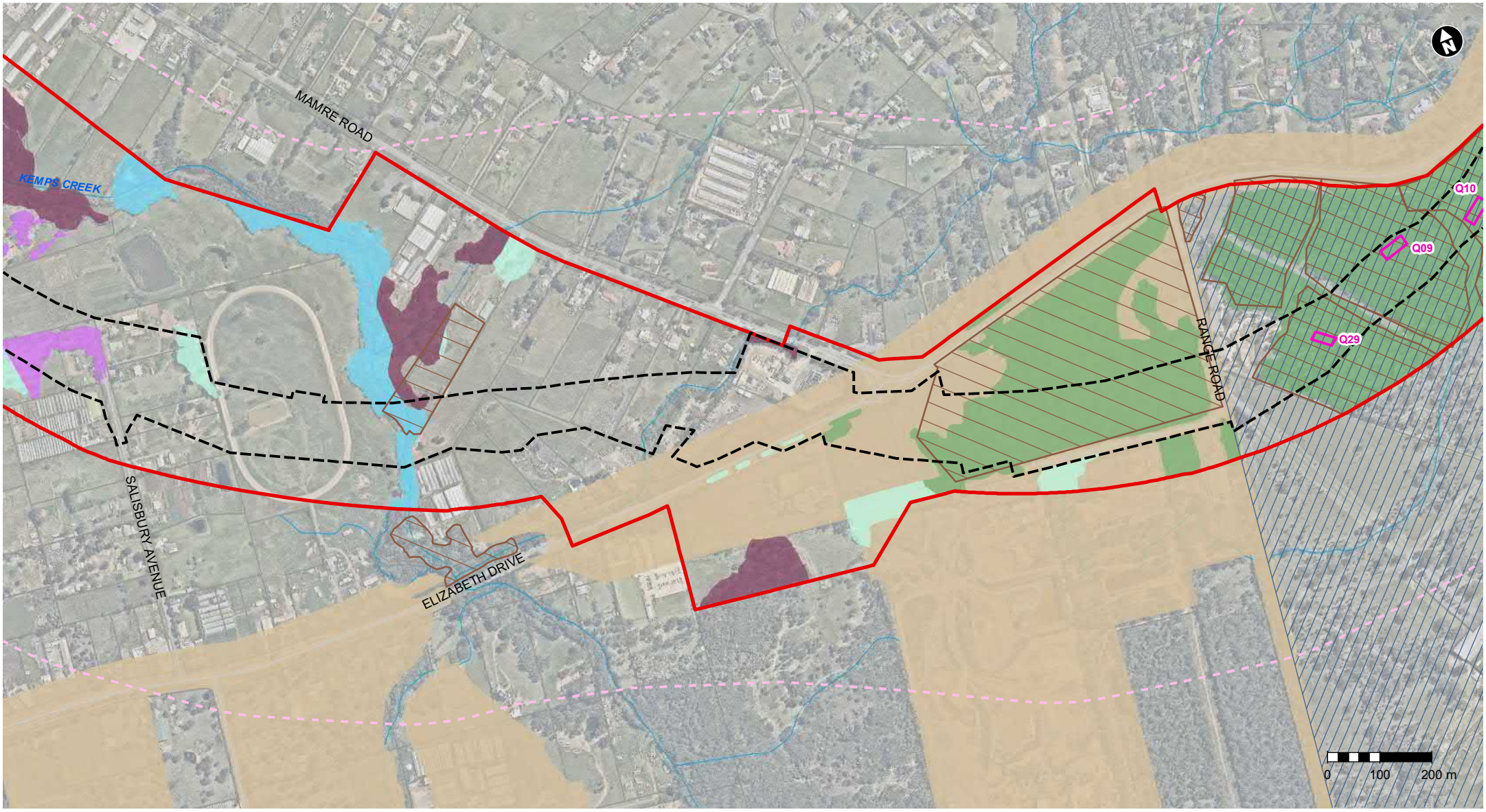

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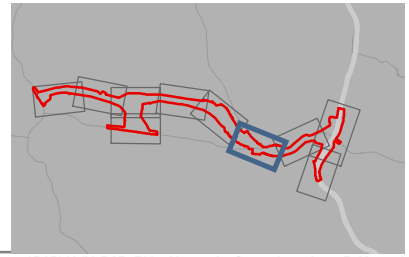

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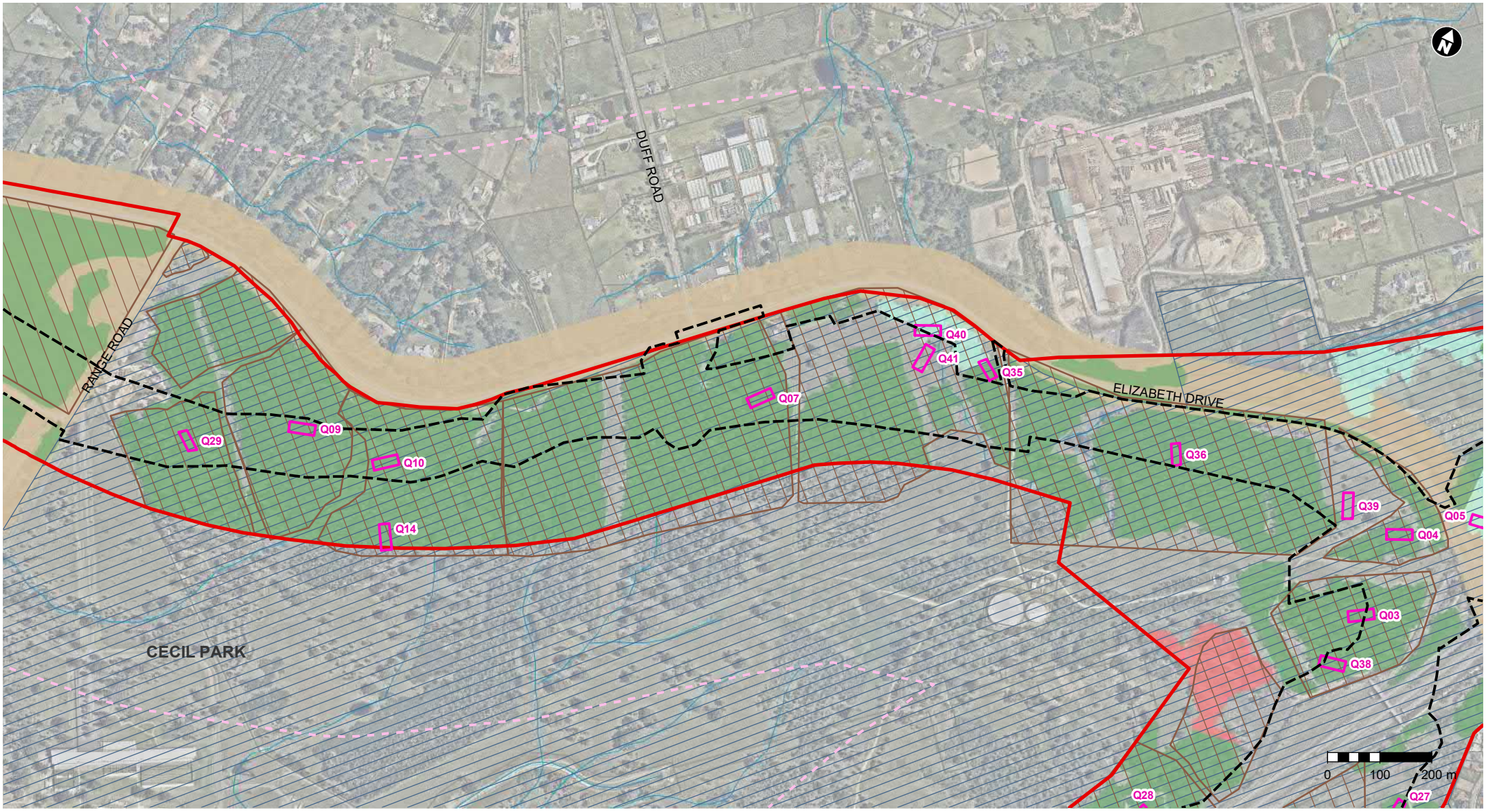

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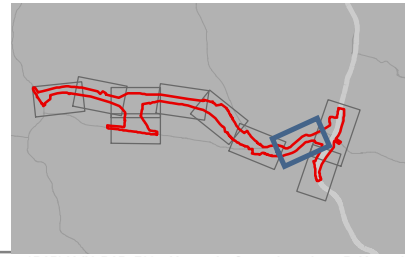

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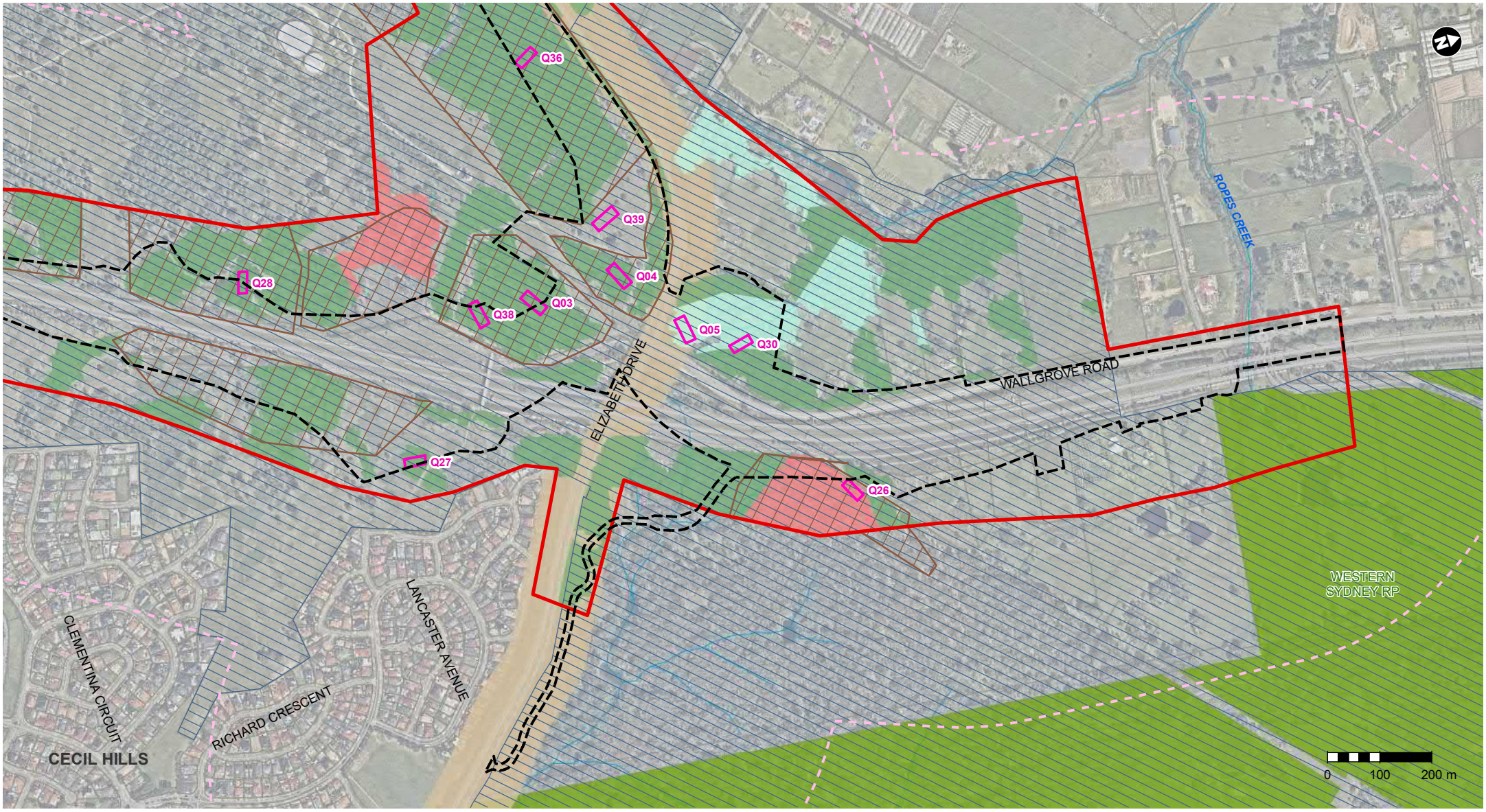

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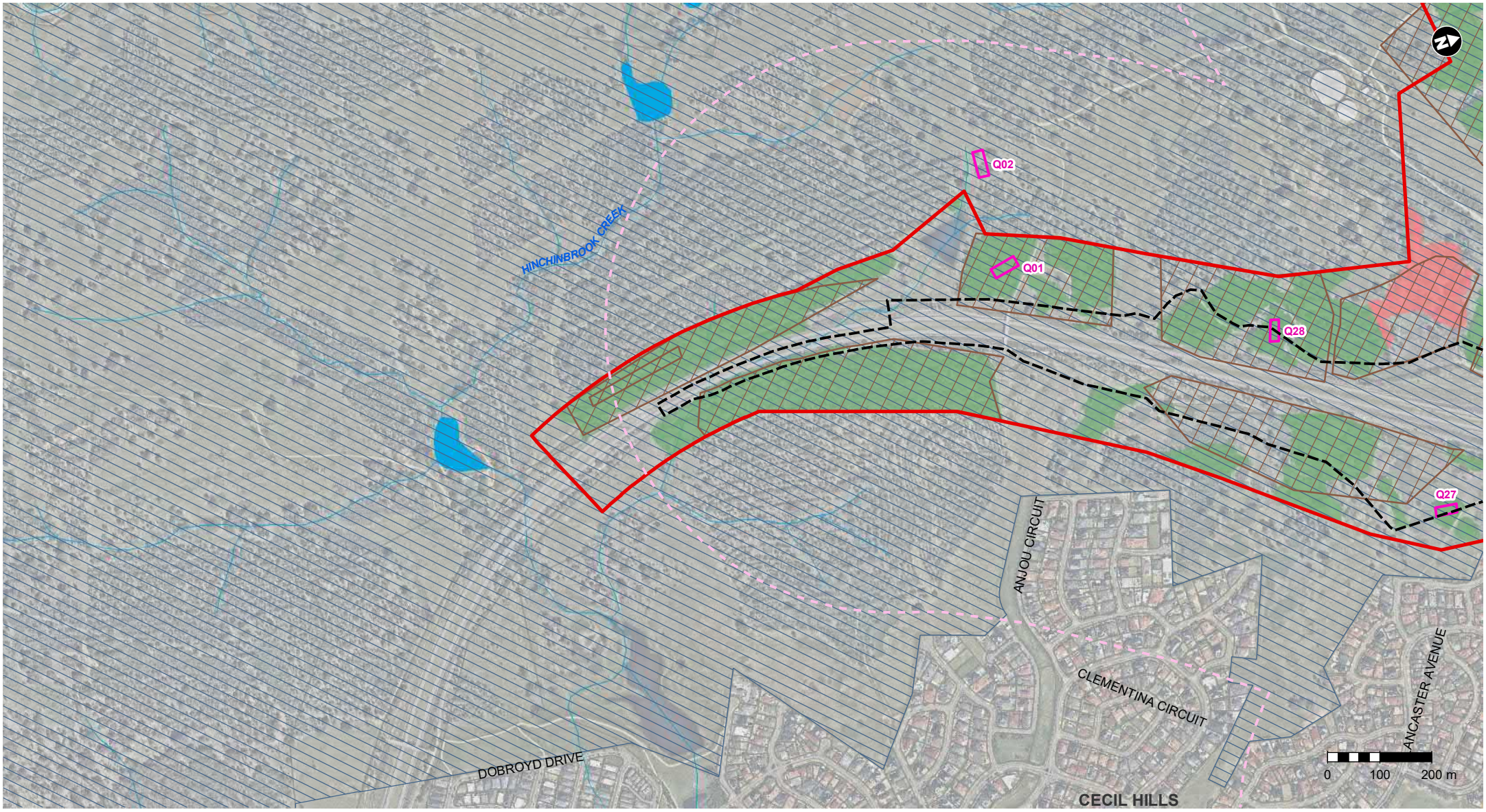

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- Grey Box - Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin Bioregion [849]
- Grey Box - Forest Red Gum grassy woodland on shale of the southern Cumberland Plain, Sydney Basin Bioregion [850]
- Grey Box - Forest Red Gum grassy woodland on shale of the southern Cumberland Plain, Sydney Basin Bioregion (derived grassland form) [850]
- Hard-leaved Scribbly Gum - Parramatta Red Gum heathy woodland of the Cumberland Plain, Sydney Basin Bioregion [883]
- Swamp Oak open forest on riverflats of the Cumberland Plain and Hunter valley [1800]

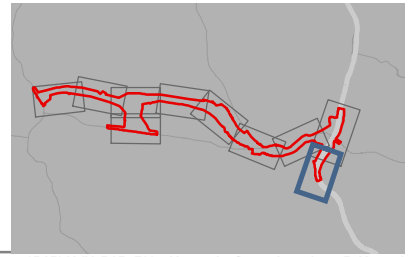

Figure 3-1 Vegetation survey locations

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Created by : CA | QA by : RB

The 2013 (OEH, 2013) Cumberland Plain mapping covers the majority of the study area, while the 2016 (OEH, 2016) mapping covers the easternmost portions of the study area around the M7 Motorway. The two vegetation maps do not overlap. The area of each vegetation community mapped by EESG (OEH, 2013, OEH, 2016) within the study area and construction footprint are listed in **Table 3-6** and shown on **Figure 2-3**.

Table 3-6 Vegetation map units and corresponding PCTs mapped by EESG (OEH, 2013 and OEH, 2016) in the study area and construction footprint

Vegetation map units (OEH, 2013, OEH, 2016)	Corresponding PCT	Total area mapped within study area (ha)	Total area mapped within construction footprint (ha)
103 - Shale/Gravel Transition Forest (OEH, 2013)	724 - Broad-leaved Ironbark - Grey Box - Melaleuca decora grassy open forest on clay/gravel soils of the Cumberland Plain, Sydney Basin Bioregion	15.56	8.28
3 - Cooks River Castlereagh Ironbark Forest (OEH, 2013)	725 - Broad-leaved Ironbark - Melaleuca decora shrubby open forest on clay soils of the Cumberland Plain, Sydney Basin Bioregion	0.46	0
S_GW01: Cumberland Moist Shale Woodland (OEH, 2016)	830 - Forest Red Gum - Grey Box shrubby woodland on shale of the southern Cumberland Plain, Sydney Basin Bioregion	4.02	1.21
11 - Alluvial Woodland (OEH, 2013) S_FoW06: Cumberland Riverflat Forest (OEH, 2016)	835 - Forest Red Gum - Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney Basin Bioregion And 1800 - Swamp Oak open forest on riverflats of the Cumberland Plain and Hunter valley [1800]	38.66	7.87
10 - Shale Plains Woodland (OEH, 2013) S_GW03: Cumberland Shale Plains Woodland (OEH, 2016)	849 - Grey Box - Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin Bioregion	36.80	12.06
9 - Shale Hills Woodland (OEH, 2013) S_GW02: Cumberland Shale Hills Woodland (OEH, 2016)	850 - Grey Box - Forest Red Gum grassy woodland on shale of the southern Cumberland Plain, Sydney Basin Bioregion (includes revegetation within Western Sydney Parklands)	44.55	15.50
6 - Castlereagh Scribbly Gum Woodland (OEH, 2013)	883 - Hard-leaved Scribbly Gum - Parramatta Red Gum heathy woodland of the Cumberland Plain, Sydney Basin Bioregion	14.40	8.56
Plant_n: Plantation (native and/or exotic) (OEH, 2016)	N/A	25.29	24.02
Total		**179.75**	**77.50**

3.2.2 Plant community types

Following desktop review and ground truthing, eight different PCTs were identified in the study area, of which seven are mapped within the construction footprint (**Table 3-7**).

Table 3-7 Ground-truthed PCTs identified in the study area and construction footprint

PCT No.	PCT Name	Area within study area (ha)	Area within construction footprint (ha)	Area within construction footprint excluding certified areas (ha)
724	Broad-leaved Ironbark - Grey Box - Melaleuca decora grassy open forest on clay/gravel soils of the Cumberland Plain, Sydney Basin Bioregion	12.82	6.91	6.91
725	Broad-leaved Ironbark - Melaleuca decora shrubby open forest on clay soils of the Cumberland Plain, Sydney Basin Bioregion	0.50	0	0
830	Forest Red Gum - Grey Box shrubby woodland on shale of the southern Cumberland Plain, Sydney Basin Bioregion	4.97	0.44	0.44
835	Forest Red Gum - Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney Basin Bioregion	20.70	3.23	3.23
849	Grey Box - Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin Bioregion	18.11	6.59	6.09
850	Grey Box - Forest Red Gum grassy woodland on shale of the southern Cumberland Plain, Sydney Basin Bioregion (includes revegetation within Western Sydney Parklands and derived grasslands in Low condition)	154.44	61.76	54.07
883	Hard-leaved Scribbly Gum - Parramatta Red Gum heathy woodland of the Cumberland Plain, Sydney Basin Bioregion	0.93	0.38	0.38
1800	Swamp Oak open forest on riverflats of the Cumberland Plain and Hunter valley	16.00	2.53	2.53
Total		**228.47**	**81.84**	**73.65**

The vegetation in the study area has a long history of disturbance and some areas have been replanted. The PCTs in the locality have similar canopy dominants, and some have high overlap in characteristic species. Consequently, identification of PCTs using characteristic or positive diagnostic species is challenging (see **Section 3.1.2** for detailed methods).

Quantitative analysis of the vegetation quadrat data was undertaken to test the justifications for assigning PCTs. The vegetation data was compared with the lists of positive diagnostic species for the vegetation communities as defined by Tozer *et al.*, (2010) that the PCTs are based on, as referenced in the identified in the BioNet Vegetation Classification data collection.

For each vegetation community, the minimum number of positive diagnostic species expected to be recorded in a sample site has been calculated (Tozer *et al.*, 2010). The presence of the minimum number of positive diagnostic species in a sample site is strong evidence that the sample belongs to the vegetation

community. It is necessary for identification using this method that the total number of native species recorded in the sample site exceeds a specified minimum; species-poor sites cannot be tested (Tozer *et al.*, 2010).

The results of the vegetation data analyses are listed in **Table 3-8**. Most of the quadrats sampled had low native species counts in comparison with the minimum number of species required for identification of the mapped PCT. As such, most of the vegetation in the study area cannot be reliably identified using solely analysis of positive diagnostic species. Other characteristics such as landscape position, soils and geology have therefore informed the assigning of vegetation patches to corresponding PCTs. The only quadrat with a sufficiently high species counts to meet the positive diagnostic species criteria for multiple PCTs was Q11.

Table 3-8 Vegetation data analysis

PCT			**724**	**725**	**830**	**835**	**849**	**850**	**883**	**1800**
Tozer et al. (2010) map unit			**DSF p502**	**DSF p1**	**GWp 514**	**FoW p33**	**GW p29**	**GW p28**	**DSF p7**	**FoW p105**
Minimum native species			**37**	**35**	**30**	**26**	**31**	**31**	**43**	**12**
Minimum positive diagnostic species			**25**	**21**	**19**	**16**	**26**	**20**	**30**	**3**
Mapped PCT	**Quadrat**	**Native species**								
724	Q11	43	33	29	7	17	29	17	20	1
	Q12	14	11	8	2	6	11	6	6	0
	Q17	24	16	13	3	8	18	10	10	0
	Q22	25	19	17	3	9	17	8	12	0
	Q34	11	8	7	4	7	9	5	4	1
	Q37	22	13	15	4	8	13	7	10	0
830	Q26	17	8	3	11	10	12	9	2	1
835	Q15	17	8	4	7	14	13	12	2	1
	Q20	17	11	8	5	12	12	8	5	4
849	Q05	20	12	5	7	13	17	12	2	2
	Q16	10	6	5	3	6	8	7	4	1
	Q30	15	8	4	9	11	12	10	1	1
	Q31	9	4	2	2	7	9	6	2	1
	Q33	13	8	7	3	10	12	7	4	0
	Q40	12	8	7	3	10	12	7	4	0

PCT			724	725	830	835	849	850	883	1800
Tozer et al. (2010) map unit			DSF p502	DSF p1	GWp 514	FoW p33	GW p29	GW p28	DSF p7	FoW p105
Minimum native species			37	35	30	26	31	31	43	12
Minimum positive diagnostic species			25	21	19	16	26	20	30	3
Mapped PCT	Quadrat	Native species								
850	Q01	19	10	5	8	7	15	11	2	0
	Q02	10	7	3	7	7	9	8	1	0
	Q03	18	8	5	11	10	13	17	3	1
	Q04	15	9	5	4	9	13	7	1	0
	Q07	15	6	4	6	6	12	10	2	1
	Q09	15	8	4	8	9	12	8	1	0
	Q10	18	9	6	7	8	14	13	3	0
	Q14	11	7	3	5	8	10	6	2	1
	Q18	7	4	3	4	4	6	5	2	1
	Q19	7	5	4	1	1	7	5	4	1
	Q24	4	1	2	1	1	3	2	2	1
	Q25	5	0	1	2	1	5	4	1	1
	Q27	15	7	5	5	7	12	11	3	1
	Q28	16	8	5	7	7	13	14	3	1
	Q29	9	5	2	4	6	8	6	1	1
	Q35	17	12	5	8	10	16	13	3	0
	Q36	7	5	2	4	4	5	5	1	0
	Q38	31	8	4	9	11	20	16	2	1
1800	Q13	8	3	2	4	6	7	7	2	1
	Q21	2	1	0	1	2	1	1	0	1
	Q23	4	1	1	0	3	2	1	1	1

3.2.3 Vegetation zones

Fourteen vegetation zones were identified within the seven PCTs in the construction footprint (**Figure 3-2**). Vegetation zones for each PCT were determined based on review of site value scores.

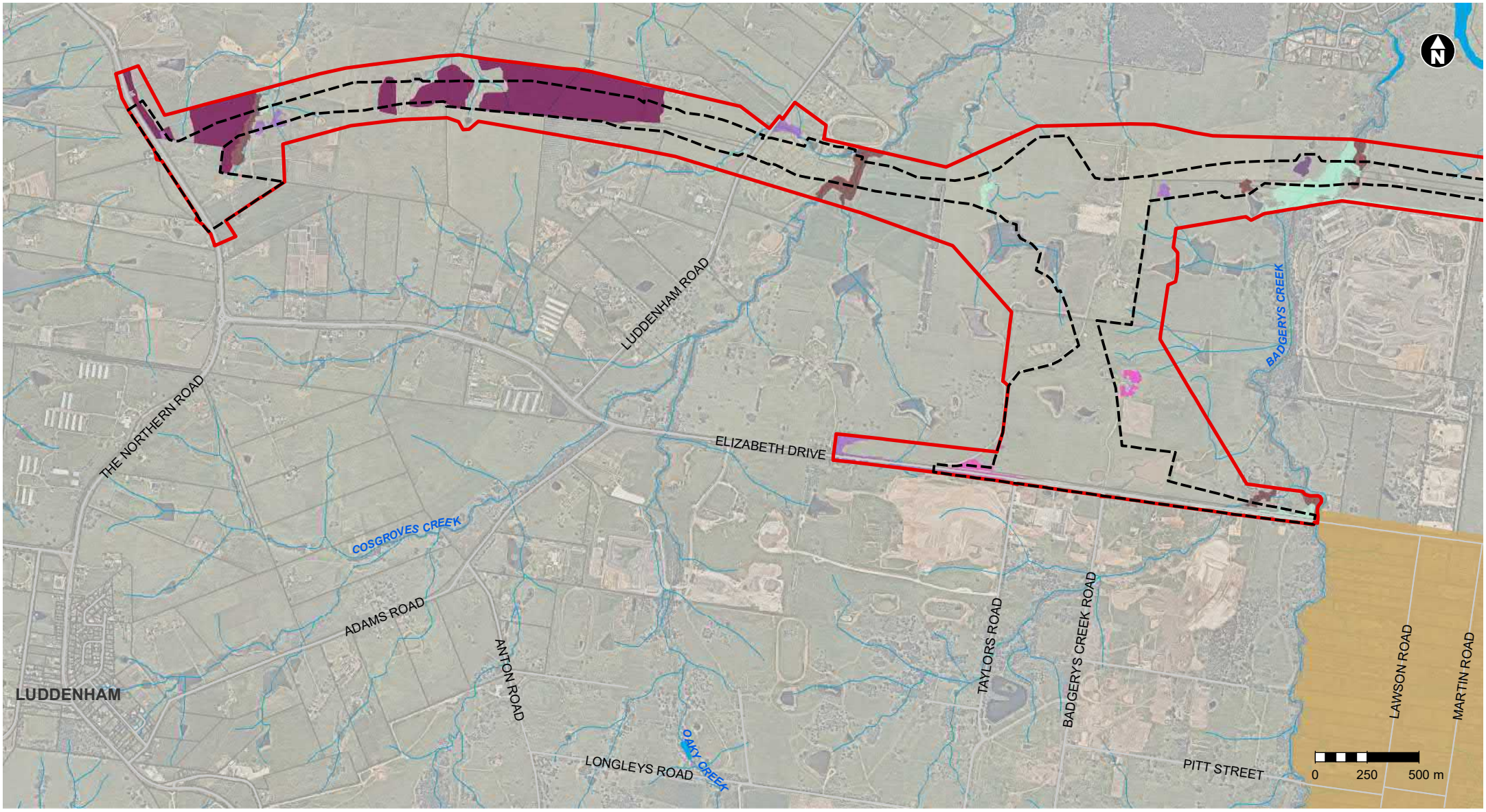
Site value is a measure of the condition of native vegetation and is assessed for each vegetation zone by calculating the scores for a range of condition attributes collected in plots, as listed in **Section 3.1.2**, against the benchmark values for each PCT.

If an assessor determines that a PCT has a site value score of 17 or less, then as per Section 5.3.1.5 of the FBA (OEH, 2014), no further assessment of native vegetation is required for that vegetation zone.

The vegetation zones and site value scores (as determined using the FBA credit calculator) for each PCT are listed in **Table 3-9**. All PCTs identified in the study area have site value scores greater than the low condition threshold score of 17, except for one vegetation zone within PCT 850. A plot could not be completed in PCT 883 due to the size and dimension of the remaining fragmented vegetation. As such this PCT does not have a site value score. Descriptions of each vegetation zone are provided below.

Table 3-9 Vegetation zones

Veg zone	Vegetation zone code	PCT Name	TEC	Site value score	Area within construction footprint excluding certified areas (ha)
1	724 - Moderate/ Good_High	Broad-leaved Ironbark - Grey Box - Melaleuca decora grassy open forest on clay/gravel soils of the Cumberland Plain, Sydney Basin Bioregion	Yes	74.64	3.50
2	724 - Moderate/ Good_Medium		Yes	55.07	2.96
3	724 - Moderate/ Good_Poor		Yes	28.99	0.45
4	830 - Moderate/ Good_Poor	Forest Red Gum - Grey Box shrubby woodland on shale of the southern Cumberland Plain, Sydney Basin Bioregion	Yes	35.94	0.44
5	835 - Moderate/ Good_Poor	Forest Red Gum - Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney Basin Bioregion	Yes	35.76	3.23
6	849 - Moderate/ Good_Medium	Grey Box - Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin Bioregion	Yes	45.65	3.54
7	849 - Moderate/ Good_Poor		Yes	22.46	2.07
8	849 - Moderate/ Good_Other (Derived Shrubland)		Yes	26.09	0.48
9	850 - Moderate/ Good_High	Grey Box - Forest Red Gum grassy woodland on shale of the southern Cumberland Plain, Sydney Basin Bioregion	Yes	50.97	3.21
10	850 - Moderate/ Good_Medium		Yes	42.03	10.14
11	850 - Moderate/ Good_Other (Revegetation)		Yes	57.97	22.65
12	850 -Low		Yes	13.77	18.07
13	883 - Poor	Hard-leaved Scribbly Gum - Parramatta Red Gum heathy woodland of the Cumberland Plain, Sydney Basin Bioregion	No	N/A	0.38
14	1800 - Moderate/ Good_Poor	Swamp Oak open forest on riverflats of the Cumberland Plain and Hunter valley	Yes	27.26	2.53
Total					**73.65**



Study area corridor
The project construction footprint
Western Sydney Parklands
NPWS Reserves
Biodiversity certified land
Cadastre
Waterways

Vegetation Zones

725 - Moderate/Good -Medium
724 - Moderate/Good - High
724 - Moderate/Good - Medium
724 - Moderate/Good - Poor
830 - Moderate/Good - Poor
835 - Moderate/Good - Poor
849 - Moderate/Good - Medium
849 - Moderate/Good - Poor
849 - Moderate/Good - Other (Derived Shrubland)
850 - Moderate/Good - High
850 - Moderate/Good - Medium
850 - Low
850 - Moderate/Good -Other (Revegetation)
883 - Poor
1800 - Moderate/Good - Poor

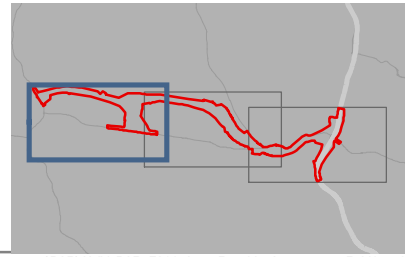


Figure 3-2 Vegetation zones

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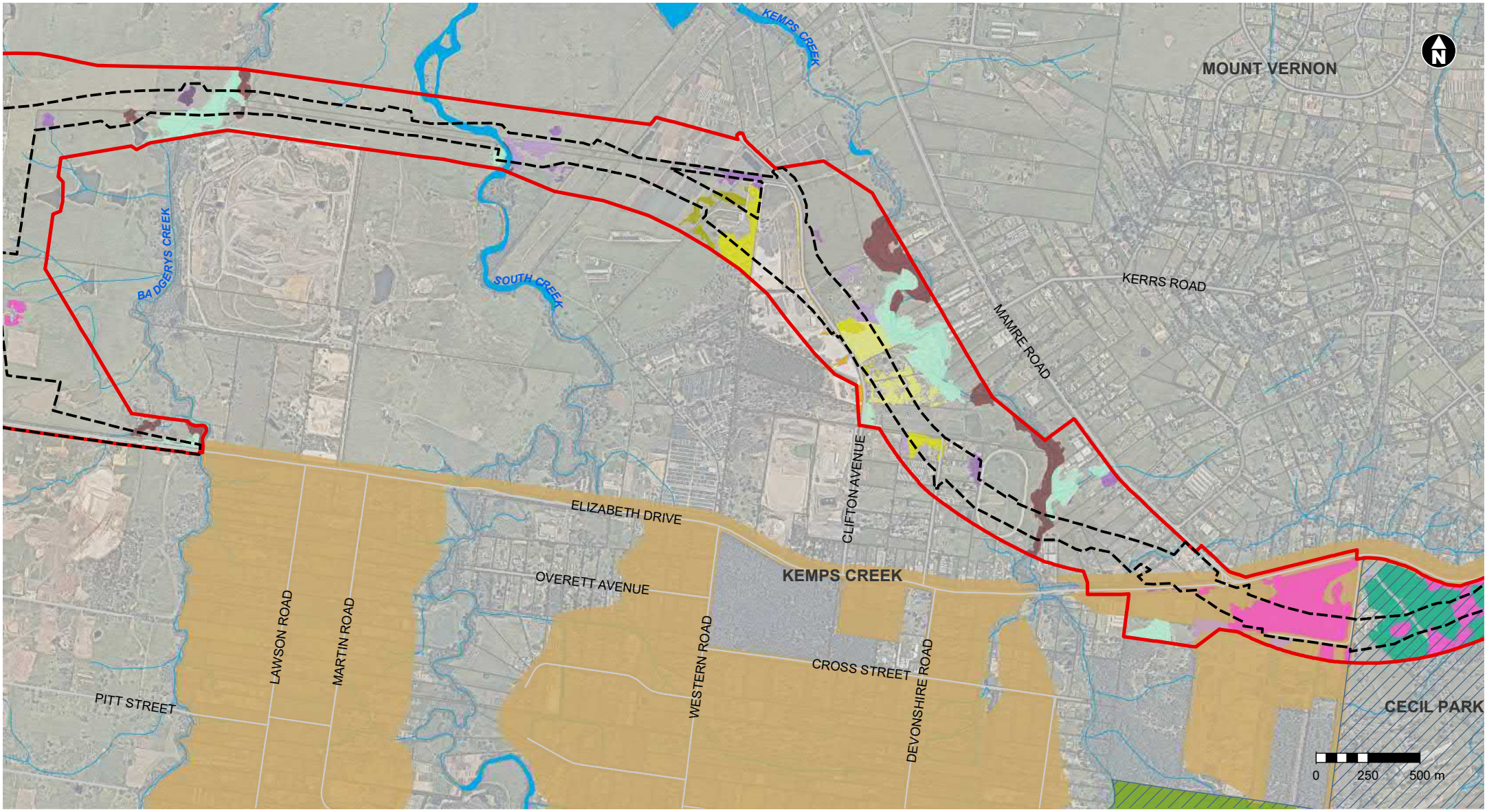

Study area corridor
The project construction footprint
Western Sydney Parklands
NPWS Reserves
Biodiversity certified land
Cadastre
Waterways

Vegetation Zones

725 - Moderate/Good -Medium
724 - Moderate/Good - High
724 - Moderate/Good - Medium
724 - Moderate/Good - Poor
830 - Moderate/Good - Poor
835 - Moderate/Good - Poor
849 - Moderate/Good - Medium
849 - Moderate/Good - Poor
849 - Moderate/Good - Other (Derived Shrubland)
850 - Moderate/Good - High
850 - Moderate/Good - Medium
850 - Low
850 - Moderate/Good -Other (Revegetation)
883 - Poor
1800 - Moderate/Good - Poor

Figure 3-2 Vegetation zones

Date: 27/06/2019 Path: \\10.10.25.32\data\GIS\MXDs\Figures\Technical_reports\BAR\JAJV_BAR_F014_AreasRequiringAssessment_R5V4.mxd
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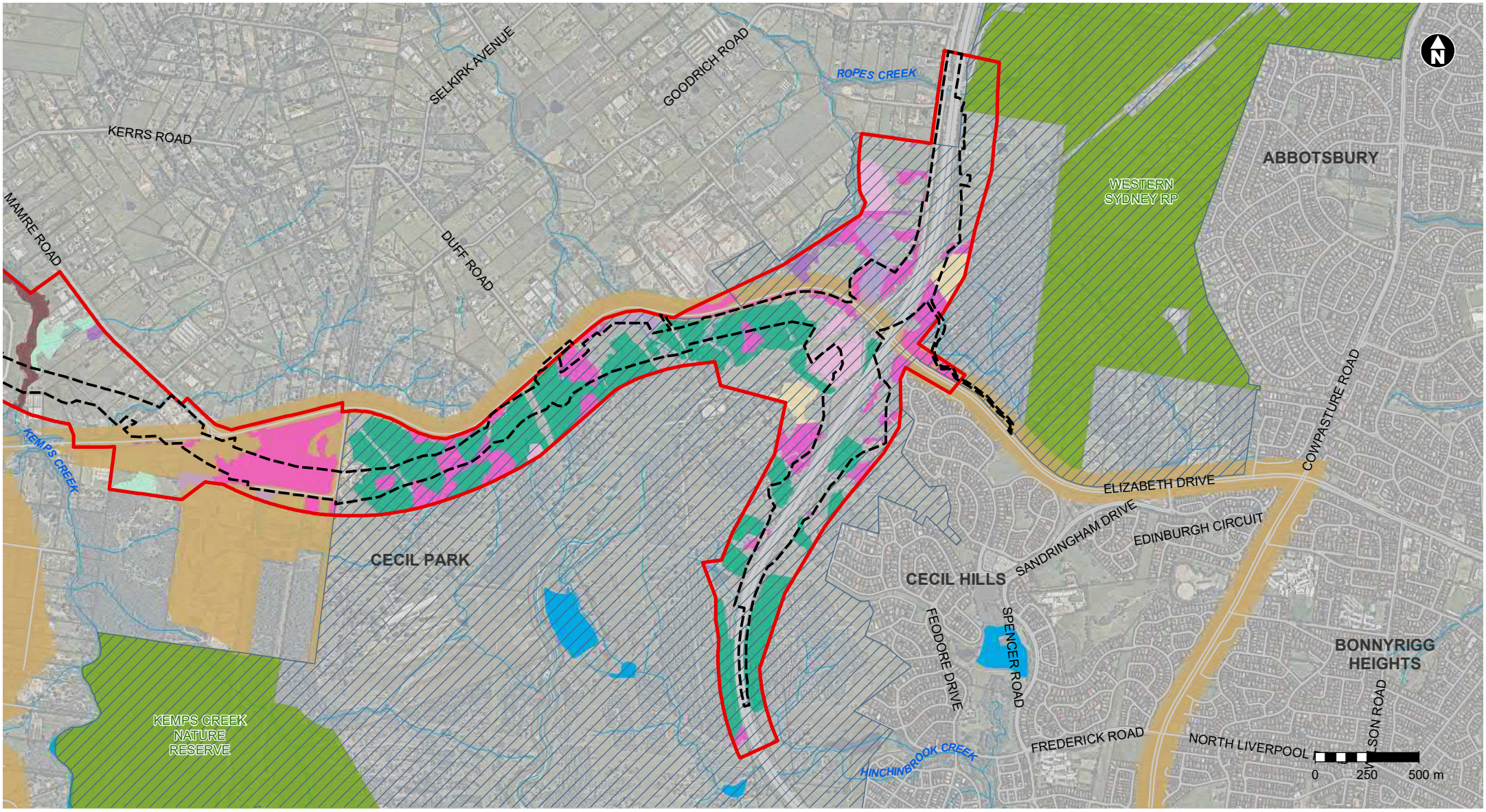


Study area corridor
The project construction footprint
Western Sydney Parklands
NPWS Reserves
Biodiversity certified land
Cadastre
Waterways

Vegetation Zones

- 725 - Moderate/Good -Medium
- 724 - Moderate/Good - High
- 724 - Moderate/Good - Medium
- 724 - Moderate/Good - Poor
- 830 - Moderate/Good - Poor
- 835 - Moderate/Good - Poor
- 849 - Moderate/Good - Medium
- 849 - Moderate/Good - Poor
- 849 - Moderate/Good - Other (Derived Shrubland)
- 850 - Moderate/Good - High
- 850 - Moderate/Good - Medium
- 850 - Low
- 850 - Moderate/Good -Other (Revegetation)
- 883 - Poor
- 1800 - Moderate/Good - Poor

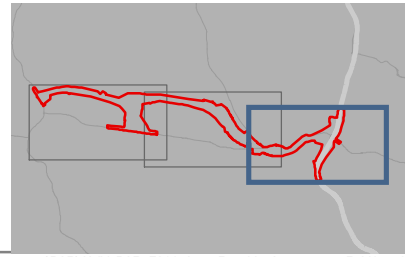


Figure 3-2 Vegetation zones

Date: 27/06/2019 Path: \\10.10.25.32\data\GIS\MXDs\Figures\Technical_reports\BAR\JAJV_BAR_F014_AreasRequiringAssessment_R5V4.mxd
Created by : CA | QA by : RB

Zone 1: Broad-leaved Ironbark – Grey Box – Melaleuca decora grassy open forest on clay/gravel soils of the Cumberland Plain, Sydney Basin Bioregion – Moderate/Good_High

Vegetation formation: KF_CH5A Dry Sclerophyll Forests (Shrub/grass sub-formation)

Vegetation class: Cumberland Dry Sclerophyll Forests

PCT: 724 **BVT:** HN512

Conservation status: TSC Act: endangered – forms Shale Gravel Transition Forest in the Sydney Basin Bioregion; EPBC Act: critically endangered – some patches meet the condition threshold to form Cumberland Plain Shale Woodlands and Shale-Gravel Transition Forest.

Estimate of per cent cleared: 75 per cent

Condition: Moderate/Good_High

Extent in the study area: 5.40 hectares

Extent in the construction footprint: 3.50 hectares

Plots completed in vegetation zone: Two (Q11, Q22)

Structure	Average height and height range (m)	Average cover and cover range	Typical species
Trees	12 (8-14)	20.5 (11-30)	*Eucalyptus tereticornis, Eucalyptus fibrosa*
Small trees	3 (2-5)	29 (16-42)	*Melaleuca decora, Melaleuca nodosa, Acacia decurrens, Acacia parramattensis*
Shrubs	1 (0.5-2)	13 (12-14)	*Bursaria spinosa, Daviesia ulicifolia, Dillwynia sieberi, Dillwynia tenuifolia, Lissanthe strigosa, Leucopogon juniperinus, Ozothamnus diosmifolius*
Ground covers	0.3 (0.1-0.5)	30.5 (23-38)	*Microlaena stipoides, Themeda triandra, Lomandra filiformis, Entolasia stricta, Aristida vagans*
Vines & climbers	N/A	0.5 (0-1)	*Glycine clandestina*

Description: Broad-leaved Ironbark – Grey Box – Melaleuca decora grassy open forest on clay/gravel soils of the Cumberland Plain, Sydney Basin Bioregion is recognised as a community associated with shale-influenced sandy soils that support a component of ironstone gravels, with relatively low fertility compared to the deeper Wianamatta shale soils of the Cumberland Plain (OEH, 2018). This PCT is an open eucalypt forest with an understorey that varies between dense shrubs and a low sparse shrub cover with an abundant ground cover of grasses.

The canopy typically includes broad-leaved ironbark *Eucalyptus fibrosa* along with a wide variety of other eucalypts depending on location. The taller paperbark *Melaleuca decora* may be prominent above a lower open shrub layer of blackthorn *Bursaria spinosa* and gorse bitter pea *Daviesia ulicifolia*. The ground cover is a mix of grasses, sedges and herbs (OEH, 2018).

Within the study area, Broad-leaved Ironbark – Grey Box – Melaleuca decora grassy open forest on clay/gravel soils of the Cumberland Plain, Sydney Basin Bioregion occurs around Clifton Avenue in the central part of the study area. The vegetation that falls within the Moderate/Good_High condition within the construction footprint consist of the larger and less disturbed patches of the PCT to the east of Clifton Avenue. The canopy is characterised by *Eucalyptus fibrosa* and *Eucalyptus tereticornis,* with an often dense layer of *Melaleuca decora* and *Melaleuca nodosa* in the midstorey. The ground layer varied from very sparse under the areas dominated by *Melaleuca* spp., to scattered shrubs, grasses and forbs in more open areas. There was observed to be high cover of lichen across much of this vegetation, and exotic cover was minimal.

The threatened flora species *Pultenaea parviflora* and *Dillwynia tenuifolia* were recorded in this vegetation zone.

It should be noted that some areas of the PCT mapped within this vegetation zone are highly fragmented patches that may not be in Moderate/Good_High condition. These areas could not be inspected due to access being withheld by the landowners, and therefore have been conservatively assumed to be in Moderate/Good_High condition. This assessment may be revised following more detailed ground truthing.


Plate 1: Broad-leaved Ironbark – Grey Box – Melaleuca decora grassy open forest on clay/gravel soils of the Cumberland Plain, Sydney Basin Bioregion – Moderate/Good_High

Zone 2: Broad-leaved Ironbark – Grey Box – Melaleuca decora grassy open forest on clay/gravel soils of the Cumberland Plain, Sydney Basin Bioregion – Moderate/Good_Medium

Vegetation formation: KF_CH5A Dry Sclerophyll Forests (Shrub/grass sub-formation)

Vegetation class: Cumberland Dry Sclerophyll Forests

PCT: 724 **BVT:** HN512

Conservation status: TSC Act: endangered – forms Shale Gravel Transition Forest in the Sydney Basin Bioregion; EPBC Act: critically endangered – some patches meet the condition threshold to form Cumberland Plain Shale Woodlands and Shale-Gravel Transition Forest.

Estimate of per cent cleared: 75 per cent

Condition: Moderate/Good_Medium

Extent in the study area: 5.59 hectares

Extent in the construction footprint: 2.96 hectares

Plots completed in vegetation zone: Three (Q12, Q17, Q37)

Structure	Average height and height range (m)	Average cover and cover range	Typical species
Trees	12-14	13.5 (12-15)	*Eucalyptus fibrosa, Eucalyptus moluccana*
Small trees	2-4	16 (9-23)	*Melaleuca decora, Melaleuca nodosa, Allocasuarina littoralis*
Shrubs	0.2-2	46.15 (16.3-76)	*Bursaria spinosa, Ozothamnus diosmifolius, Cassinia aculeata*
Ground covers	0.1-0.5	54.55 (39.1-70)	*Microlaena stipoides, Poa sieberiana, Cenchrus clandestinus*, Setaria parviflora**
Vines & climbers	N/A	N/A	N/A

Description: Broad-leaved Ironbark – Grey Box – Melaleuca decora grassy open forest on clay/gravel soils of the Cumberland Plain, Sydney Basin Bioregion in Moderate/Good_Medium condition is located to the west of the northern extent of Clifton Avenue in the central section of the construction footprint.

This vegetation generally has a canopy dominated by *Eucalyptus fibrosa* with some *Eucalyptus moluccana,* a midstorey of *Melaleuca decora* and *Melaleuca nodosa,* and an often diverse shrub layer including *Bursaria spinosa, Ozothamnus diosmifolius* and *Daviesia ulicifolia.* Some areas of this vegetation zone comprised a dense shrub layer dominated by *Melaleuca nodosa,* with trees sparse to absent and a reduced

ground layer. The ground layer in this vegetation zone is disturbed and consists of a mixture of native and exotic species. Common native groundlayer species include *Microlaena stipoides, Poa sieberiana, Lomandra multiflora* and *Einadia* spp. Perennial exotic grasses such as *Cenchrus clandestinus, Ehrharta erecta* and *Setaria parviflora* are often abundant in the ground layer.

The threatened flora species *Dillwynia tenuifolia* was recorded in this vegetation zone.

Plate 2: Broad-leaved Ironbark – Grey Box – Melaleuca decora grassy open forest on clay/gravel soils of the Cumberland Plain, Sydney Basin Bioregion – Moderate/Good_Medium

Zone 3: Broad-leaved Ironbark – Grey Box – Melaleuca decora grassy open forest on clay/gravel soils of the Cumberland Plain, Sydney Basin Bioregion – Moderate/Good_Poor

Vegetation formation: KF_CH5A Dry Sclerophyll Forests (Shrub/grass sub-formation)

Vegetation class: Cumberland Dry Sclerophyll Forests

PCT: 724 **BVT:** HN512

Conservation status: TSC Act: endangered – forms Shale Gravel Transition Forest in the Sydney Basin Bioregion; EPBC Act: critically endangered – some patches meet the condition threshold to form Cumberland Plain Shale Woodlands and Shale-Gravel Transition Forest.

Estimate of per cent cleared: 75 per cent

Condition: Moderate/Good_Poor

Extent in the study area: 1.83 hectares

Extent in the construction footprint: 0.45 hectares

Plots completed in vegetation zone: One (Q34)

Structure	Average height and height range (m)	Average cover and cover range	Typical species
Trees	8-9	3	*Eucalyptus tereticornis, Eucalyptus fibrosa*
Small trees	8	15	*Melaleuca decora*
Shrubs	2	1	*Bursaria spinosa*
Ground covers	0.1-0.3	52	*Microlaena stipoides, Brunoniella australis, Cenchrus clandestinus*, Sporobolus africanus*, Paspalum dilatatum**
Vines & climbers	N/A	1	*Glycine clandestina*

Description: Broad-leaved Ironbark – Grey Box – Melaleuca decora grassy open forest on clay/gravel soils of the Cumberland Plain, Sydney Basin Bioregion in Moderate/Good_Poor condition occurs as scattered, fragmented patches to the west of the northern extent of Clifton Avenue in the central section of the construction footprint.

This vegetation is highly degraded and has been intensively grazed, with abundant cow dung observed in the ground layer during site inspections. The canopy is reduced to occasional trees of *Eucalyptus fibrosa* and *Eucalyptus tereticornis,* and scattered *Melaleuca decora* in the midstorey. The shrub layer comprised isolated plants of *Bursaria spinosa* and several dead individuals of *Acacia decurrens.* The ground layer in this vegetation zone is highly reduced, and consists of grazed native and exotic grasses, mainly the native *Microlaena stipoides* and the exotic *Cenchrus clandestinus.* Native species diversity and cover in the ground layer of this vegetation zone is generally low.

Plate 3: Broad-leaved Ironbark – Grey Box – Melaleuca decora grassy open forest on clay/gravel soils of the Cumberland Plain, Sydney Basin Bioregion – Moderate/Good_Poor

Zone 4: Forest Red Gum - Grey Box shrubby woodland on shale of the southern Cumberland Plain, Sydney Basin Bioregion - Moderate/Good_Poor

Vegetation formation: KF_CH3 Grassy Woodlands

Vegetation class: Coastal Valley Grassy Woodlands

PCT: 830 **BVT:** HN524

Conservation status: TSC Act: endangered – Moist Shale Woodland in the Sydney Basin Bioregion, EPBC Act: critically endangered – some patches meet the condition threshold to form Western Sydney Dry Rainforest and Moist Woodland on Shale.

Estimate of per cent cleared: 75 per cent

Condition: Moderate/Good_Poor

Extent in the study area: 4.97 hectares

Extent in the construction footprint: 0.44 hectares

Plots completed in vegetation zone: One (Q26)

Structure	Average height and height range (m)	Average cover and cover range	Typical species
Trees	10-18	10	*Eucalyptus moluccana, Eucalyptus tereticornis*
Small trees	4	1	*Acacia implexa*
Shrubs	1-2	20	*Clerodendrum tomentosum, Breynia oblongifolia, Olea europaea subsp. cuspidata*, Lantana camara**
Ground covers	0.1-0.5	71	*Microlaena stipoides, Oplismenus aemulus, Chloris gayana**
Vines & climbers	N/A	1	*Glycine clandestina, Asparagus asparagoides**

Description: Forest Red Gum – Grey Box shrubby woodland on shale of the southern Cumberland Plain, Sydney Basin Bioregion occurs on protected aspects on steeper shale hills and rises of the southern half of the Cumberland Plain. It can be distinguished from the grassy woodlands in the region by the prevalence of waxy-leaved shrubs and small trees such as *Clerodendrum tomentosum* in the understorey and a ground cover of herbs, fleshy twiners and grasses (OEH, 2018).

This PCT has a canopy mostly dominated by *Eucalyptus tereticornis* and *Eucalyptus moluccana*; however, there is a distinct band of *Corymbia maculata* along the sheltered slopes between Cecil Hills and Prospect Reservoir. It has been extensively cleared, with remaining stands often choked by dense thickets of *Olea europaea subsp. cuspidata*, which reduces species diversity (OEH, 2018).

The Forest Red Gum - Grey Box shrubby woodland on shale of the southern Cumberland Plain, Sydney Basin Bioregion in the study area is located on steeper south-facing slopes in the Western Sydney Parklands in the east of the study area, to the north-east and south-west of the M7/Elizabeth Drive intersection.

The area of this PCT within the construction footprint is limited to the disturbed westernmost portion of a larger patch of the PCT, located on a slope to the east of the M7. This vegetation consists of a woodland of *Eucalyptus moluccana* and *Eucalyptus tereticornis,* with an open understorey that includes scattered thickets of *Clerodendrum tomentosum, Acacia implexa* and the priority weeds *Lantana camara* and *Olea europaea* subsp. *cuspidata.* Denser stands of *Lantana camara* were observed in some areas of the PCT. The ground layer is grassy and herbaceous, with a high litter component, and was dominated by a mixture of native and exotic grasses and forbs.

Plate 4: Forest Red Gum – Grey Box shrubby woodland on shale of the southern Cumberland Plain, Sydney Basin Bioregion – Moderate/Good_Poor

Zone 5: Forest Red Gum – Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney Basin Bioregion – Moderate/Good_Poor

Vegetation formation: KF_CH9 Forested Wetlands

Vegetation class: Coastal Floodplain Wetlands

PCT: 835 **BVT:** HN526

Conservation status: TSC Act: endangered – River-Flat Eucalypt Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions

Estimate of per cent cleared: 93 per cent

Condition: Moderate/Good_Poor

Extent in the study area: 20.70 hectares

Extent in the construction footprint: 3.23 hectares

Plots completed in vegetation zone: Two (Q15, Q20)

Structure	Average height and height range (m)	Average cover and cover range	Typical species
Trees	12 (8-16)	29.5 (20-39)	*Eucalyptus tereticornis, Angophora floribunda, Eucalyptus amplifolia*
Small trees	8 (5-12)	4 (3-5)	*Melaleuca styphelioides, Casuarina glauca*
Shrubs	2	24.05 (17.1-31)	*Bursaria spinosa*
Ground covers	0.3 (0.1-0.5)	98.4 (94.8-102)	*Microlaena stipoides, Pratia purpurascens, Tradescantia fluminensis*, Ehrharta erecta*, Bidens pilosa**
Vines & climbers	N/A	2.3 (1-3.6)	*Glycine tabacina*

Description: Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney Basin Bioregion is an open eucalypt forest situated on broad alluvial flats of the Hawkesbury and Nepean river systems, and also forms narrower ribbons alongside streams and creeks that drain the Cumberland Plain (OEH, 2018). The canopy typically includes one of either *Angophora floribunda* or *Angophora subvelutina*, and one or both of *Eucalyptus tereticornis* and *Eucalyptus amplifolia*.

The understorey within this PCT is characterised by an occasional sparse to open small tree stratum of *Melaleuca* spp. and *Acacia* spp., and a sparse lower shrub layer of *Bursaria spinosa*. The ground layer is characterised by an abundant cover of grasses with small herbs and ferns.

In the study area, Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney Basin Bioregion occurs on flats adjoining Badgerys Creek, South Creek and Kemps Creek and their tributaries. Areas of this PCT within the construction footprint are limited to a wide band around Badgerys Creek, and smaller fragmented patches around South Creek, a tributary of Badgerys Creek that crosses Elizabeth Drive, and various smaller drainage lines crossing the western two-thirds of the footprint.

The Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney Basin Bioregion in Moderate/Good – Poor condition is characterised by a canopy of *Eucalyptus tereticornis* and *Eucalyptus amplifolia,* with *Angophora floribunda* and *Angophora subvelutina* also present, sometimes as a canopy dominant. *Melaleuca decora* and *Melaleuca styphelioides* are occasionally present in the midstorey, and there is often a dense shrub layer of *Bursaria spinosa.* The ground layer is dominated by the native grass *Microlaena stipoides,* with the exotic species *Tradescantia fluminensis* and *Ehrharta erecta* also abundant.

Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney Basin Bioregion intergrades with Grey Box – Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin Bioregion where the alluvium content of the soils reduces and the Wianamatta Group shale derived clay content increases. Where soil (and groundwater) salinity increases, Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney Basin Bioregion grades into Swamp Oak open forest on riverflats of the Cumberland Plain and Hunter valley.

Plate 5: Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney Basin Bioregion – Moderate/Good_Poor

Zone 6: Grey Box – Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin Bioregion - Moderate/Good_Medium

Vegetation formation: KF_CH3 Grassy Woodlands

Vegetation class: Coastal Valley Grassy Woodlands

PCT: 849 **BVT:** HN528

Conservation status: TSC Act: critically endangered – forms Cumberland Plain Woodland in the Sydney Basin Bioregion; EPBC Act: critically endangered – some patches meet the condition threshold to form Cumberland Plain Shale Woodlands and Shale-Gravel Transition Forest.

Estimate of per cent cleared: 93 per cent

Condition: Moderate/Good_Medium

Extent in the study area: 9.89 hectares

Extent in the construction footprint (excluding biodiversity certified areas): 3.54 hectares

Plots completed in vegetation zone: Three (Q05, Q30, Q40)

Structure	Average height and height range (m)	Average cover and cover range	Typical species
Trees	12 (8-14)	15.7 (10-25)	*Eucalyptus moluccana, Eucalyptus tereticornis, Corymbia maculata*
Small trees	3 (1-5)	7.5 (5-10)	*Olea europaea subsp. cuspidata**
Shrubs	1.5 (1-3)	7 (1-18)	*Bursaria spinosa, Lantana camara*
Ground covers	0.2 (0.1-0.4)	93.3 (60-115)	*Microlaena stipoides, Oplismenus aemulus, Setaria parviflora, Ehrharta erecta, Cynodon dactylon*
Vines & climbers	N/A	3 (1-5)	*Glycine clandestina, Glycine tabacina, Cayratia clematidea*

Description: Grey Box – Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin Bioregion is an open grassy woodland found on the gentle topography associated with the shale plains of western Sydney. This PCT is dominated by *Eucalyptus moluccana*, *Eucalyptus tereticornis* and ironbarks such as *Eucalyptus crebra* and *Eucalyptus fibrosa*, with localised patches of *Corymbia maculata*. The understorey is typified by a sparse to moderate cover of shrubs and a high cover of grasses and forbs (OEH, 2018).

This PCT is closely affiliated with Grey Box – Forest Red Gum grassy woodland on shale of the southern Cumberland Plain, Sydney Basin Bioregion (PCT 850), which also occurs in the study area; together these two communities form the critically endangered ecological community Cumberland Plain Woodland in the Sydney Basin Bioregion.

This vegetation zone is mapped across the study area, mainly as smaller fragmented patches on the flatter or more gently sloping areas in the northern and western parts of the study area. Within the construction footprint, this vegetation zone comprises patches that are disturbed, but have high native groundcover and a moderate level of species diversity. The largest patch of this vegetation zone within the construction footprint is located to the north-west of the intersection between the M7 and Elizabeth Drive.

This vegetation is characterised by a canopy of *Eucalyptus moluccana, Eucalyptus tereticornis* and *Corymbia maculata,* with *Acacia decurrens* and the priority weed *Olea europaea* subsp. *cuspidata.* Some patches include a shrub layer dominated by *Bursaria spinosa,* and sporadic infestation of the priority weed *Lantana camara,* which forms dense stands within some parts of this vegetation zone. The ground layer is dominated by native grasses such as *Microlaena stipoides* and *Oplismenus aemulus,* with the cosmopolitan native species *Cynodon dactylon* and the exotic species *Setaria parviflora, Ehrharta erecta* and *Paspalum dilatatum* also prevalent.


Plate 6: Grey Box – Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin Bioregion – Moderate/Good_Medium

Zone 7: Grey Box – Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin Bioregion – Moderate/Good_Poor

Vegetation formation: KF_CH3 Grassy Woodlands

Vegetation class: Coastal Valley Grassy Woodlands

PCT: 849 **BVT:** HN528

Conservation status: TSC Act: critically endangered – forms Cumberland Plain Woodland in the Sydney Basin Bioregion; EPBC Act: critically endangered – some patches meet the condition threshold to form Cumberland Plain Shale Woodlands and Shale-Gravel Transition Forest.

Estimate of per cent cleared: 93 per cent

Condition: Moderate/Good_Poor

Extent in the study area: 7.76 hectares

Extent in the construction footprint (excluding biodiversity certified areas): 2.07 hectares

Plots completed in vegetation zone: Two (Q31, Q33)

Structure	Average height and height range (m)	Average cover and cover range	Typical species
Trees	8 (6-10)	10-15	*Eucalyptus amplifolia, Angophora subvelutina*
Small trees	5 (4-7)	2-10	*Melaleuca decora*
Shrubs	1.5 (1-2)	0-11	*Bursaria spinosa*
Ground covers	0.3 (0.1-0.5)	60	*Microlaena stipoides, Cenchrus clandestinus*, Brunoniella australis, Pratia purpurascens*
Vines & climbers	N/A	1	*Glycine clandestine, Araujia sericifera**

Description: Grey Box – Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin Bioregion in Moderate/Good_Poor condition encompasses the more disturbed and fragmented parts of this PCT, which occur as isolated patches across the western two-thirds of the construction footprint.

This vegetation is highly degraded and has been subject to intensive grazing and/or edge effects and weed invasion from adjoining roads and other disturbances. The sampled patches within this vegetation zone have a canopy of *Eucalyptus amplifolia* with *Angophora subvelutina;* other patches in this zone were observed to be dominated by *Eucalyptus tereticornis* and *Eucalyptus moluccana. Melaleuca decora* occurs as scattered trees in the midstorey, and in some patches is the only tree species. Some patches include a

shrub layer of *Bursaria spinosa.* The ground layer varies from intensively grazed, mostly native grasses to dense cover of exotic grass such as *Cenchrus clandestinus.*

Plate 7: Grey Box – Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin Bioregion – Moderate/Good_Poor

Zone 8: Grey Box – Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin Bioregion – Moderate/Good_Other (Derived Shrubland)

Vegetation formation: KF_CH3 Grassy Woodlands

Vegetation class: Coastal Valley Grassy Woodlands

PCT: 849 **BVT:** HN528

Conservation status: TSC Act: critically endangered – forms Cumberland Plain Woodland in the Sydney Basin Bioregion; EPBC Act: critically endangered – some patches meet the condition threshold to form Cumberland Plain Shale Woodlands and Shale-Gravel Transition Forest.

Estimate of per cent cleared: 93 per cent

Condition: Moderate/Good_Other (Derived Shrubland)

Extent in the study area: 0.48 hectares

Extent in the construction footprint: 0.48 hectares

Plots completed in vegetation zone: One (Q16)

Structure	Average height and height range (m)	Average cover and cover range	Typical species
Trees	N/A	N/A	N/A
Small trees	N/A	N/A	N/A
Shrubs	2 (1-3)	40	*Bursaria spinosa*
Ground covers	0.1 (0-0.2)	50	*Themeda triandra, Microlaena stipoides, Aristida vagans, Bidens pilosa*, Dichondra repens, Cenchrus clandestinus**
Vines & climbers	N/A	N/A	N/A

Description: The vegetation zone Grey Box – Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin Bioregion – Moderate/Good_Other (Derived Shrubland) consists of a single patch of regenerating shrubland located to the west of Badgerys Creek. This vegetation zone is comprised of a shrub layer of *Bursaria spinosa* over a grassy ground layer dominated by the native species *Microlaena stipoides, Themeda triandra* and *Aristida vagans,* with the exotic grasses *Cenchrus clandestinus* and *Ehrharta erecta* also abundant.

Veg Zone 8 showing dense shrub layer of *Bursaria spinosa*

Veg Zone 8 with heavily grazed ground layer dominated by *Microlaena stipoides*

Plate 8: Grey Box – Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin Bioregion – Moderate/Good_Other (Derived Shrubland)

Zone 9: Grey Box – Forest Red Gum grassy woodland on shale of the southern Cumberland Plain, Sydney Basin Bioregion – Moderate/Good_High

Vegetation formation: KF_CH3 Grassy Woodlands

Vegetation class: Coastal Valley Grassy Woodlands

PCT: 850 **BVT:** HN529

Conservation status: TSC Act: critically endangered – forms Cumberland Plain Woodland in the Sydney Basin Bioregion; EPBC Act: critically endangered – some patches meet the condition threshold to form Cumberland Plain Shale Woodlands and Shale-Gravel Transition Forest.

Estimate of per cent cleared: 88 per cent

Condition: Moderate/Good_High

Extent in the study area: 8.40 hectares

Extent in the construction footprint (excluding biodiversity certified areas): 3.21 hectares

Plots completed in vegetation zone: Three (Q03, Q04, Q38)

Structure	Average height and height range (m)	Average cover and cover range	Typical species
Trees	18 (10-22)	19.5 (19-20)	*Eucalyptus moluccana, Angophora subvelutina*
Small trees	2.5 (1.5-4)	8.5 (5-12)	*Acacia implexa, Acacia parramattensis, Acacia decurrens*
Shrubs	1.5 (1-2)	4.5 (1-8)	*Bursaria spinosa, Dodonaea viscosa*
Ground covers	0.4 (0.1-0.5)	107.5 (102-113)	*Microlaena stipoides, Themeda triandra, Dichondra repens, Brunoniella pumilio, Sida rhombifolia**
Vines & climbers	N/A	2.5 (2-3)	*Pandorea pandorana, Glycine clandestina, Glycine tabacina*

Description: Grey Box – Forest Red Gum grassy woodland on shale of the southern Cumberland Plain, Sydney Basin Bioregion is an open grassy woodland found on the higher elevations associated with the hills and rises south from Prospect. This PCT is dominated by *Eucalyptus moluccana*, *Eucalyptus tereticornis*, with *Eucalyptus crebra* also common. *Acacia implexa* occurs in the small tree layer, often in regrowth stands (OEH, 2018).

This PCT is closely affiliated with Grey Box – Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin Bioregion (PCT 849), which also occurs in the study area; together these two communities form the critically endangered ecological community Cumberland Plain Woodland in the Sydney Basin Bioregion.

Grey Box – Forest Red Gum grassy woodland on shale of the southern Cumberland Plain, Sydney Basin Bioregion in Moderate/Good_High condition is located in the east of the construction footprint, in the area to the south-west of the M7/Elizabeth Drive intersection. This vegetation zone includes areas with relatively high native species diversity, structural diversity and low occurrence of exotic species. Part of the vegetation zone is within a Biobanking site and is managed for conservation.

This vegetation zone is characterised by a canopy of *Eucalyptus moluccana, Eucalyptus tereticornis, Corymbia maculata* and *Angophora subvelutina,* with *Acacia parramattensis* and *Acacia implexa* in the midstorey. The shrub layer is dominated by *Bursaria spinosa*, with *Dodonaea viscosa* sometimes present. The ground layer is dominated by the native grass species *Microlaena stipoides,* but other native grass and forb species such as *Themeda triandra, Rytidosperma* spp., *Brunoniella pumilio* and *Dichondra repens* are also common.


Plate 9: Grey Box – Forest Red Gum grassy woodland on shale of the southern Cumberland Plain, Sydney Basin Bioregion – Moderate/Good_High

Zone 10: Grey Box – Forest Red Gum grassy woodland on shale of the southern Cumberland Plain, Sydney Basin Bioregion – Moderate/Good_Medium

Vegetation formation: KF_CH3 Grassy Woodlands

Vegetation class: Coastal Valley Grassy Woodlands

PCT: 850 **BVT:** HN529

Conservation status: TSC Act: critically endangered – forms Cumberland Plain Woodland in the Sydney Basin Bioregion; EPBC Act: critically endangered – some patches meet the condition threshold to form Cumberland Plain Shale Woodlands and Shale-Gravel Transition Forest.

Estimate of per cent cleared: 88 per cent

Condition: Moderate/Good_Medium

Extent in the study area: 48.68 hectares

Extent in the construction footprint (excluding biodiversity certified areas): 10.14 hectares

Plots completed in vegetation zone: Seven (Q02, Q07, Q10, Q27, Q28, Q29, Q36)

Structure	Average height and height range (m)	Average cover and cover range	Typical species
Trees	15 (10-22)	12.3 (8-21)	*Eucalyptus moluccana, Corymbia maculata, Eucalyptus tereticornis*
Small trees	3 (2-5)	0.9 (0-2)	*Acacia implexa*
Shrubs	1 (0.5-3)	15.4 (0-67)	*Rubus parvifolius, Rubus fruticosus (sp. agg)*, Olea europaea subsp. cuspidata**
Ground	0.3 (0.1-0.5)	101 (39-128)	*Microlaena stipoides, Chloris ventricosa,*

Structure	Average height and height range (m)	Average cover and cover range	Typical species
covers			*Brunoniella australis, Paspalum dilatatum*, Verbena bonariensis*, Senecio pterophorus**
Vines & climbers	N/A	1.6 (0-4)	*Glycine clandestina, Glycine tabacina, Araujia sericifera**

Description: Grey Box – Forest Red Gum grassy woodland on shale of the southern Cumberland Plain, Sydney Basin Bioregion in Moderate/Good_Medium condition forms one of the larger vegetation zones in the study area and construction footprint and occurs predominantly across the Western Sydney Parklands in the east of the study area.

This vegetation zone consists of woodland with a canopy of *Eucalyptus moluccana, Eucalyptus tereticornis* and *Corymbia maculata* with *Acacia implexa* occasionally present in the midstorey. The native shrub layer is largely absent; some areas support dense thickets of the native scrambling shrub *Rubus parvifolius.* The ground layer is grassy and dominated by the native grass *Microlaena stipoides,* with other native grass species such as *Themeda triandra, Chloris ventricosa, Rytidosperma racemosum* and *Aristida* spp. also common. Native forb species including *Brunoniella australis, Dichondra repens, Geranium homeanum* and *Glycine clandestina* featured in low to moderate abundance in the ground layer.

There is a moderate cover of exotic species in this vegetation zone, with the exotic grasses *Paspalum dilatatum, Cenchrus clandestinus* and *Setaria parviflora* often present and dominant in some patches. The weedy shrub species *Senecio pterophorus, Bidens pilosa, Sida rhombifolia* and *Verbena bonariensis* frequently occur.

Plate 10: Grey Box – Forest Red Gum grassy woodland on shale of the southern Cumberland Plain, Sydney Basin Bioregion – Moderate/Good_Medium

Zone 11: Grey Box – Forest Red Gum grassy woodland on shale of the southern Cumberland Plain, Sydney Basin Bioregion - Moderate/Good_Other (Revegetation)

Vegetation formation: KF_CH3 Grassy Woodlands

Vegetation class: Coastal Valley Grassy Woodlands

PCT: 850 **BVT:** HN529

Conservation status: TSC Act: critically endangered – forms Cumberland Plain Woodland in the Sydney Basin Bioregion; EPBC Act: critically endangered – some patches meet the condition threshold to form Cumberland Plain Shale Woodlands and Shale-Gravel Transition Forest.

Estimate of per cent cleared: 88 per cent

Condition: Moderate/Good_Other (Revegetation)

Extent in the study area: 66.02 hectares

Extent in the construction footprint (excluding biodiversity certified areas): 22.65 hectares

Plots completed in vegetation zone: Four (Q01, Q09, Q14, Q35)

Structure	Average height and height range (m)	Average cover and cover range	Typical species
Trees	8 (6-12)	20.6 (16-30)	*Corymbia maculata, Eucalyptus moluccana, Eucalyptus tereticornis*
Small trees	3 (2-5)	18.4 (0-60)	*Acacia parramattensis, Acacia decurrens*
Shrubs	1 (0.5-3)	1.8 (0-4)	*Dillwynia sieberi, Olea europaea subsp. cuspidata, Dodonaea viscosa subsp. cuneata*
Ground covers	0.3 (0.1-0.5)	134.8 (97-172)	*Microlaena stipoides, Dichondra repens, Einadia trigonos, Sida rhombifolia*, Paspalum dilatatum*, Senecio pterophorus**
Vines & climbers	N/A	2.4 (1-3)	*Glycine clandestina, Glycine tabacina*

Description: Grey Box – Forest Red Gum grassy woodland on shale of the southern Cumberland Plain, Sydney Basin Bioregion in Moderate/Good_Other (Revegetation) condition forms the largest vegetation zones in the study area and construction footprint and consists of revegetated areas in the Western Sydney Parklands south of Elizabeth Drive in the east of the study area.

These areas were historically cleared and used for grazing, prior to reservation in the Western Sydney Regional Park in the 1990s. The plantings in this area date from the mid-1990s to 2001, with methods including planted tubestock and direct seeding. Trees in this vegetation zone are generally even-aged, about 0.2 metres to 0.3 metres diameter breast height, and planted in rows. The most frequently occurring tree species in this vegetation zone are *Eucalyptus moluccana, Eucalyptus tereticornis* and *Corymbia maculata,* with *Eucalyptus eugenioides* and *Eucalyptus fibrosa* also present*. Acacia decurrens,* along with other *Acacia* species, is abundant and is often present in dense thickets.

The ground layer in revegetated areas is dominated by the native grass species *Microlaena stipoides,* which forms a thick carpet and was estimated in quadrats sampling this vegetation zone to cover 50 per cent to 80 per cent of the ground stratum. Exotic grasses including *Setaria parviflora* and *Paspalum dilatatum* are persistent in most areas, but not dominant. Frequently recorded native groundlayer species include *Dichondra repens, Glycine clandestina* and *Cyperus gracilis.* The exotic shrubs *Senecio pterophorus* and *Sida rhombifolia* are widespread in this vegetation zone.

Plate 11: Grey Box – Forest Red Gum grassy woodland on shale of the southern Cumberland Plain, Sydney Basin Bioregion – Moderate/Good_Other (Revegetation)

Zone 12: Grey Box – Forest Red Gum grassy woodland on shale of the southern Cumberland Plain, Sydney Basin Bioregion – Low

Vegetation formation: KF_CH3 Grassy Woodlands

Vegetation class: Coastal Valley Grassy Woodlands

PCT: 850 **BVT:** HN529

Conservation status: TSC Act: critically endangered – forms Cumberland Plain Woodland in the Sydney Basin Bioregion

Estimate of per cent cleared: 88 per cent

Condition: Low

Extent in the study area: 31.33 hectares

Extent in the construction footprint: 18.07 hectares

Plots completed in vegetation zone: Four (Q18, Q19, Q24, Q25)

Structure	Average height and height range (m)	Average cover and cover range	Typical species
Trees	N/A	N/A	N/A
Small trees	N/A	N/A	N/A
Shrubs	N/A	N/A	N/A
Ground covers	0.2 (0.1-0.5)	107 (93-117)	*Aristida ramosa, Cenchrus clandestinus*
Vines & climbers	N/A	N/A	N/A

Description: Grey Box – Forest Red Gum grassy woodland on shale of the southern Cumberland Plain, Sydney Basin Bioregion in Low condition comprises areas of derived native grassland in the west of the study area. This vegetation zone was initially classified as Derived grasslands on shale hills of the Cumberland Plain (50 – 300 metres above sea level) (PCT 806), however no benchmarks have been identified for PCT 806 in the BioNet Vegetation Classification data collection (OEH, 2018), therefore site value could not be calculated. As such, the vegetation zone has been assigned to the assumed pre-clearance PCT. This vegetation zone is in Low condition, with a site value score of 13.77.

Areas within this vegetation zone consist of grazed grasslands with a mixture of native and exotic grasses present. Native species diversity is low, with native species counts of four to seven in quadrats sampled in this zone. Most areas within this zone are dominated by the native grass *Aristida ramosa,* with *Themeda triandra* and the cosmopolitan native species *Cynodon dactylon* also abundant. Exotic grasses such as *Paspalum dilatatum, Cenchrus clandestinus* and *Axonopus fissifolius* were often co-dominant. Native forbs such as *Asperula conferta, Hypericum gramineum* and *Tricoryne elatior* occur in low abundance.

Plate 12: Grey Box – Forest Red Gum grassy woodland on shale of the southern Cumberland Plain, Sydney Basin Bioregion – Low

Zone 13: Hard-leaved Scribbly Gum – Parramatta Red Gum heathy woodland of the Cumberland Plain, Sydney Basin Bioregion – Poor

Vegetation formation: KF_CH5B Dry Sclerophyll Forests (Shrubby sub-formation)

Vegetation class: Sydney Sand Flats Dry Sclerophyll Forests

PCT: 883 **BVT:** HN542

Conservation status: TSC Act: vulnerable – does not meet the condition threshold for Castlereagh Scribbly Gum Woodland in the Sydney Basin Bioregion; EPBC Act: endangered – does not meet the condition threshold for Castlereagh Scribbly Gum and Agnes Banks Woodlands of the Sydney Basin Bioregion.

Estimate of per cent cleared: 50 per cent

Condition: Poor

Extent in the study area: 0.93 hectares

Extent in the construction footprint: 0.38 hectares

Plots completed in vegetation zone: None

Description: Hard-leaved Scribbly Gum – Parramatta Red Gum heathy woodland of the Cumberland Plain, Sydney Basin Bioregion occurs on poorly consolidated sand deposits on hinterland plains and valleys of the Sydney region (OEH, 2018). The woodland comprises an open, low-growing eucalypt cover dominated by *Eucalyptus sclerophylla*, *Angophora bakeri* and *Eucalyptus parramattensis subsp. parramattensis*, with a sparse cover of *Melaleuca decora* often present. A well-developed native shrub layer is present, and the ground cover is usually a diverse mix of species typically including a high cover of grasses and sedges (OEH, 2018).

During site inspections in 2017, Hard-leaved Scribbly Gum – Parramatta Red Gum heathy woodland of the Cumberland Plain, Sydney Basin Bioregion in Moderate/Good condition was observed to occur to the west of Clifton Avenue in the central part of the study area. While an FBA plot could not be completed in this area due to property access restrictions, a rapid assessment was undertaken. Almost all this vegetation was cleared in late 2017.

The only remaining areas of PCT 883 in the construction footprint are some about five metre wide strips of degraded vegetation in the road reserve to the west of Clifton Avenue. These areas could not be sampled due to the size and dimensions of the remaining fragmented patches, which range from about 0.02 hectares to about 0.27 hectares in size. The 0.27 hectare patch consists of a five metres wide x 470 metre long strip of degraded roadside vegetation in the road reserve adjoining cleared and disturbed areas.

The vegetation in narrow roadside patches consist of occasional trees of *Eucalyptus fibrosa,* and *Melaleuca decora,* with stands of small trees and shrubs including *Acacia* spp., *Allocasuarina* spp. and *Bursaria spinosa.* The ground layer varies from sparse to dense cover of low native shrubs, however invasive exotic grasses, predominantly *Eragrostis curvula,* are dominant in the ground layer of almost all areas of this vegetation.

Given the small size and poor condition of the remnant, it is unlikely that this area meets the criteria for the TEC under either the TSC or EPBC Acts. It is therefore excluded from further assessment in this report.

Plate 13: Hard-leaved Scribbly Gum – Parramatta Red Gum heathy woodland of the Cumberland Plain, Sydney Basin Bioregion – Poor

Zone 14: Swamp Oak open forest on riverflats of the Cumberland Plain and Hunter valley – Moderate/Good_Poor

Vegetation formation: KF_CH9 Forested Wetlands

Vegetation class: Coastal Floodplain Wetlands

PCT: 1800 **BVT:** HN674

Conservation status: TSC Act: endangered – forms Swamp Oak Floodplain Forest of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions; EPBC Act: some patches meet the diagnostic criteria and condition threshold to form Coastal Swamp Oak (*Casuarina glauca*) Forest of New South Wales and South East Queensland ecological community.

Estimate of per cent cleared: 60 per cent

Condition: Moderate/Good_Poor

Extent in the study area: 16.00 hectares

Extent in the construction footprint: 2.53 hectares

Plots completed in vegetation zone: Three (Q13, Q21, Q23)

Structure	Average height and height range (m)	Average cover and cover range	Typical species
Trees	14-16	0.7 (0-2)	*Eucalyptus tereticornis*
Small trees	12-14	40.3 (31-50)	*Casuarina glauca*
Shrubs	1-6	22.1 (5-41.2)	*Olea europaea subsp. cuspidata*, Lantana camara*, Ligustrum lucidum*, Lycium ferocissimum**
Ground covers	0.1-0.4	76.1 (67.3-90)	*Tradescantia fluminensis*, Ehrharta erecta*, Chloris gayana*, Themeda triandra*
Vines & climbers	N/A	1.7 (1-3)	*Cardiospermum grandiflorum*, Araujia sericifera**

Description: Swamp Oak open forest on riverflats of the Cumberland Plain and Hunter valley is found on the riverflats of the Cumberland Plain in western Sydney and in the Hunter Valley (OEH, 2018). This PCT is distinguished by prominent stands *Casuarina glauca* found along or near streams. These are often relatively young trees, amongst a mix of old and young eucalypts such as *Angophora floribunda*, *Eucalyptus tereticornis* and *Eucalyptus moluccana*. This PCT features an open grassy and herbaceous understorey.

It is possible that this PCT is a pioneering community that is re-establishing following clearing, with the salt-tolerant *Casuarina glauca* able to survive increased salinity associated with rising water tables around creek lines following clearing, where eucalypts may not (OEH, 2018).

Swamp Oak open forest on riverflats of the Cumberland Plain and Hunter valley in Moderate/Good_Poor condition adjoins drainage lines across the study area, including Cosgroves Creek, and parts of Kemps Creek, South Creek and Badgerys Creek. This vegetation zone is comprised of a dense canopy of *Casuarina glauca,* with occasional trees of *Eucalyptus* spp. and *Melaleuca styphelioides.* The understorey is generally open, with exotic small trees and shrubs such as *Olea europaea subsp. cuspidata, Ligustrum lucidum, Lantana camara,* and *Lycium ferocissimum* often present.

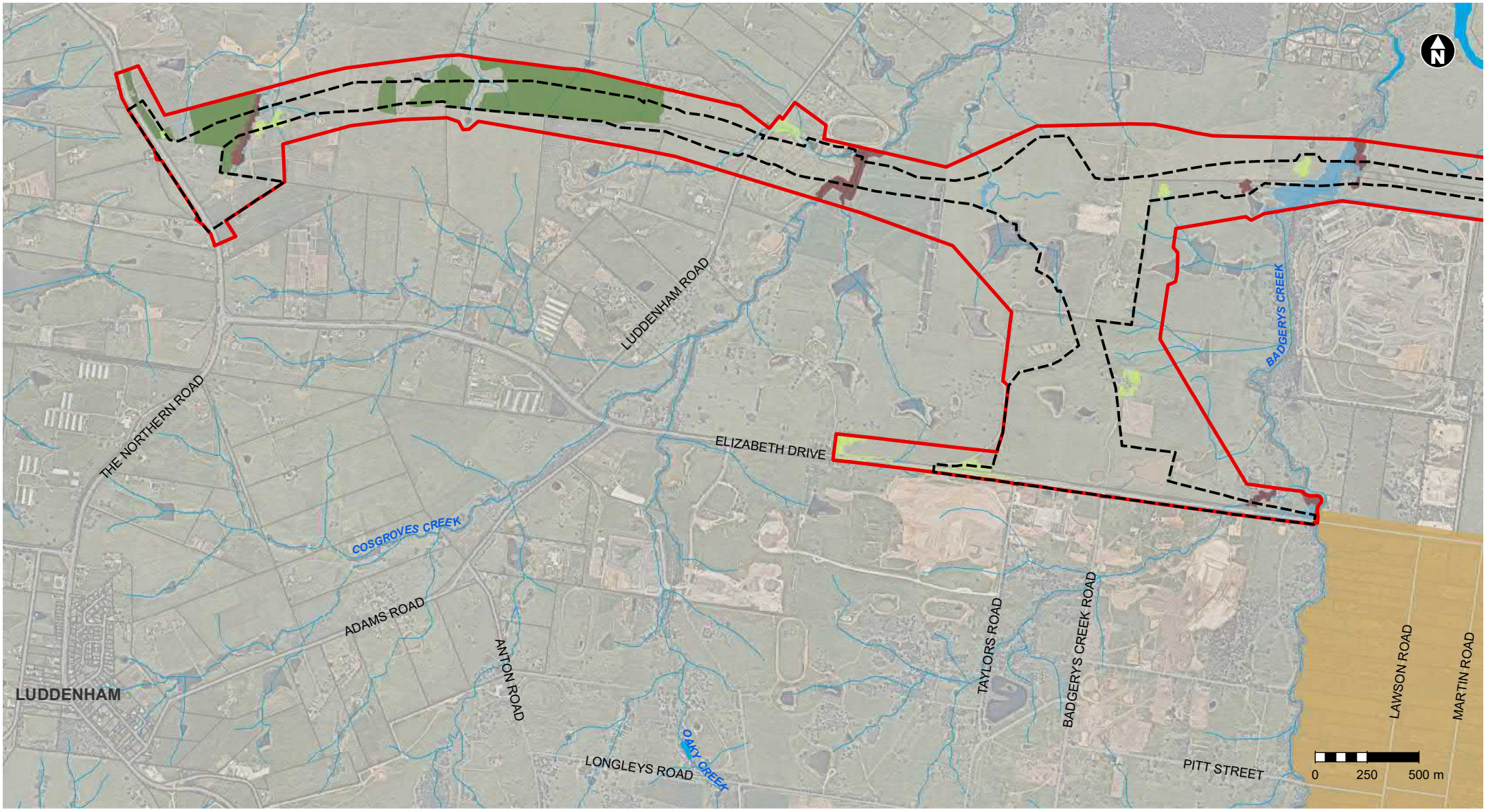
The ground layer is sparse and characterised by *Casuarina* leaf litter, with the exotic forb *Tradescantia fluminensis* often dominant. Some areas have a grassy ground layer, with the native species *Microlaena stipoides* and *Themeda triandra* and the exotic species *Ehrharta erecta, Chloris gayana* and *Cenchrus clandestinus* present. The invasive exotic rush *Juncus acutus* forms dense thickets along some drainage lines.

Plate 14: Swamp Oak open forest on riverflats of the Cumberland Plain and Hunter valley – Moderate/Good_Poor

3.3 Threatened ecological communities listed under the TSC Act

The BioNet Vegetation Classification data collection (OEH, 2018) predicts the equivalence of PCTs with Commonwealth and NSW TECs, however these must be used with caution as they can often only be consistent with a part of the PCT or there can be multiple equivalent TECs provided. The final determination which is published by the NSW Scientific Committee provides the legal definition of each TEC and these are the documents that are used to determine equivalence of PCTs with TECs in the sections below.

The PCTs identified within the study area are all known to be associated TECs listed under the TSC Act and/or the EPBC Act. Seven PCTs meet the criteria for six listed TECs under the TSC Act. Of these, five TECs are located within the construction footprint (see **Table 3-10)**. Two TECs listed under the EPBC Act were also identified within the study area. These are discussed in detail in **Section 8.4.3**. One PCT (PCT 883) is unlikely to meet the criteria for the associated TSC Act and EPBC Act TECs and was therefore excluded from further assessment. TECs are shown in **Figure 3-3** below.



Study area corridor
The project construction footprint
Western Sydney Parklands
NPWS Reserves
Cadastre
Waterways

Threatened Ecological Communities (TEC)

Castlereagh Scribbly Gum Woodland in the Sydney Basin Bioregion
Cooks River/Castlereagh Ironbark Forest in the Sydney Basin Bioregion
Cumberland Plain Woodland in the Sydney Basin Bioregion
Cumberland Plain Woodland in the Sydney Basin Bioregion (derived grassland form)
Moist Shale Woodland in the Sydney Basin Bioregion
River-Flat Eucalypt Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions
Shale Gravel Transition Forest in the Sydney Basin Bioregion
Swamp Oak Floodplain Forest of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions

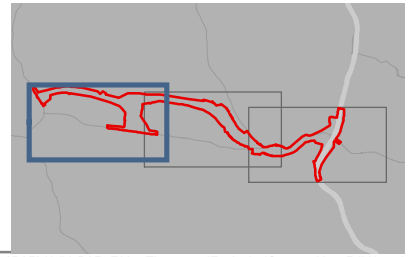
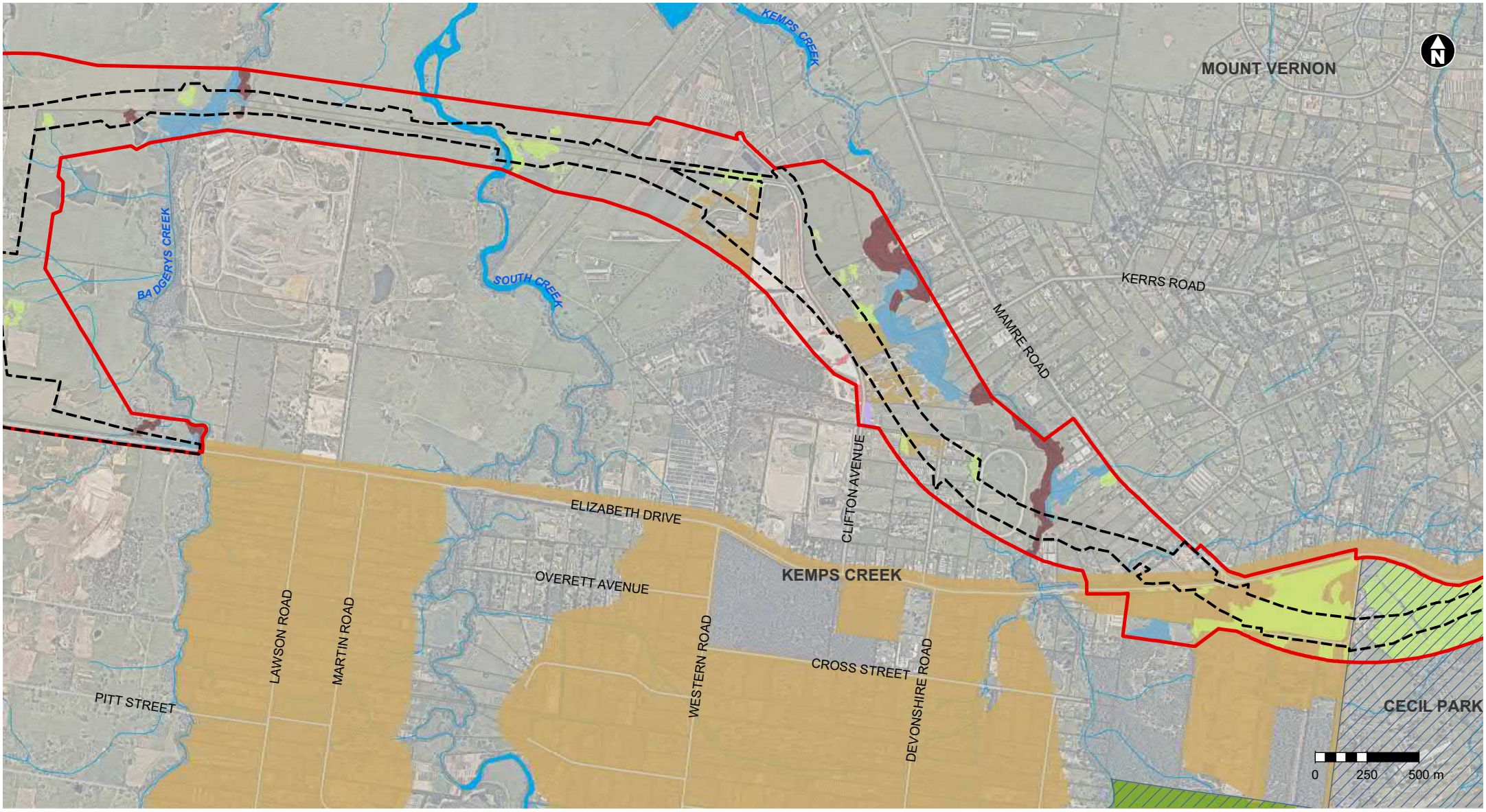


Figure 3-3 Threatened ecological communities

Date: 27/06/2019 Path: \\10.10.25.32\data\GIS\MXDs\Figures\Technical_reports\BAR\JAJV_BAR_F007_ThreatenedEcologicalCommunities_R4V4.mxd
Created by : RB | QA by : NS



Study area corridor
The project construction footprint
Western Sydney Parklands
NPWS Reserves
Cadastre
Waterways

Threatened Ecological Communities (TEC)

- Castlereagh Scribbly Gum Woodland in the Sydney Basin Bioregion
- Cooks River/Castlereagh Ironbark Forest in the Sydney Basin Bioregion
- Cumberland Plain Woodland in the Sydney Basin Bioregion
- Cumberland Plain Woodland in the Sydney Basin Bioregion (derived grassland form)
- Moist Shale Woodland in the Sydney Basin Bioregion
- River-Flat Eucalypt Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions
- Shale Gravel Transition Forest in the Sydney Basin Bioregion
- Swamp Oak Floodplain Forest of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions

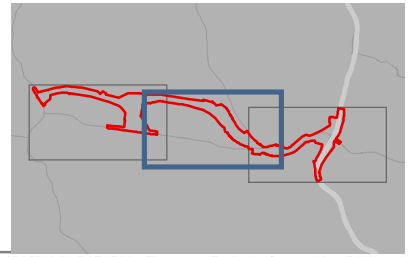
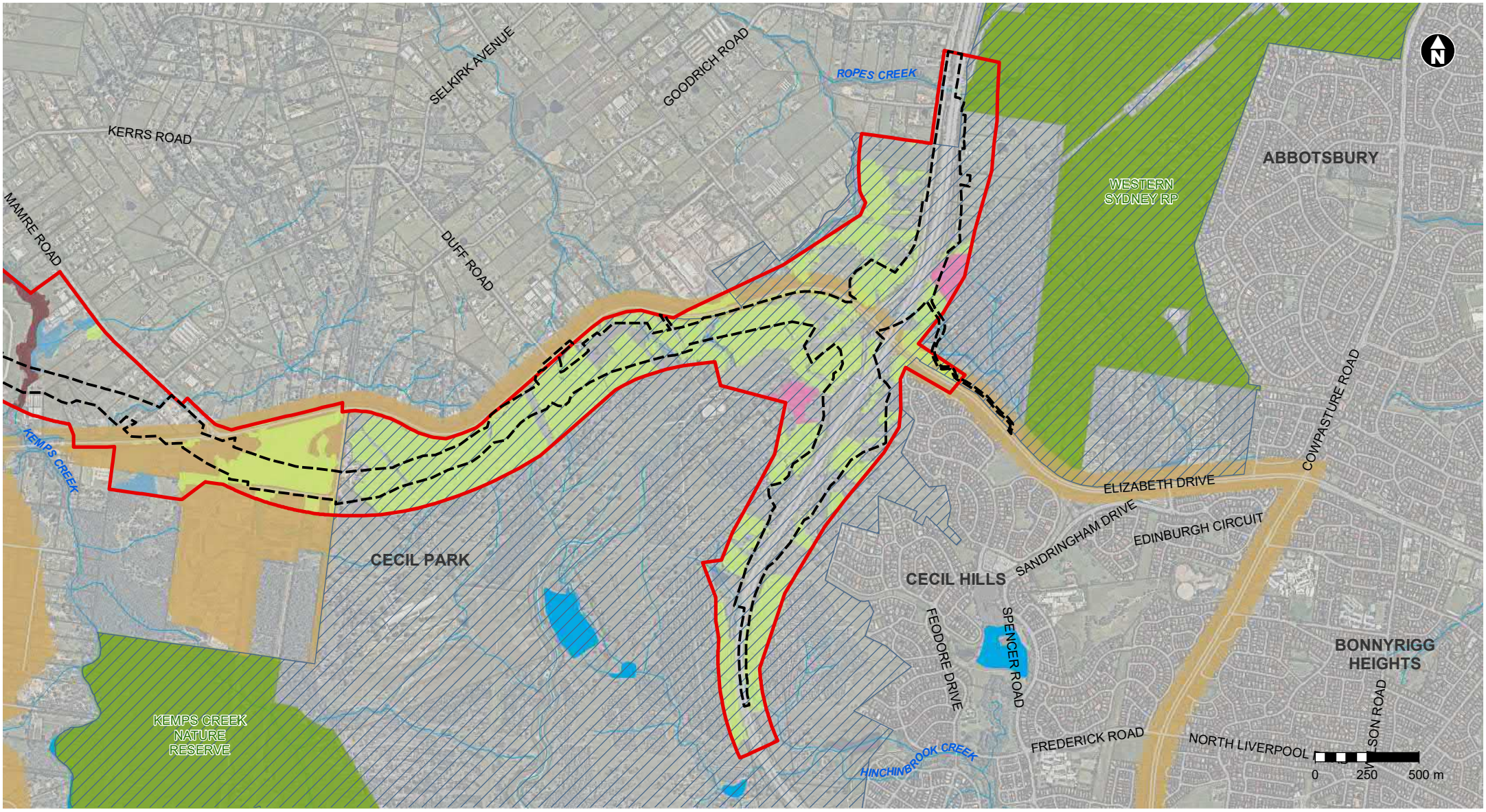


Figure 3-3 Threatened ecological communities

Date: 27/06/2019 Path: \\10.10.25.32\data\GIS\MXDs\Figures\Technical_reports\BAR\JAJV_BAR_F007_ThreatenedEcologicalCommunities_R4V4.mxd
Created by : RB | QA by : NS



Study area corridor
The project construction footprint
Western Sydney Parklands
NPWS Reserves
Cadastre
Waterways

Threatened Ecological Communities (TEC)

Castlereagh Scribbly Gum Woodland in the Sydney Basin Bioregion
Cooks River/Castlereagh Ironbark Forest in the Sydney Basin Bioregion
Cumberland Plain Woodland in the Sydney Basin Bioregion
Cumberland Plain Woodland in the Sydney Basin Bioregion (derived grassland form)
Moist Shale Woodland in the Sydney Basin Bioregion
River-Flat Eucalypt Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions
Shale Gravel Transition Forest in the Sydney Basin Bioregion
Swamp Oak Floodplain Forest of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions

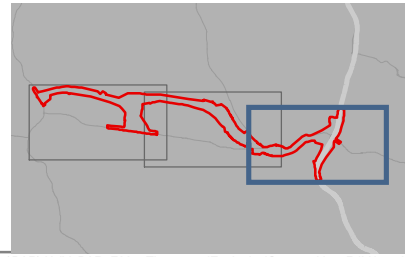


Figure 3-3 Threatened ecological communities

Date: 27/06/2019 Path: \\10.10.25.32\data\GIS\MXDs\Figures\Technical_reports\BAR\JAJV_BAR_F007_ThreatenedEcologicalCommunities_R4V4.mxd
Created by : RB | QA by : NS

Table 3-10 TECs listed under the TSC Act identified within the study area and construction footprint

TEC Name	TSC Act Status	Corresponding PCT(s)	Area within study area (ha)	Area within construction footprint (ha)	Area within construction footprint excluding certified areas (ha)
Shale Gravel Transition Forest in the Sydney Basin Bioregion	E	724	12.82	6.91	6.91
Cooks River/Castlereagh Ironbark Forest in the Sydney Basin Bioregion	E	725	0.50	0	0
Moist Shale Woodland in the Sydney Basin Bioregion	E	830	4.97	0.44	0.44
River-Flat Eucalypt Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions	E	835	20.70	3.23	3.23
Cumberland Plain Woodland in the Sydney Basin Bioregion	CE	849 850	172.55 (includes about 66.02 ha of revegetation and about 31.33 ha of derived native grassland in Low condition)	68.35 (includes about 22.74 ha of revegetation and about 18.07 ha of derived native grassland in Low condition)	60.16 (includes about 22.65 ha of revegetation and about 18.07 ha of derived native grassland in Low condition)
Swamp oak floodplain forest of the NSW North Coast, Sydney Basin and South East Corner bioregions	E	1800	16.00	2.53	2.53
Total			**227.54**	**81.46**	**73.27**

CE = Critically Endangered, E = Endangered, V = Vulnerable

3.3.1 Cumberland Plain Woodland in the Sydney Basin Bioregion

Cumberland Plain Woodland in the Sydney Basin Bioregion is listed as a critically endangered ecological community under the TSC Act. Within the study area, this ecological community corresponds to two PCTs. These are Grey Box – Forest Red Gum grassy woodland on shale of the southern Cumberland Plain, Sydney Basin Bioregion (PCT 850) and Grey Box – Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin Bioregion (PCT 849).

Cumberland Plain Woodland in the Sydney Basin Bioregion is located in a rainshadow area in western Sydney and is associated with clay soils derived from Wianamatta Group geology and occasionally alluvial substrates. It is characterised by a canopy of *Eucalyptus moluccana* Grey Box and *E. tereticornis* Forest Red Gum, often with *E. crebra* Narrow-leaved Ironbark, *E. eugenioides* Narrow-leaved Stringybark and *Corymbia maculata* Spotted Gum (TSSC, 2009) (OEH, 2011). Paragraph two of the Final Determination (OEH, 2011) outlines that the community can be present as a derived native grassland, or as a shrubland (where shrubs may sometimes occur in locally dense stands following partial or complete clearing).

PCT 850 is largely present across the Western Sydney Parklands in the east of the study area. This vegetation zone consists of woodland with a canopy of *Eucalyptus moluccana, Eucalyptus tereticornis* and *Corymbia maculata*

PCT 849 is present across the study area, mainly as smaller fragmented patches on the flatter or more gently sloping areas in the northern and western parts of the study area. smaller patches scattered across the study area. Areas of PCT 849 in the study area have a canopy dominated by *Eucalyptus moluccana, Eucalyptus tereticornis* and *Corymbia maculata*.

A comparison of the vegetation mapped as PCTs 849 and 850 in the study area with the relevant paragraphs of the final determination for Cumberland Plain Woodland in the Sydney Basin Bioregion was undertaken (see **Table 3-11** overleaf).

The vegetation of both PCT 849 and PCT 850 is consistent with the floristic composition, distribution, landscape position and soil associations detailed in the final determination for Cumberland Plain Woodland in the Sydney Basin Bioregion (OEH, 2011).

The NSW Scientific Committee does not exclude patches of vegetation as Cumberland Plain Woodland on the basis of condition or structure thresholds. Therefore, all the vegetation within the study area identified as PCT 849 and PCT 850 (including the derived native grassland vegetation zone) are considered Cumberland Plain Woodland in the Sydney Basin Bioregion under the TSC Act.

This community also forms part of the critically endangered Cumberland Plain Shale Woodland and Shale-Gravel Transition Forest under the EPBC Act. This is discussed in **Section 8.4.3.**

3.3.2 River-Flat Eucalypt Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions

River-flat Eucalypt Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner Bioregions is listed as an endangered ecological community under the TSC Act. Within the study area, it corresponds to the PCT Forest Red Gum – Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney Basin Bioregion (PCT 835).

River-flat Eucalypt Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner Bioregions is an ecological community associated with silts, clay-loams and sandy loams on periodically inundated alluvial flats, drainage lines and river terraces associated with coastal floodplains (OEH, 2011). The canopy is characterised by *Eucalyptus tereticornis* Forest Red gum, *E. amplifolia* Cabbage Gum, *Angophora floribunda* Rough-barked Apple and *A. subvelutina* Broad-leaved Apple.

PCT 835 is recognised in the BioNet Vegetation Classification data collection as corresponding to River-flat Eucalypt Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner Bioregions. Within the study area, this TEC is present in patches in the alluvial soils along Kemps Creek, South Creek and Badgerys Creek. Here, the vegetation is dominated by a canopy of *Eucalyptus tereticornis, Angophora floribunda,* and *Eucalyptus amplifolia* with a midstorey of *Melaleuca* spp., and a ground layer dominated by *Microlaena stipoides,* with the exotic species *Tradescantia fluminensis* and *Ehrharta erecta* also abundant.

Table 3-11 Comparison of areas mapped as PCTs 849 and 850 in the study area with final determination for Cumberland Plain Woodland in the Sydney Basin bioregion

Final determination identification attributes	Final determination paragraph extract	Comparison with areas mapped as PCTs 849 and 850
Location	Paragraph 2: Located in the Sydney Basin bioregion on the Cumberland Plain, a rainshadow area to the west of Sydney's Central Business District.	The study area is within the Sydney Basin Bioregion. The study area is on the Cumberland Plain in western Sydney.
Soils and landscape position	Paragraph 2: associated with clay soils derived from Wianamatta Group geology, or more rarely alluvial substrates. Typically occurs on flat to undulating or hilly terrain up to about 350 m elevation but may also occur on locally steep sites and at slightly	The study area is underlain by Bringelly Shale, part of the Wianamatta Group, with some areas of alluvial sands along drainage lines (Clark & Jones, 1991). The topography in and around the study area

Final determination identification attributes	Final determination paragraph extract	Comparison with areas mapped as PCTs 849 and 850
	higher elevations.	consists of rolling hills and small valleys between generally north-south ridge lines.
Floristic composition	Paragraph 3: Cumberland Plain Woodland is characterised by the following assemblage of species: 112 species listed.	Of the 112 species listed, 62 were recorded in the study area and 46 were recorded in areas mapped as PCT 849 or PCT 850.
Characteristic tree species	Paragraph 5: characterised by an upper-storey that is usually dominated by *Eucalyptus moluccana* (Grey Box) and *E. tereticornis* (Forest Red Gum), often with *E. crebra* (Grey Ironbark), *E. eugenioides* (Narrow-leaved Stringybark), *Corymbia maculata* (Spotted Gum) or other less frequently occurring eucalypts, including *Angophora floribunda*, *A. subvelutina* (Broad-leaved Apple), *E. amplifolia* (Cabbage Gum) and *E. fibrosa* (Broad-leaved Ironbark).	Areas mapped as PCT 849 are characterised by a canopy of *Eucalyptus moluccana, Eucalyptus tereticornis* and *Corymbia maculata,* with some patches dominated by *Eucalyptus amplifolia* and *Angophora subvelutina.* Areas mapped as PCT 850 (where not present as a derived native grassland or shrubland) are characterised by a canopy of *Eucalyptus moluccana, Eucalyptus tereticornis* and *Corymbia maculata,* with *Eucalyptus crebra, Eucalyptus fibrosa* and *Eucalyptus eugenioides* also occurring.
Structure	Paragraph 6: The structure of the community varies depending on past and current disturbances, particularly clearing, fire and grazing. Contemporary tree-dominated stands of the community are largely relics or regrowth of originally taller forests and woodlands, which are likely to have had scattered shrubs and a largely continuous grassy groundcover. After total or partial clearing, the tree canopy may remain sparse or may regrow to form dense stands of saplings and small trees, which are typically associated with a ground layer of reduced cover and diversity. Either or both of the upper-storey and mid-storey may be absent from the community. Native grasslands derived from clearing of the woodland and forest are also part of this community if they contain characteristic non-woody species listed in paragraph 3.	The vegetation mapped as PCTs 849 and 850 in the study area predominantly ranges from woodland to open-forest, with areas of derived native grassland and derived shrubland. In Western Sydney Parklands, much of the Cumberland Plain Woodland present has been established by revegetation of previously cleared land. This revegetation has used species characteristic of Cumberland Plain Woodland, presumably propagated from local providence seed. The fact that this vegetation has been revegetated does not preclude it from being eligible for listing under the BC Act.

A comparison of the vegetation mapped as PCT 835 in the study area with the relevant paragraphs of the final determination for River-flat Eucalypt Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner Bioregions was undertaken (see **Table 3-12**).

Table 3-12 Comparison of areas mapped as PCT 835 in the study area with final determination for River-flat Eucalypt Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner Bioregions

Final determination identification attributes	Final determination paragraph extract	Comparison with areas mapped as PCT 835
Location	Paragraph 3: Known from parts of the Local Government Areas of Port Stephens, Maitland, Singleton, Cessnock, Lake Macquarie, Wyong, Gosford, Hawkesbury, Baulkham Hills, Blacktown, Parramatta, Penrith, Blue Mountains, Fairfield, Holroyd, Liverpool, Bankstown, Wollondilly, Camden, Campbelltown, Sutherland, Wollongong, Shellharbour, Kiama, Shoalhaven, Eastern Capital City Regional, Eurobodalla and Bega Valley but may occur elsewhere in these bioregions.	The study area traverses the LGAs of Penrith to the north-west, Fairfield to the north-east and Liverpool to the south.
Soils and landscape position	Paragraph 1: associated with silts, clay-loams and sandy loams, on periodically inundated alluvial flats, drainage lines and river terraces associated with coastal floodplains. Generally, occurs below 50 m elevation, but may occur on localised river flats up to 250 m above sea level	The study area is underlain by Bringelly Shale, with areas of alluvial sands along drainage lines. The elevation of the areas mapped as PCT 835 vary from between about 35 and 80 m above sea level.
Floristic composition	Paragraph 1: River-Flat Eucalypt Forest on Coastal Floodplains is characterised by the following assemblage of species: 88 species listed	Of the 88 species listed, 52 were recorded in the study area and 23 were recorded in areas mapped as PCT 835.
Characteristic tree species	Paragraph 4: While the composition of the tree stratum varies considerably, the most widespread and abundant dominant trees include *Eucalyptus tereticornis* (Forest Red Gum), *E. amplifolia* (Cabbage Gum), *Angophora floribunda* (Rough-barked Apple) and *A. subvelutina* (Broad-leaved Apple).	Areas mapped as PCT 835 are characterised by a canopy of *Eucalyptus tereticornis* and *Eucalyptus amplifolia,* with *Angophora floribunda* and *Angophora subvelutina* also present, sometimes as a canopy dominant.
Structure	Paragraph 1: 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 vegetation mapped as PCT 835 in the study area is mostly of open-forest structure.

This vegetation is consistent with the floristic composition, distribution, landscape position and soil associations detailed in the final determination for River-flat Eucalypt Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions (OEH, 2011).

3.3.3 Swamp oak floodplain forest of the NSW North Coast, Sydney Basin and South East Corner bioregions

Swamp oak floodplain forest of the NSW North Coast, Sydney Basin and South East Corner bioregions is listed as an endangered ecological community under the TSC Act. Within the study area, it corresponds to the PCT Swamp Oak open forest on riverflats of the Cumberland Plain and Hunter valley (PCT 1800).

Swamp oak floodplain forest of the NSW North Coast, Sydney Basin and South East Corner bioregions occurs on coastal floodplains of NSW where the groundwater is saline or sub-saline. It is associated with grey-black clay-loams and sandy-loams on waterlogged or periodically inundated flats, drainage lines, lake margins and estuarine fringes (OEH, 2011). The composition of this ecological community is primarily

determined by the duration and frequency of waterlogging and level of salinity in the groundwater. The canopy layer is often sparse and dominated by *Casuarina glauca*.

PCT 1800 is recognised in the BioNet Vegetation Classification data collection as corresponding to Swamp oak floodplain forest of the NSW North Coast, Sydney Basin and South East Corner bioregions. This TEC is present along the major creek lines in the study area and is characterised by a canopy of *Casuarina glauca.* Within the study area, a shrub layer is often absent while the ground layer is dominated by *Microlaena stipoides.* In some patches, exotic species including *Tradescantia fluminensis* are in high abundance.

A comparison of the vegetation mapped as PCT 1800 in the study area with the relevant paragraphs of the final determination for Swamp Oak Floodplain Forest of the NSW North Coast, Sydney Basin and South East Corner Bioregions was undertaken (see **Table 3-13**).

Table 3-13 Comparison of areas mapped as PCT 1800 in the study area with final determination for Swamp Oak Floodplain Forest of the NSW North Coast, Sydney Basin and South East Corner Bioregions

Final determination identification attributes	Final determination paragraph extract	Comparison with areas mapped as PCT 1800
Location	Paragraph 3: Known from parts of the Local Government Areas of Tweed, Byron, Lismore, Ballina, Richmond Valley, Clarence Valley, Coffs Harbour, Bellingen, Nambucca, Kempsey, Hastings, Greater Taree, Great Lakes, Port Stephens, Maitland, Newcastle, Cessnock, Lake Macquarie, Wyong, Gosford, Pittwater, Warringah, Hawkesbury, Baulkham Hills, Hornsby, Lane Cove, Blacktown, Auburn, Parramatta, Canada Bay, Rockdale, Kogarah, Sutherland, Penrith, Fairfield, Liverpool, Bankstown, Wollondilly, Camden, Campbelltown, Wollongong, Shellharbour, Kiama, Shoalhaven, Eurobodalla and Bega Valley but may occur elsewhere in these bioregions.	The study area traverses the LGAs of Penrith to the north-west, Fairfield to the north-east and Liverpool to the south.
Soils and landscape position	Paragraph 1: associated with grey-black clay-loams and sandy loams, where the groundwater is saline or sub-saline, on waterlogged or periodically inundated flats, drainage lines, lake margins and estuarine fringes associated with coastal floodplains.	The study area is underlain by Bringelly Shale, with areas of alluvial sands along drainage lines where the groundwater is sub-saline.
Floristic composition	Paragraph 1: Swamp Oak Floodplain Forest is characterised by the following assemblage of species: 45 species listed	Of the 45 species listed, 11 were recorded in the study area and two were recorded in areas mapped as PCT 1800.
Characteristic tree species	Paragraph 4: *Casuarina glauca* (Swamp Oak) is the dominant species northwards from Bermagui.	Areas mapped as PCT 1800 are characterised by a canopy of *Casuarina glauca*
Structure	Paragraph 1: The structure of the community may vary from open forests to low woodlands, scrubs or reedlands with scattered trees.	The vegetation mapped as PCT 1800 in the study area is mostly of open-forest structure.

The vegetation mapped as PCT 1800 is consistent with the floristic composition, distribution, landscape position and soil associations detailed in the final determination for Swamp oak floodplain forest of the NSW North Coast, Sydney Basin and South East Corner bioregions (OEH, 2011).

3.3.4 Shale Gravel Transition Forest in the Sydney Basin Bioregion

Shale Gravel Transition Forest in the Sydney Basin Bioregion is listed as an endangered ecological community under the TSC Act. Within the study area, it corresponds to the PCT Broad-leaved Ironbark – Grey Box – Melaleuca decora grassy open forest on clay/gravel soils of the Cumberland Plain, Sydney Basin Bioregion (PCT 724).

Shale Gravel Transition Forest in the Sydney Basin Bioregion occurs where shallow deposits of Tertiary alluvium overlie shale soils. As alluvial influences decline, the community grades into Cumberland Plain Woodland, Cooks River/Castlereagh Ironbark Forest or Castlereagh Scribbly Gum Woodland (OEH, 2011). Characteristic canopy species include *Eucalyptus fibrosa*, *E. moluccana* and *E. tereticornis* while a sparse shrub stratum of *Bursaria spinosa, Daviesia ulicifolia* and *Lissanthe strigosa* also often present.

PCT 724 is recognised in the BioNet Vegetation Classification data collection as corresponding to Shale Gravel Transition Forest in the Sydney Basin Bioregion. This TEC is present in the central region of the study area around Clifton Avenue. The canopy in areas mapped as PCT 724 is dominated by *Eucalyptus fibrosa* and *Eucalyptus tereticornis,* with an often dense layer of *Melaleuca decora* and *Melaleuca nodosa* in the midstorey. The ground layer varied from very sparse under the areas dominated by *Melaleuca* spp., to scattered shrubs, grasses and forbs in more open areas. In the more disturbed fragmented patches, the ground layer consists of a mixture of native and exotic species.

A comparison of the vegetation mapped as PCT 724 in the study area with the relevant paragraphs of the final determination for Shale Gravel Transition Forest in the Sydney Basin Bioregion was undertaken (see **Table 3-14**).

Table 3-14 Comparison of areas mapped as PCT 724 in the study area with final determination for Shale Gravel Transition Forest in the Sydney Basin Bioregion

Final determination identification attributes	Final determination paragraph extract	Comparison with areas mapped as PCT 1800
Location	Paragraph 3: The community is or has been known to occur in the Auburn, Bankstown, Baulkham Hills, Blacktown, Fairfield, Hawkesbury, Holroyd, Liverpool, Parramatta and Penrith Local Government Areas, but may occur elsewhere in the Sydney Basin Bioregion.	The study area traverses the LGAs of Penrith to the north-west, Fairfield to the north-east and Liverpool to the south.
Soils and landscape position	Paragraph 5: occurs primarily in areas where shallow deposits of Tertiary alluvium overlie shale soils but may also occur in association with localised concentrations of iron-indurated gravel.	Within the study area, PCT 724 is mapped on the Blacktown soil landscape which is associated with Wianamatta group shales. In these areas, there are also concentrations of iron-indurated gravels.
Floristic composition	Paragraph 1: Swamp Oak Floodplain Forest is characterised by the following assemblage of species: 43 species listed	Of the 43 species listed, 37 were recorded in the study area and 31 were recorded in areas mapped as PCT 724.
Characteristic tree species	Paragraph 4: Usually with trees of *Eucalyptus fibrosa* sometimes with *E. moluccana* and *Eucalyptus tereticornis*. *Melaleuca decora* is frequently present in a small tree stratum.	Areas mapped as PCT 724 are characterised by a canopy of *Eucalyptus fibrosa* and *Eucalyptus tereticornis,* with *Eucalyptus moluccana* also recorded. *Melaleuca decora* and *Melaleuca nodosa* were often present in the midstorey.
Structure	Paragraph 4: predominantly of open-forest structure	The vegetation mapped as PCT 724 in the study area is mostly of open-forest structure, with poorer condition patches of the PCT of woodland structure.

The vegetation mapped as PCT 724 is consistent with the floristic composition, distribution, landscape position and soil associations detailed in the final determination for Shale Gravel Transition Forest in the Sydney Basin Bioregion (TSSC, 2009) (OEH, 2011).

This community also forms part of the critically endangered Cumberland Plain Shale Woodland and Shale-Gravel Transition Forest under the EPBC Act. This is discussed in **Section 8.4.3**.

3.3.5 Moist Shale Woodland in the Sydney Basin Bioregion

Moist Shale Woodland in the Sydney Basin Bioregion is listed as an endangered ecological community under the TSC Act. Within the study area, it corresponds to the PCT Forest Red Gum – Grey Box shrubby woodland on shale of the southern Cumberland Plain, Sydney Basin Bioregion (PCT 830)

Moist Shale Woodland in the Sydney Basin Bioregion occurs on clay soils derived from Wianamatta Shale in the southern half of the Cumberland Plain. It is usually situated in hilly country with higher elevations and increased rainfall. Its canopy is dominated by *Eucalyptus tereticornis, E. moluccana, E. crebra* and *Corymbia maculata* (OEH, 2011).

The area of Moist Shale Woodland in the Sydney Basin Bioregion in the study area is limited to the disturbed westernmost portion of a larger patch of the TEC, located on a slope to the east of the M7. This vegetation consists of a woodland of *Eucalyptus moluccana* and *Eucalyptus tereticornis,* with an open understorey that includes scattered thickets of *Clerodendrum tomentosum, Acacia implexa* and the priority weeds *Lantana camara* and *Olea europaea* subsp. *cuspidata.* Denser stands of *Lantana camara* were observed in some areas of the PCT. The ground layer is grassy and herbaceous, with a high litter component, and was dominated by a mixture of native and exotic grasses and forbs.

A comparison of the vegetation mapped as PCT 830 in the study area with the relevant paragraphs of the final determination for Moist Shale Woodland in the Sydney Basin Bioregion was undertaken (see **Table 3-15**).

Table 3-15 Comparison of areas mapped as PCT 830 in the study area with final determination for Moist Shale Woodland in the Sydney Basin Bioregion

Final determination identification attributes	Final determination paragraph extract	Comparison with areas mapped as PCT 1800
Location	Paragraph 7: Part of the Moist Shale Woodland is or has been known to occur in the Camden, Campbelltown, Fairfield, Holroyd, Liverpool, Penrith, and Wollondilly Local Government Areas, but may occur elsewhere in the Sydney Basin Bioregion.	The study area traverses the LGAs of Penrith to the north-west, Fairfield to the north-east and Liverpool to the south.
Soils and landscape position	Paragraph 5: usually occurs on soils derived from Wianamatta Shale on higher country in the southern half of the Cumberland Plain.	The study area is underlain by Bringelly Shale, part of the Wianamatta Group, with some areas of alluvial sands along drainage lines (Clark & Jones, 1991). The topography in and around the study area consists of rolling hills and small valleys between generally north-south ridge lines.
Floristic composition	Paragraph 1: Moist Shale Woodland is characterised by the following assemblage of species: 36 species listed.	Of the 36 species listed, 27 were recorded in the study area and 12 were recorded in areas mapped as PCT 830.

Final determination identification attributes	Final determination paragraph extract	Comparison with areas mapped as PCT 1800
Characteristic tree species	Paragraph 4: The canopy of the Moist Shale Woodland generally has trees of *Eucalyptus tereticornis* and *Eucalyptus moluccana,* with *Eucalyptus crebra* and *Corymbia maculata* occurring occasionally.	Areas mapped as PCT 830 are characterised by a canopy of *Eucalyptus moluccana* and *Eucalyptus tereticornis.*
Structure	No structural criteria listed.	The vegetation mapped as PCT 830 in the study area is of woodland structure.

The vegetation mapped as PCT 830 is consistent with the floristic composition, distribution, landscape position and soil associations detailed in the final determination for Moist Shale Woodland in the Sydney Basin Bioregion (OEH, 2011).

3.4 Fauna habitat types

Vegetation communities within the study area were consolidated into broader fauna habitats based on general similarities in vegetation type, geology, landscape setting, habitat connectivity and fauna habitat values. These fauna habitats are woodland, riparian forest, grassland; and wetlands and watercourses (**Figure 4-1**).

3.4.1 Woodland

Woodland habitat covers about 160.44 hectares of the study area and includes the following PCTs: 724, 725, 830, 849, 850 (except the Low condition derived native grassland) and 883.

Woodland habitats of the study area provide shelter, foraging and breeding habitat for a range of common fauna. Canopy trees include Spotted Gum *Corymbia maculata*, Forest Red Gum *Eucalyptus tereticornis* and Grey Box *Eucalyptus moluccana*. These species provide blossom resources for common nectarivorous birds, small gliders and flying-foxes. Dense understorey grasses, coarse woody debris and leaf litter provide shelter habitat for small terrestrial amphibians and reptiles.

Isolated occurrences of woodland habitat in the western portion of the study area are represented as very small, highly disturbed patches within cleared agricultural land. These patches provide very limited fauna habitat values, similar to those associated with scattered trees within the cleared grassland habitats of the study area.

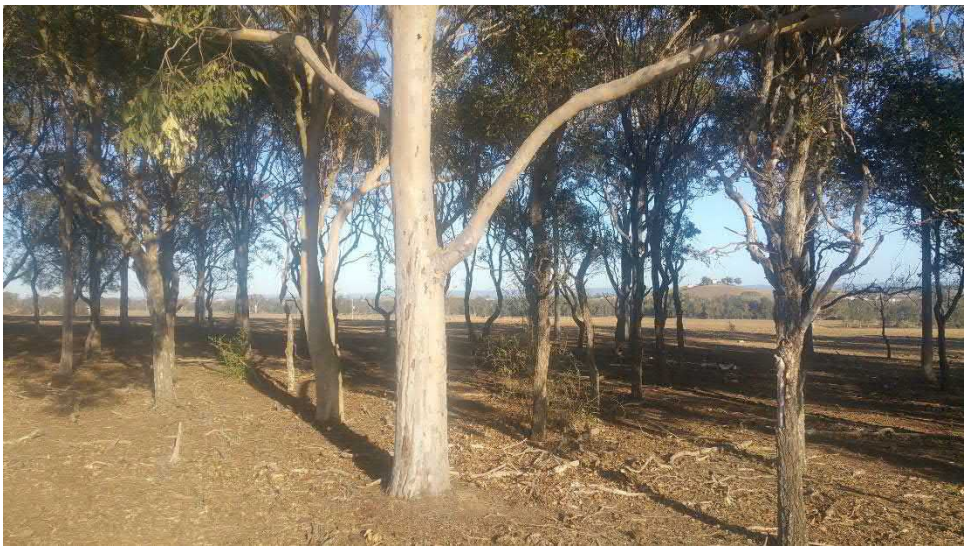


Plate 15: Isolated patch of woodland habitat in the western portion of the study area

Smaller patches of woodland habitat occur on shale substrates in the central portion of the study area around Clifton Avenue. These patches retain some degree of habitat connectivity to larger occurrences of woodland outside the study area.

Plate 16: Woodland habitat in the central portion of the study area

The largest area of woodland habitat occurs in the eastern portion of the study area, mostly on land within the Western Sydney Parklands. Woodland habitat within the eastern portion of the study area comprises patches of mature vegetation interspersed with regenerating areas and small patches of grassland. Existing motorways and major roads provide the most significant barriers to woodland habitat connectivity in the eastern portion of the study area.

Plate 17: Mature woodland in the eastern portion of the study area

Plate 18: Regenerating areas in the eastern portion of the study area

Large living or dead hollow-bearing trees are relatively scarce throughout the woodland habitat within the study area, mostly concentrated in a few locations (eg in the southern portion of the study area adjacent to the west side of the M7). Many tree hollows within woodland habitat were observed to be used as nesting habitat by common bird species typically associated with grassland or more tolerant of disturbance. These species were; Sulphur-crested Cockatoo *Cacatua galerita*, Little Corella *Cacatua sanguinea*, Eastern Rosella *Platycercus eximius* and Rainbow Lorikeet *Trichoglossus moluccanus*.

Plate 19: One of the larger hollow-bearing trees within the Woodland habitat of the study area

Southern Boobook *Ninox boobook*, Sugar Glider *Petaurus breviceps*, Common Brushtail Possum *Trichosurus vulpecula* and several microbat species were recorded from some areas of mature woodland habitat where larger trees (including hollow-bearing trees) were present. These species are all likely to use tree hollows within the study area as diurnal roosting or breeding habitat.


Plate 20: Sugar Glider *Petaurus breviceps* recorded within the study area

The Noisy Miner *Manorina melanocephala* was recorded within all woodland patches and was abundant at most locations within this habitat. The Noisy Miner is a highly adaptable, gregarious and aggressive species often occurring in altered landscapes (especially where understorey vegetation is sparse or absent), within edge effected areas of fragmented native forests and woodland or in regenerating (as opposed to mature) woodland habitats (Barati, et al., 2016).

Many small birds typically associated with woodland habitats were largely absent from the woodland habitat of the study area when compared to bird assemblages from more mature, intact woodland communities in western Sydney (eg Castlereagh and Wianamatta Nature Reserves). Smaller birds such as Superb Fairy-wren *Malurus cyaneus*, White-browed Scrubwren *Sericornis frontalis* and Red-browed Finch *Neochmia temporalis* were typically recorded from small areas within woodland habitats supporting a dense shrub layer of native or exotic plant species. Patches of dense understorey vegetation provide important refuge for small bird species that persist in disturbed or fragmented woodland habitats where the Noisy Miner and other despotic species are dominant.

3.4.2 Riparian Forest

Riparian forest habitat covers about 36.70 hectares of the study area and includes the following PCTs: 835 and 1800. Riparian forest habitat occurs on alluvial flats along Kemps, South, Badgerys and Cosgroves Creeks and an unnamed drainage line in the western portion of the study area. Riparian forest typically occurs as linear strips of native vegetation surrounded by largely cleared grazing land.

The width and condition of riparian forest habitat varies throughout the study area. Wider patches of riparian forest (eg along some sections of Kemps and Badgerys Creeks) support large mature *Eucalyptus* trees (some with small or medium sized hollows) and dense understorey vegetation. Sugar Gliders and some species of small woodland birds were recorded within these wider patches of riparian forest habitat during surveys. Other, narrower patches supported few *Eucalyptus* trees, most of which were relatively young and unlikely to provide habitat for hollow-dependent fauna. Further, dense understorey vegetation was scarce or absent in narrow patches and consequently small birds were also scarce or absent at these locations.

Riparian forest along Kemps, Badgerys and Cosgroves Creeks provides some (albeit narrow) north south habitat connectivity beyond the boundaries of the study area. Riparian forest associated with South Creek provides connectivity to the south of the study area, however this habitat has been cleared along South Creek to the north. The unnamed drainage line in the western portion of the study area is very narrow, fragmented and disturbed and provides negligible habitat connectivity.

3.4.3 Grassland

Grassland habitat covers about 684.54 hectares of the study area and includes all areas not covered by woodland, riparian forest, wetlands or waterways. Grassland habitat includes the derived grassland PCT 850 in low condition. Most of the grassland habitat within the study area does not conform to any native PCTs.

It is likely that native grassland habitats would have historically occurred within the study area only as understorey vegetation in very open woodland patches, or as a derived successional community following natural stochastic events such as intense fire. The grassland habitat of the study area is now comprised almost entirely of land cleared of native forest or woodland for grazing, cropping and more recently for residential and industrial development.

Native fauna most frequently recorded from grassland habitat during surveys were highly adaptable species typically associated with cleared landscapes. Large scattered paddock trees and stags occur within grassland habitat in some sections of the study area. These include a small number of large living trees and stags in the western portion of the study area supporting small, medium and large hollows. During surveys, most hollows in scattered trees in the western portion of the study area were occupied as nesting habitat by Little Corella, Long-billed Corella *Cacatua tenuirostris*, Eastern Rosella and Red-rumped Parrot *Psephotus haematonotus.*

It is likely that small hollows in scattered paddock trees would also provide roosting habitat for common, adaptable microbats such as White-striped Freetail Bat *Tadarida australis* and Gould's Wattled Bat *Chalinolobus gouldii*. Given the landscape setting of these trees it is considered highly unlikely that hollows within the grasslands of the study area would provide suitable roosting or nesting habitat for large forest owls or species more typically associated with intact forest and woodland habitats.

Scattered trees and landscape planted specimens include large mature *Eucalyptus* trees and other species that provide blossom or fruit resources for nectivorous and frugivorous birds and flying-foxes.

Plate 21: Paddock tree within grassland habitat

3.4.4 Wetlands and watercourses

Wetlands and watercourses habitat cover about 11.98 hectares of the study area and includes all permanent and ephemeral water bodies and drainage lines. Wetlands of the study area are comprised entirely of constructed dams. Most dams are located within cleared grazing lands and provide limited habitat value for most wetland-dependent fauna (eg Australasian Bittern). Some of these dams support emergent and/or submerged aquatic vegetation. Very few provide dense bankside vegetation and/or shelter habitat such as rocks and coarse woody debris.

Plate 22: Dam within cleared grassland

A small number of dams within the study area are located within woodland habitat in the eastern portion of the study area. These dams provide some aquatic vegetation as well as bankside shelter habitat. These dams may provide suitable habitat for some frog and reptile species but are considered too small to provide habitat for most wetland-dependent birds. These dams may also provide a water resource for woodland fauna such as birds, macropods and microbats.

Plate 23: Dam within woodland habitat

Watercourses of the study area occur as natural drainage lines within riparian corridors. Most watercourses within the study area have been heavily altered by earthworks, construction, pollution, vegetation clearing, erosion and sedimentation. Further detail regarding the watercourses and aquatic habitat present within the study area is provided in **Section 4.3**.

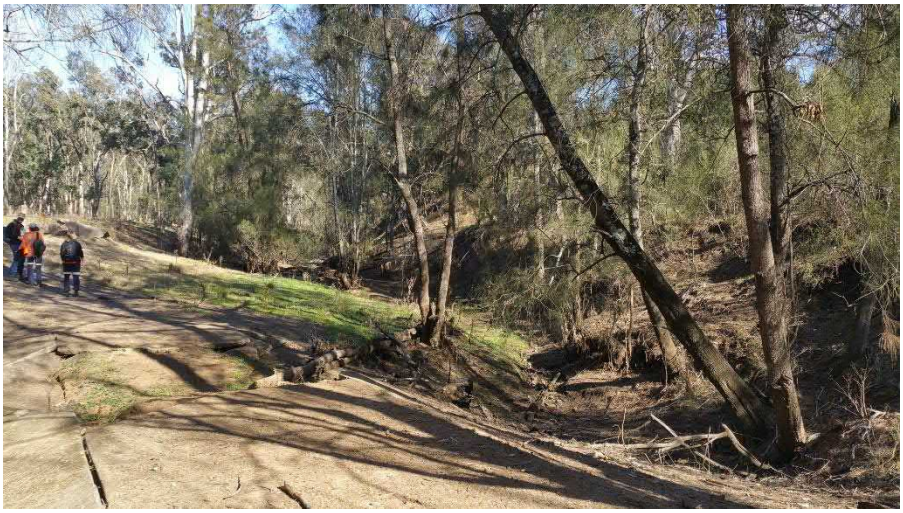


Plate 24: Watercourse within the study area

3.5 Groundwater dependent ecosystems

Groundwater dependent ecosystems (GDEs) are ecological communities that are dependent, either entirely or in part, on the presence of groundwater for their health or survival. The RIAR *Water Risk Assessment Guidelines for Groundwater Dependent Ecosystems* (Serov, et al., 2012) adopts the definition of a GDE as:

> *Ecosystems which have their species composition and natural ecological processes wholly or partially determined by groundwater.*

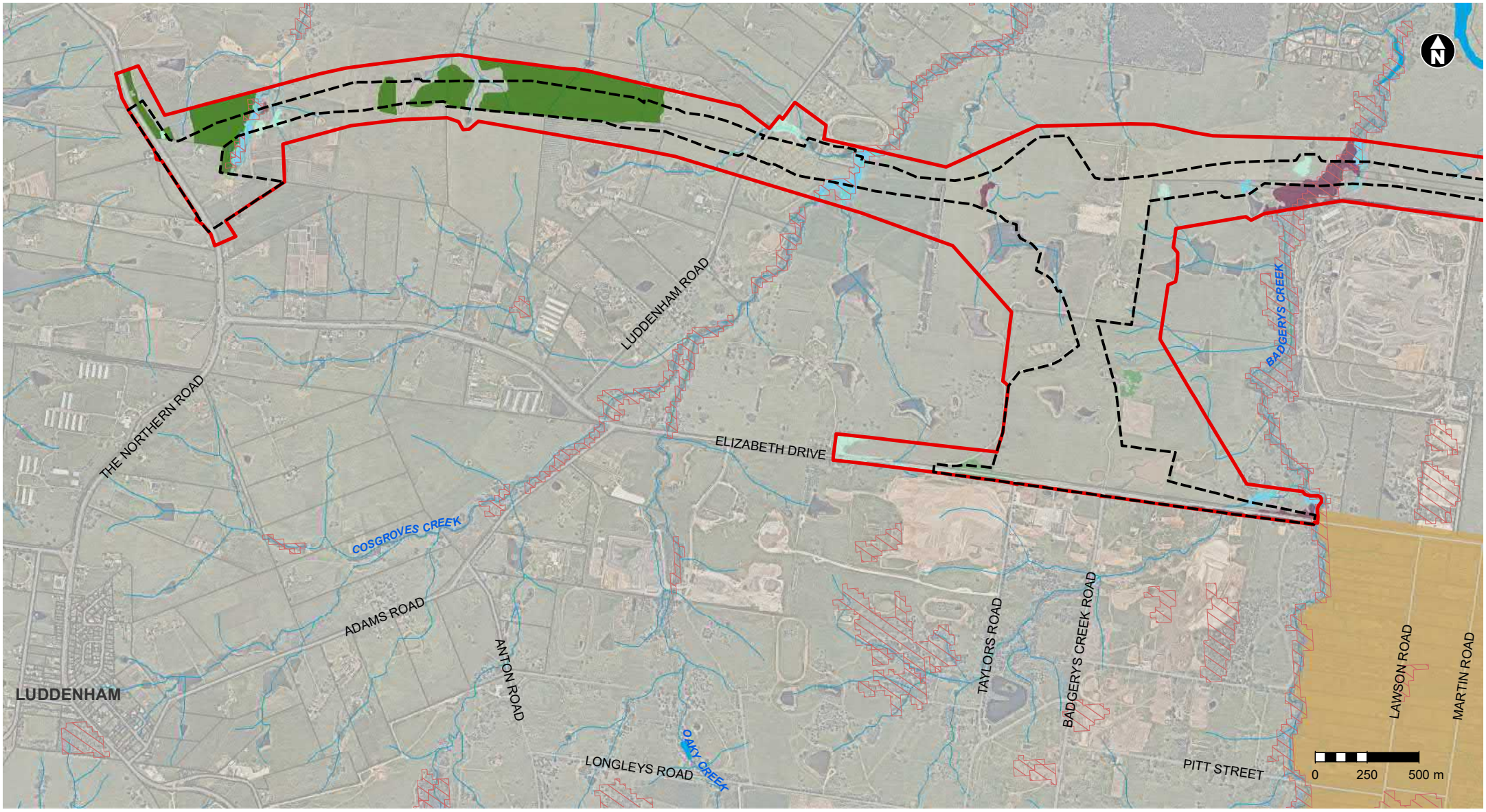
An assessment of groundwater resources and potential impacts of the project was completed to support the EIS, M12 Motorway EIS: Groundwater Assessment (JAVJ, 2018). As part of this assessment, The Bureau of Meteorology's GDE Atlas was reviewed to determine the occurrence of potential groundwater dependent ecosystems within and surrounding the study area.

The results of that review show that South Creek is considered to have a high potential to support aquatic GDE (based on a national assessment), while moderate to high potential GDEs (based on national assessment) were also mapped within the study area, generally near the four creek crossings (Cosgroves, Badgerys, South and Kemps Creeks).

The vegetation in areas that have been identified as having a moderate to high potential to be dependent on groundwater has been mapped as four PCTs:

- Swamp Oak open forests on riverflats of the Cumberland Plain and Hunter Valley (on Cosgroves and Kemps Creek)
- Forest Red Gum – Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney Basin Bioregion (Badgerys Creek)
- Grey Box – Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin Bioregion (eastern extent of the footprint, near the intersection with the M7)
- Grey-Box – Forest Red Gum grassy woodland on shale of the southern Cumberland Plain, Sydney Basin (eastern extent of the footprint, near the intersection with the M7).

There is no potential groundwater dependent vegetation at the crossing of South Creek, the area that could be groundwater dependent is to the south of the crossing point and outside of the construction footprint. **Figure 3-4** identifies the GDEs within the study area.



Study area corridor
The project construction footprint
Western Sydney Parklands
Biodiversity certified land
NPWS Reserves
Cadastre
Waterways

Groundwater Dependent Ecosystems (BoM, 2018)
Surface dependent
Subsurface dependent

Plant Community Type (PCT)

- Broad-leaved Ironbark - Grey Box - Melaleuca decora grassy open forest on clay/gravel soils of the Cumberland Plain, Sydney Basin Bioregion [724]
- Broad-leaved Ironbark - Melaleuca decora shrubby open forest on clay soils of the Cumberland Plain, Sydney Basin Bioregion [725]
- Forest Red Gum - Grey Box shrubby woodland on shale of the southern Cumberland Plain, Sydney Basin Bioregion [830]
- Forest Red Gum - Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney Basin Bioregion [835]
- Grey Box - Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin Bioregion [849]
- Grey Box - Forest Red Gum grassy woodland on shale of the southern Cumberland Plain, Sydney Basin Bioregion [850]
- Grey Box - Forest Red Gum grassy woodland on shale of the southern Cumberland Plain, Sydney Basin Bioregion (derived grassland form) [850]
- Hard-leaved Scribbly Gum - Parramatta Red Gum heathy woodland of the Cumberland Plain, Sydney Basin Bioregion [883]
- Swamp Oak open forest on riverflats of the Cumberland Plain and Hunter valley [1800]

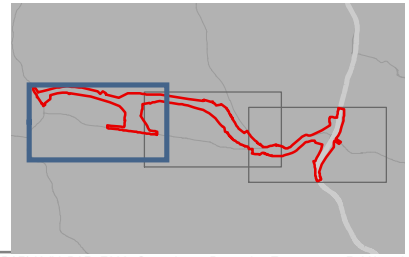


Figure 3-4 Groundwater dependent ecosystems

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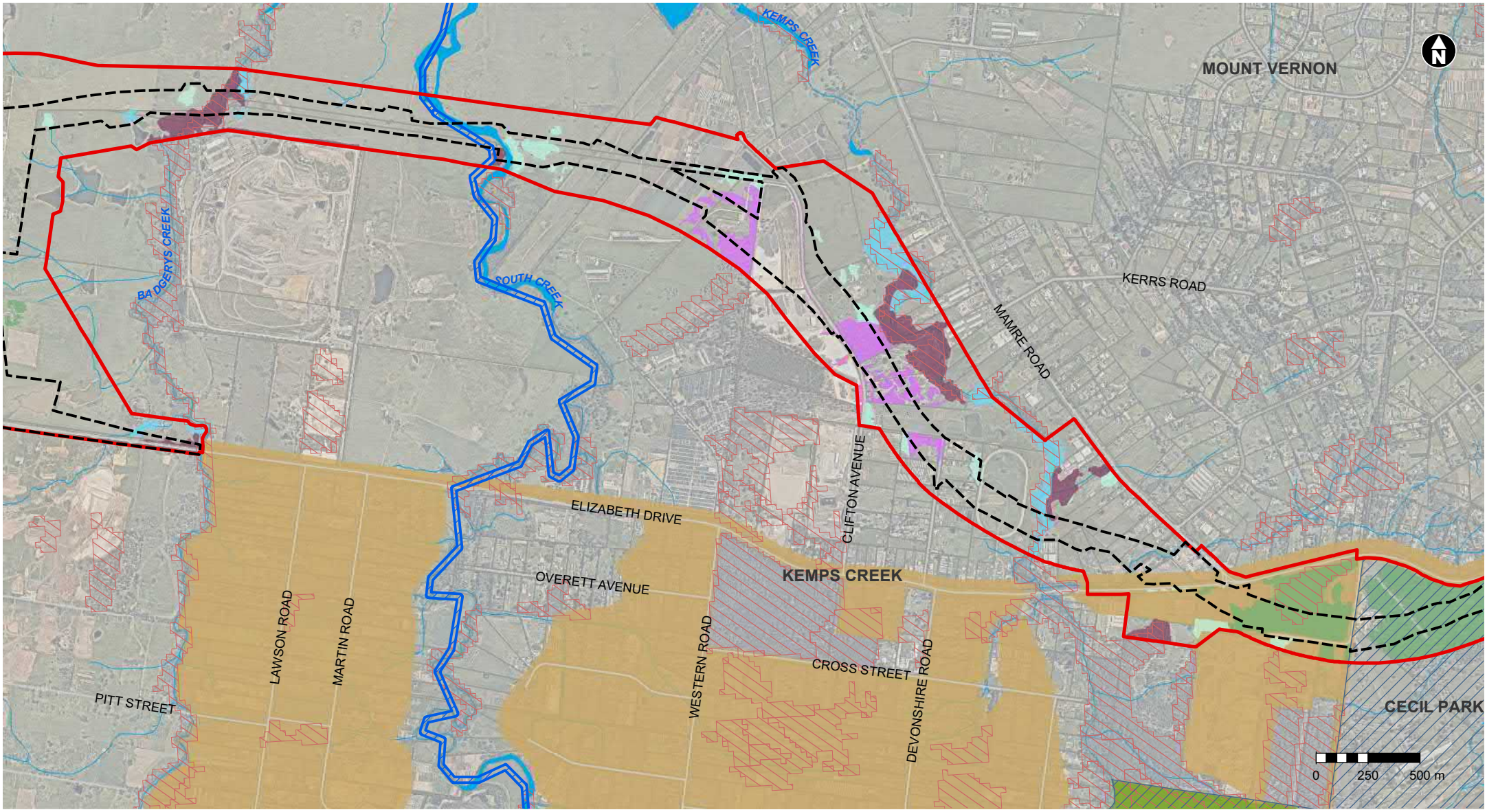

Study area corridor
The project construction footprint
Western Sydney Parklands
Biodiversity certified land
NPWS Reserves
Cadastre
Waterways
Groundwater Dependent Ecosystems (BoM, 2018)
Surface dependent
Subsurface dependent

Plant Community Type (PCT)

- Broad-leaved Ironbark - Grey Box - Melaleuca decora grassy open forest on clay/gravel soils of the Cumberland Plain, Sydney Basin Bioregion [724]
- Broad-leaved Ironbark - Melaleuca decora shrubby open forest on clay soils of the Cumberland Plain, Sydney Basin Bioregion [725]
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- Swamp Oak open forest on riverflats of the Cumberland Plain and Hunter valley [1800]

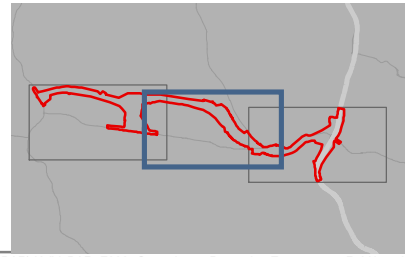

Figure 3-4 Groundwater dependent ecosystems

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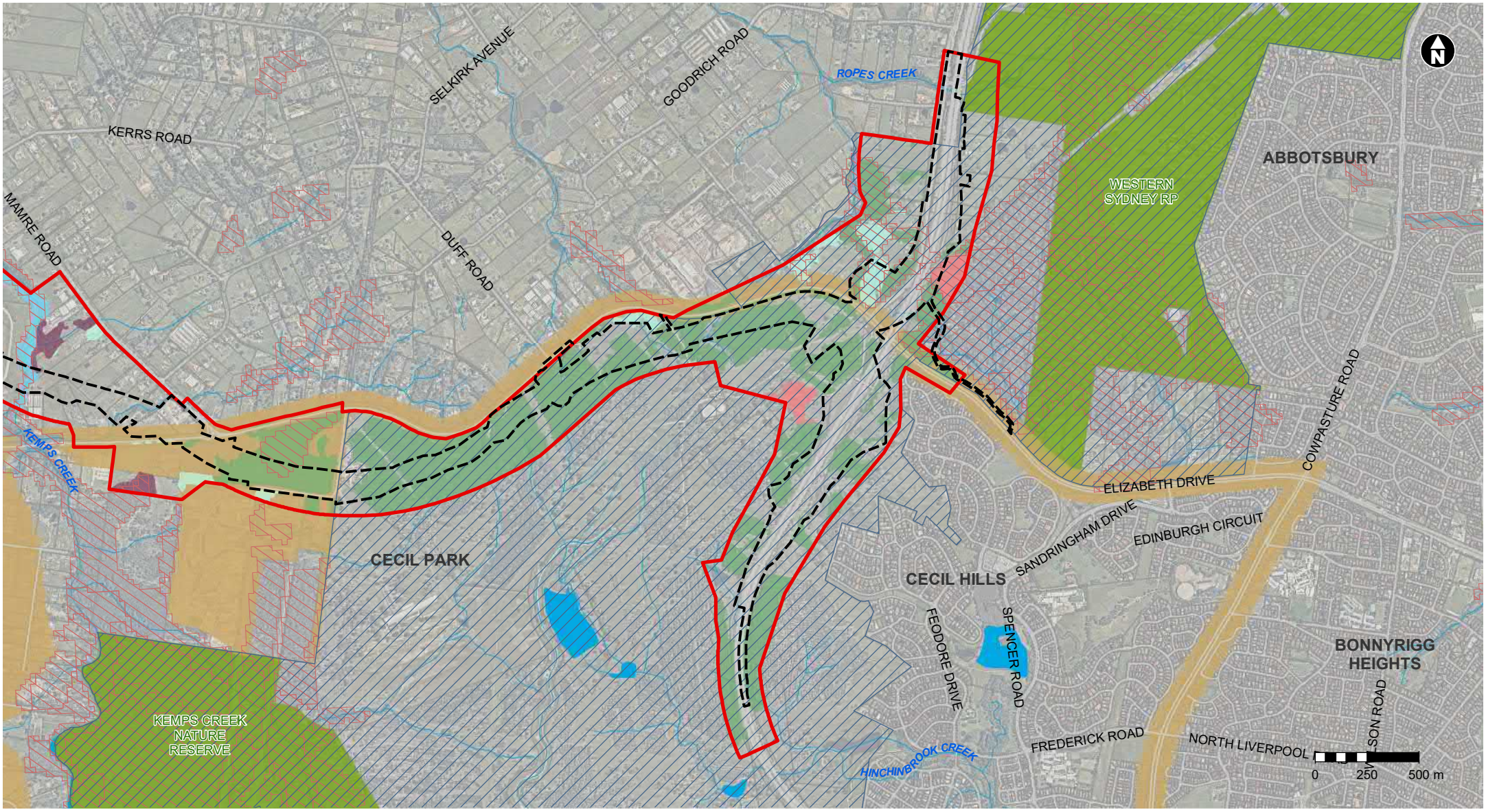

Study area corridor
The project construction footprint
Western Sydney Parklands
Biodiversity certified land
NPWS Reserves
Cadastre
Waterways
Groundwater Dependent Ecosystems (BoM, 2018)
Surface dependent
Subsurface dependent

Plant Community Type (PCT)

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- Broad-leaved Ironbark - Melaleuca decora shrubby open forest on clay soils of the Cumberland Plain, Sydney Basin Bioregion [725]
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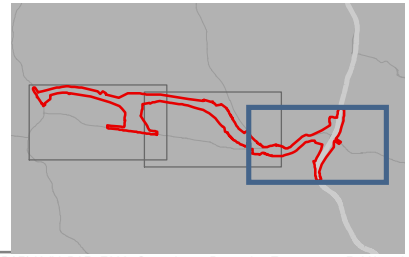

Figure 3-4 Groundwater dependent ecosystems

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4 Threatened species

4.1 Candidate species

The candidate species for assessment in the BAR were initially identified using the BioBanking credit calculator (OEH, n.d.). Additional information on potentially occurring species was taken from the following databases:

- BioNet – Species Sightings Search Atlas of NSW Wildlife (OEH, 2017)
- BioNet Threatened Species Data Collection (OEH, 2018)
- RIAR Fisheries Fish Records Viewer (DPI, 2018)
- The Commonwealth DoEE Protected Matters Search Tool (DoEE, 2018)
- Critical habitat register (OEH, 2016).

Existing reports on the ecology of the locality were also reviewed (see **Section 3.1.1**).

Candidate species include all species credit species, ecosystem/species credit species and Commonwealth (EPBC Act) listed threatened species considered from the desktop assessment to have a moderate or high likelihood of occurrence (**Annexure B**). Candidate species also include those that have been identified as requiring survey in the BioBanking credit calculator, or that have been recorded during field surveys. In addition, Attachment A (addenda in the SEARs) provided by DoEE identified eight threatened flora, six threatened fauna and four endangered ecological communities which were included as candidate species. In total, twelve threatened flora species (**Annexure B**) and 32 threatened fauna species (**Annexure B**) were identified as candidate species and formed the target of the threatened species survey.

4.1.1 Candidate threatened flora species

The BioNet threatened species database searches identified 22 threatened plant species listed under the TSC Act and/or EPBC Act as being previously recorded within 10 kilometres of the study area.

The credit calculator identified 21 candidate threatened flora species credit species. The geographic distribution and habitat requirements of each species were reviewed and a total of 12 candidate threatened flora species were confirmed on the basis of a moderate to high likelihood of occurrence in the study area (see **Table 4-1**). Justification for the likelihood of occurrence determined for each species is provided in **Annexure B**.

Table 4-1 Candidate threatened flora species

Scientific name	Common name	TSC Act status	EPBC Act status	Associated PCTs in construction footprint	Able to occupy low condition vegetation?
Acacia bynoeana	Bynoe's Wattle	E	V	724, 849, 883	Yes
Dillwynia tenuifolia	Dillwynia tenuifolia	V	-	724, 849, 883	Yes
Acacia pubescens	Downy Wattle	V	V	724, 849, 850, 883	Yes
Grevillea juniperina subsp. juniperina	Juniper-leaved Grevillea	V	-	724, 849, 850, 883	Yes
Marsdenia viridiflora subsp. viridiflora - endangered population	Marsdenia viridiflora subsp. viridiflora in the Bankstown, Blacktown, Camden, Campbelltown, Fairfield, Holroyd, Liverpool and Penrith local	EP	-	724, 830, 835, 849, 850, 1800	Yes

Scientific name	Common name	TSC Act status	EPBC Act status	Associated PCTs in construction footprint	Able to occupy low condition vegetation?
	government areas				
Pultenaea pedunculata	Matted Bush-pea	E	-	724, 849, 850	Yes
Micromyrtus minutiflora	Micromyrtus minutiflora	E	V	724	Yes
Persoonia nutans	Nodding Geebung	E	E	724, 883	Yes
Pultenaea parviflora	Pultenaea parviflora	E	V	724, 883	Yes
Grevillea parviflora subsp. parviflora	Small-flower Grevillea	V	V	724, 883	Yes
Pimelea spicata	Spiked Rice-flower	E	E	830, 849, 850	Yes
Cynanchum elegans	White-flowered Wax Plant	E	E	806, 830, 835, 849, 850,	Yes

EP = Endangered Population, E = Endangered, V = Vulnerable

4.1.2 Candidate threatened fauna species

The threatened species database searches identified 64 threatened fauna species listed under the TSC Act and/or EPBC Act as potentially occurring in the locality of the study area. The credit calculator identified 10 candidate species credit fauna species and 28 candidate ecosystem credit fauna species.

A desktop assessment was undertaken of the geographic distribution and habitat requirements of each species. Based on these results, a total of 32 candidate threatened fauna species were considered to have a moderate to high likelihood of occurrence within the study area (see **Table 2-4**). Justification for the desktop likelihood of occurrence determined for each species is provided in **Annexure B**.

Table 4-2 Candidate threatened fauna species

Common name	Scientific name	TSC Act status	EPBC Act status	Ecosystem or species credit species	Vegetation type (Ecosystem credit) or habitat constraints (Species credit)
Ecosystem credit species					
Barking Owl	*Ninox connivens*	V	-	Ecosystem	PCT 724, PCT 830, PCT 835, PCT 849, PCT 850, PCT 1800
Black-chinned Honeyeater	*Melithreptus gularis*	V	-	Ecosystem	PCT 724, PCT 830, PCT 835, PCT 849, PCT 850, PCT 1800
Brown Treecreeper (eastern subspecies)	*Climacteris picumnus subsp. victoriae*	V	-	Ecosystem	PCT 724, PCT 830, PCT 835, PCT 849, PCT 850, PCT 1800

Common name	Scientific name	TSC Act status	EPBC Act status	Ecosystem or species credit species	Vegetation type (Ecosystem credit) or habitat constraints (Species credit)
Bush Stone-curlew	*Burhinus grallarius*	E	-	Ecosystem	PCT 724, PCT 830, PCT 835, PCT 849, PCT 850, PCT 1800
Diamond Firetail	*Stagonopleura guttata*	V	-	Ecosystem	PCT 724, PCT 830, PCT 835, PCT 849, PCT 850, PCT 1800
Eastern False Pipistrelle	*Falsistrellus tasmaniensis*	V	-	Ecosystem	PCT 724, PCT 830, PCT 835, PCT 849, PCT 850, PCT 1800
Eastern Freetail-bat	*Mormopterus norfolkensis*	V	-	Ecosystem	PCT 724, PCT 830, PCT 835, PCT 849, PCT 850, PCT 1800
Flame Robin	*Petroica phoenicea*	V	-	Ecosystem	PCT 724, PCT 830, PCT 835, PCT 849, PCT 850, PCT 1800
Gang-gang Cockatoo	*Callocephalon fimbriatum*	V	-	Ecosystem	PCT 724, PCT 830, PCT 835, PCT 849, PCT 850
Glossy Black-cockatoo	*Calyptorhynchus lathami*	V	-	Ecosystem	PCT 724
Greater Broad-nosed Bat	*Scoteanax rueppellii*	V	-	Ecosystem	PCT 724, PCT 830, PCT 835, PCT 849, PCT 850, PCT 1800
Hooded Robin (south-eastern form)	*Melanodryas cucullata subs. cucullata*	V	-	Ecosystem	PCT 724, PCT 830, PCT 835, PCT 849, PCT 850, PCT 1800
Little Eagle	*Hieraaetus morphnoides*	V	-	Ecosystem	PCT 724, PCT 830, PCT 835, PCT 849, PCT 850, PCT 1800
Little Lorikeet	*Glossopsitta pusilla*	V	-	Ecosystem	PCT 724, PCT 830, PCT 835, PCT 849, PCT 850, PCT 1800
Masked Owl	*Tyto novaehollandiae*	V	-	Ecosystem	PCT 724, PCT 830, PCT 835, PCT 849, PCT 850, PCT 1800
Speckled Warbler	*Chthonicola sagittata*	V	-	Ecosystem	PCT 724, PCT 830, PCT 835, PCT 849, PCT 850, PCT 1800
Spotted Harrier	*Circus assimilis*	V	-	Ecosystem	PCT 835, PCT 849, PCT 850

Common name	Scientific name	TSC Act status	EPBC Act status	Ecosystem or species credit species	Vegetation type (Ecosystem credit) or habitat constraints (Species credit)
Square-tailed Kite	*Lophoictinia isura*	V	-	Ecosystem	PCT 724, PCT 830, PCT 835, PCT 849, PCT 850, PCT 1800
Swift Parrot	*Lathamus discolor*	E	CE	Ecosystem	PCT 724, PCT 830, PCT 835, PCT 849, PCT 850, PCT 1800
Turquoise Parrot	*Neophema pulchella*	V	-	Ecosystem	PCT 724, PCT 830, PCT 835, PCT 849, PCT 850, PCT 1800
Varied Sittella	*Daphoenositta chrysoptera*	V	-	Ecosystem	PCT 724, PCT 830, PCT 835, PCT 849, PCT 850, PCT 1800
Yellow-bellied Sheathtail-bat	*Saccolaimus flaviventris*	V	-	Ecosystem	PCT 724, PCT 830, PCT 835, PCT 849, PCT 850, PCT 1800
Ecosystem/species credit species					
Eastern Bentwing-bat	*Miniopterus schreibersii oceanensis*	V	-	Ecosystem/species	Land containing caves or similar structures
Grey-headed Flying-fox	*Pteropus poliocephalus*	V	V	Ecosystem/species	Land within 40 m of rainforest, coastal scrub, riparian or estuarine communities
Large-eared Pied Bat	*Chalinolobus dwyeri*	V	V	Ecosystem/species	Land containing escarpments, cliffs, caves, deep crevices, old mine shafts or tunnels
Little Bentwing-bat	*Miniopterus australis*	V	-	Ecosystem/species	N/A
Southern Myotis	*Myotis macropus*	V	-	Ecosystem/species	Hollow-bearing trees, bridges, caves or artificial structures within 200 m of riparian zone

Common name	Scientific name	TSC Act status	EPBC Act status	Ecosystem or species credit species	Vegetation type (Ecosystem credit) or habitat constraints (Species credit)
Species credit species					
Black Bittern	*Ixobrychus flavicollis*	V	-	Species	Land within 40 m of freshwater and estuarine wetlands, in areas of permanent water and dense vegetation or emergent aquatic vegetation
Cumberland Plain Land Snail	*Meridolum corneovirens*	E	-	Species	Land containing bark or leaf litter accumulation
Green and Golden Bell Frog	*Litoria aurea*	E	V	Species	Land within 100 m of emergent aquatic or riparian vegetation
Koala	*Phascolarctos cinereus*	V	V	Species	N/A
Regent Honeyeater	*Anthochaera phrygia*	CE	CE	Species	N/A

CE = Critically Endangered, E = Endangered, V = Vulnerable

4.2 Threatened species survey

4.2.1 Terrestrial flora surveys

Targeted flora surveys were undertaken over 16 person days by Arcadis ecologists in October and November 2017 and August 2018. These surveys followed the methods described in the *Threatened Biodiversity Survey and Assessment Guidelines for Developments and Activities – Working Draft 2004* (DoEC, 2004) and with reference to the NSW Guide for Surveying Threatened Plants (OEH, 2016).

Targeted flora surveys were completed for all candidate flora species with suitable habitat. A list of threatened flora species that required survey was created using the results of the Biobanking credit calculator (OEH, n.d.), BioNet records (OEH, 2017) and Protected Matters Search Tool (DoEE, 2018). This list was then refined based on suitability of habitat features present including associated PCTs, soil and geological preferences. The list of flora species targeted during surveys and the associated survey effort is listed in **Table 4-4** below.

Areas of potential habitat were identified for the candidate flora species and targeted surveys were then performed. These targeted surveys consisted of parallel field traverses on a 10 metre spacing, to account for the smallest of the growth forms that were being targeted. The timing of the surveys also adheres to the survey timing requirements as detailed in the Threatened Species Profile Database (OEH, 2018) for each candidate flora species.

Cryptic species are difficult to detect and/or distinguish from other species. For cryptic species considered likely to occur within the study area such as *Pimelea spicata*, the field survey included visiting a reference population to identify the flowering time. By surveying during flowering times, survey times were optimised as the detectability of the plant was increased. A reference population of *Pimelea spicata* in Western

Sydney Parklands (near the Lizard Log carpark) was visited numerous times during the survey period and flowering at the reference population was recorded throughout the survey period.

Weather conditions at the time of the flora surveys were generally warm, clear and still.
The weather records from the Horsley Park Equestrian Centre AWS (station 067119), about one kilometre from the eastern edge of the study area, for the surveyed dates are detailed in **Table 4-3**.

Table 4-3 Weather conditions during targeted flora survey period (BoM, 2018)

Date	Temperature		Rain	Wind Speed at 3pm	
	Min (°C)	Max (°C)	mm	Direction	Speed (km/h)
5 October 2017	13.2	30.3	0	ESE	4
30 October 2017	16.7	35.1	0.2	NW	31
2 November 2017	10.5	23.9	0	E	17
9 November 2017	9.4	23.9	0	E	17
13 November 2017	14	23.9	0	ESE	20
14 August 2018	2.3	22.5	0	NNW	7

Table 4-4 Targeted flora surveys

Species	TSC Act status	EPBC Act status	Survey location	Minimum survey requirements (OEH, 2016)	Survey technique used	Seasonal survey requirements (TSPD)	Survey timing	Adequacy against guidelines
Bynoes Wattle *Acacia bynoeana*	E	V	PCTs: 724, 849, 883	Parallel field traverses. For a small shrub in dense vegetation the recommended maximum distance between field traverses is 10m, in open vegetation it is 15m.	Random meander. 10 m spaced parallel transects. Quadrats (30 minutes for each quadrat sampled).	September – March	October-November 2017 August 2018	Adequate
Downy Wattle *Acacia pubescens*	V	V	PCTs: 724, 849, 850, 883	Parallel field traverses. For a medium shrub in dense vegetation the recommended maximum distance between field traverses is 10m, in open vegetation it is 20m.	Random meander. 10 m spaced parallel transects. Quadrats (30 minutes for each quadrat sampled).	All year	October-November 2017 August 2018	Adequate
White-flowered Wax Plant *Cynanchum elegans*	E	E	PCTs: 830, 835, 849, 850	Parallel field traverses. For a climber in dense vegetation the recommended maximum distance between field traverses is 5m, in open vegetation it is 10m.	Random meander. 10 m spaced parallel transects. Quadrats (30 minutes for each quadrat sampled).	All year	October-November 2017	Adequate
Dillwynia tenuifolia	V	-	PCTs: 724, 849, 883	Parallel field traverses. For a medium shrub in dense vegetation the recommended maximum distance between field traverses is 10m, in open vegetation it is 20m.	Random meander. 10 m spaced parallel transects. Quadrats (30 minutes for each quadrat sampled).	All year	October-November 2017 August 2018	Adequate
Juniper-leaf Grevillea *(Grevillea juniperina subsp. juniperina)*	V	-	PCTs: 724, 849, 850, 883	Parallel field traverses. For a medium shrub in dense vegetation the recommended maximum distance between field traverses is 10m, in open vegetation it is 20m.	Random meander. 10 m spaced parallel transects. Quadrats (30 minutes for each quadrat sampled).	All year	October-November 2017 August 2018	Adequate

Species	TSC Act status	EPBC Act status	Survey location	Minimum survey requirements (OEH, 2016)	Survey technique used	Seasonal survey requirements (TSPD)	Survey timing	Adequacy against guidelines
Grevillea parviflora subsp. parviflora	V	V	PCTs:724, 883	Parallel field traverses. For a small shrub in dense vegetation the recommended maximum distance between field traverses is 10m, in open vegetation it is 15m.	Random meander. 10 m spaced parallel transects. Quadrats (30 minutes for each quadrat sampled).	All year	October-November 2017 August 2018	Adequate
Marsdenia viridiflora subsp. viridiflora population in the Bankstown, Blacktown, Camden, Campbelltown, Fairfield, Holroyd, Liverpool and Penrith local government areas	EP	-	PCTs: 724, 830, 835, 849, 850, 1800	Parallel field traverses. For a climber in dense vegetation the recommended maximum distance between field traverses is 5m, in open vegetation it is 10m.	Random meander. 10 m spaced parallel transects. Quadrats (30 minutes for each quadrat sampled).	All year	October-November 2017 August 2018	Adequate
Micromyrtus minutiflora	E	V	PCTs: 724	Parallel field traverses. For a medium shrub in dense vegetation the recommended maximum distance between field traverses is 10m, in open vegetation it is 20m.	Random meander. 10 m spaced parallel transects. Quadrats (30 minutes for each quadrat sampled).	All year	October-November 2017 August 2018	Adequate
Nodding Geebung *Persoonia nutans*	E	E	PCTs: 724, 883	Parallel field traverses. For a medium shrub in dense vegetation the recommended maximum distance between field traverses is 10m, in open vegetation it is 20m.	Random meander. 10 m spaced parallel transects. Quadrats (30 minutes for each quadrat sampled).	All year	October-November 2017 August 2018	Adequate

Species	TSC Act status	EPBC Act status	Survey location	Minimum survey requirements (OEH, 2016)	Survey technique used	Seasonal survey requirements (TSPD)	Survey timing	Adequacy against guidelines
Spiked Rice-flower *(Pimelea spicata)*	E	E	PCTs: 830, 849, 850	Parallel field traverses. For a small shrub in dense vegetation the recommended maximum distance between field traverses is 10m, in open vegetation it is 15m. This species flowers sporadically, with flowering dependent on climatic conditions. Survey requires checking of flowering at reference populations in the locality as an indicator of flowering time.	Random meander. 10 m spaced parallel transects. Quadrats (30 minutes for each quadrat sampled). *Pimelea spicata* was recorded in flower at the reference site (Lizard Log carpark in Western Sydney Parklands).	All year	October-November 2017	Adequate
Sydney Bush-pea *(Pultenaea parviflora)*	E	V	PCTs: 724, 883	Parallel field traverses. For a small shrub in dense vegetation the recommended maximum distance between field traverses is 10m, in open vegetation it is 15m.	Random meander. 10 m spaced parallel transects. Quadrats (30 minutes for each quadrat sampled).	All year	October-November 2017 August 2018	Adequate
Matted Bush-pea *(Pultenaea pedunculata)*	E	-	PCTs: 724, 849, 850	Parallel field traverses. For a small shrub in dense vegetation the recommended maximum distance between field traverses is 10m, in open vegetation it is 15m.	Random meander. 10 m spaced parallel transects. Quadrats (30 minutes for each quadrat sampled).	September – November	October-November 2017 August 2018	Adequate

EP = Endangered Population, E = Endangered, V = Vulnerable

4.2.2 Terrestrial fauna surveys

Desktop assessment was undertaken to determine potential occurrence of threatened fauna in the study area. Resources used to assess initial likelihood of occurrence of threatened fauna are listed in **Section 4.1**. The list of threatened fauna species with potential habitat present within the study area (based on initial desktop assessment) is included in **Annexure B**.

Following the desktop assessment, fauna habitat values in the study area were identified and assessed using the following methods:

- Habitat assessment – field assessments to identify fauna habitat values and potential habitat for threatened fauna
- Stratification and site selection – identification and mapping of fauna habitat units and suitable sites for targeted surveys
- Targeted surveys – undertaken at selected sites for all threatened fauna considered likely to occur within the study area.

The methods used to determine the fauna habitat values of the study area are described below.

Habitat assessment

Broad fauna habitat values such as vegetation type, structure and condition were assessed during rapid vegetation assessments undertaken throughout the study area during the survey. A range of additional fauna habitat elements (eg leaf litter, hollow-bearing trees, key foraging resources and coarse woody debris) were assessed at all FBA plot sites (**Figure 3-1**).

Specific fauna habitat assessments were also undertaken at 43 sites across the study area (**Figure 4-1**). The aim of the fauna habitat assessments was to gather information on the type and condition of fauna habitats present.

At each habitat assessment site, the following fauna habitat features were recorded:

- Type and structure of the vegetation, including as assessment of the ‘naturalness’ in terms of the presence of remnant vegetation or planted and re-growth areas and the extent of modification
- Presence and relative abundance of large mature trees
- Presence and abundance of hollow-bearing trees (living trees and stags), and the landscape setting of these trees (eg isolated tree in paddock, tall mature tree in riparian habitat)
- Presence and abundance of fallen logs and coarse woody debris
- Presence of significant keystone species (eg apex predators such as large forest owls) and critical habitat elements for threatened fauna
- Disturbance regimes, both past and ongoing including grazing and weed abundance
- Density of each vegetation strata (structural diversity)
- Presence and quality of wet areas or waterbodies, and significant aquatic habitats where present
- Size of remnant patches and extent of connectivity, movement corridors and refuge value.

The results of the field habitat assessments were used to establish fauna habitat stratification units, to refine the likelihood of occurrence for threatened fauna and to determine the areas that should be targeted for fauna surveys.

Stratification and site selection

Fauna habitat stratification was undertaken to classify the native vegetation of the study area by similar habitat features and ensure that all potential fauna habitats across the study area would be adequately surveyed. The study area was stratified into four broad fauna habitat types (**Figure 4-1**). These were:

- Woodland – including all mature and regenerating grassy, shrubby and heathy woodland vegetation within the study area not associated with riparian corridors on alluvial flats
- Riparian forest – including all mature and regenerating forest/woodland vegetation associated with drainage lines on alluvial flats throughout the study area
- Grassland – including all native and exotic grasslands, pastures and parklands within the study area. Scattered trees and landscape plants may also be present

- Wetlands and watercourses – including all naturally occurring and constructed permanent or ephemeral dams, ponds, creeks and drainage channels within the study area.

Sites for targeted surveys were selected within each of these stratification units. Site selection was based on presence/absence of suitable habitat for each of the threatened fauna species considered likely to occur in the locality.

Targeted fauna surveys

Targeted surveys were undertaken for all threatened fauna species considered to have a 'moderate' or 'high' likelihood of occurrence in the study area based on the combined results of the desktop assessment and site habitat assessment.

Targeted fauna surveys were designed to address the requirements outlined in the *Threatened Biodiversity Survey and Assessment Guidelines for Developments and Activities – Working Draft 2004*. The following guidelines were also used to determine appropriate survey requirements for threatened terrestrial fauna:

- DECC (TSC Act) – *Threatened species survey and assessment guidelines: field survey methods for fauna – Amphibians* (DECC, 2009)
- CoA (EPBC Act) – *Survey Guidelines for Australia's Threatened Frogs* (2011), *Reptiles* (2011), *Birds* (2010), *Mammals* (2011) and *Bats* (2010)
- NSW NPWS (TSC Act) – *Environmental Impact Assessment Guidelines for the Green and Golden Bell Frog* (*Litoria aurea*) (2003)
- CoA (EPBC Act) – *Significant impact guidelines for the vulnerable green and golden bell frog* (*Litoria aurea*) (2009)
- NSW NPWS (TSC Act) – *Environmental Impact Assessment Guidelines for Cumberland Plain Land Snail* (*Meridolum corneovirens*) (2000)
- DoE (EPBC Act) – *EPBC Act referral guidelines for the vulnerable koala* (DoE, 2014).

The fauna species that were identified from the background review and habitat assessment that were targeted during the survey are discussed below and shown in **Table 4-5**, overleaf.

4.2.3 Threatened species survey limitations

Field surveys and survey effort met the requirements of the FBA and a majority of the study area was able to be surveyed. However, in some areas, surveys were constrained by landowner permissions and restricted access. As such, while survey effort was shared amongst the stratified fauna habitats as equally as possible, all sites targeted for survey could not be accessed (eg properties within the central extent of the study area, surrounding Clifton Avenue). Where possible, vegetation and potential fauna habitat (ie hollow bearing trees) were viewed from the roadside or public areas to verify habitat condition and available habitat in the study area.

As some threatened flora species can remain cryptic throughout the year, such as *Pimelea spicata*, reference sites and populations were visited where possible to determine the possibility of detection within the study area, and ensure surveys were conducted at the optimal time of year.

Table 4-5 Targeted fauna survey details

Species	Minimum survey requirements	Seasonal survey requirements	Survey techniques used	Survey effort	Survey timing	Survey adequacy
Cumberland Plain Land Snail	Dependent upon size and amount of potential habitat present within the study area.	All year. All weather conditions.	Targeted searches for live snails or empty shells within all suitable Woodland and Riparian Forest fauna habitats. Searches at the base of trees and beneath rocks and debris.	14 sites throughout the study area in suitable woodland habitat. Total 14 person hours at one person hour/site.	15 June 2017 28 September 2017 9 November 2017 1 August 2018	Surveys considered adequate to determine presence/absence within the study area.
Green and Golden Bell Frog	Four nights (EPBC) or three nights (TSC) of survey under optimal conditions. One hour per small (<0.3ha) site and four hours per larger area (wetlands, lagoons).	September to March (EPBC) or August to February (TSC). Warm, windless nights within one week of heavy rainfall (>50mm in seven days).	Initial field habitat assessment to identify potential habitat. Nocturnal call detection, call playback and spotlighting surveys within all suitable habitat. Equivalent surveys undertaken at one reference site (Olympic Park, Homebush).	Seven sites throughout the study area in suitable wetland and watercourse habitat. One hour by two people at one site over five separate nights. One hour by two people at six sites over seven separate nights Total 94 person hours.	22 February 2018 27 February 2018 28 February 2018 8 March 2018 9 March 2018 16 October 2018 17 October 2018	Surveys considered adequate to determine presence/absence within the study area.
Regent Honeyeater	20 hours over 10 days – area searches in areas < 50ha. 20 hours over five days - targeted surveys of blossoming trees with other nectivores present.	All year. Diurnal bird surveys within four hours after sunrise.	Diurnal bird 2 ha area surveys, Swift Parrot 2 ha area surveys and Swift Parrot transects within all Woodland and Riparian Forest habitats. Incidental searches of large scattered trees within grassland habitat.	12 Diurnal bird sites. Four Swift Parrot area search sites. 10 Swift Parrot transect sites. 20 minutes by two people per diurnal/Swift Parrot 2 ha area search site. One hour by two people per Swift Parrot transect survey. Total 640 person hours 2 ha area searches.	Diurnal bird surveys: 23 May 2017 21 August 2017 22 August 2017 24 August 2017 12 October 2017 30 October 2017 9 November 2017 1 August 2018 2 August 2018 Targeted Swift Parrot surveys: 24 May 2017 25 May 2017	Surveys considered adequate to determine presence/absence within the study area.

Species	Minimum survey requirements	Seasonal survey requirements	Survey techniques used	Survey effort	Survey timing	Survey adequacy
				Total 20 person hours transect surveys.	17 July 2017 10 July 2017 21 July 2017 22 July 2017 24 August 2017 26 July 2018 1 August 2018 2 August 2018	
Swift Parrot	20 hours over eight days – area searches in areas < 50ha. 20 hours over eight days - targeted surveys of blossoming trees with other nectivores present.	March to July (EPBC).	Diurnal bird 2 ha area surveys, Swift Parrot 2 ha area surveys and Swift Parrot transects within all Woodland and Riparian Forest habitats. Incidental searches of large scattered trees within grassland habitat.	12 Diurnal bird sites. Four Swift Parrot area search sites. 10 Swift Parrot transect sites 20 minutes by two people per diurnal/Swift Parrot 2 ha area search site. One hour by two people per Swift Parrot transect survey. Total 640 person hours 2 ha area searches. Total 20 person hours transect surveys.	Diurnal bird surveys: 23 May 2017 21 August 2017 22 August 2017 24 August 2017 12 October 2017 30 October 2017 9 November 2017 1 August 2018 2 August 2018 Targeted Swift Parrot surveys: 24 May 2017 25 May 2017 17 July 2017 10 July 2017 21 July 2017 22 July 2017 24 August 2017 26 July 2018 1 August 2018 2 August 2018	Surveys considered adequate to determine presence/absence within the study area.

Species	Minimum survey requirements	Seasonal survey requirements	Survey techniques used	Survey effort	Survey timing	Survey adequacy
Black Bittern	One hour survey at dawn or dusk per natural wetland. 20 minute survey at dawn or one hour before dusk at each identified water source.	All year.	Initial field habitat assessment to identify potential habitat. Targeted Black Bittern surveys: Dusk call detection, call playback and observation followed by spotlighting surveys while traversing habitat to detect or flush birds within all suitable habitat. All wetland bird surveys at dams throughout the study area. All diurnal 2ha area bird searches within Riparian Forest habitat throughout the study area.	Targeted Black Bittern surveys: Two sites located within suitable wetland and watercourse habitat. One hour by two people at each site over five separate nights. Wetland bird surveys: Six sites at dams throughout the study area. 20 minutes by two people at each site. All diurnal 2ha area bird searches within Riparian Forest habitat.	Targeted Black Bittern surveys: 22 August 2018 23 August 2018 27 August 2018 28 August 2018 29 August 2018 Wetland bird surveys: 19 October 2017 1 August 2018 2 August 2018 All diurnal bird surveys within Riparian Forest habitat.	Surveys considered adequate to determine presence/absence within the study area.
Bush Stone-curlew	Targeted diurnal and/or nocturnal survey per stratification unit.	All year.	Targeted Bush Stone-curlew surveys: Nocturnal call detection, call playback and observation followed by spotlighting surveys while traversing habitat to detect or flush birds within all suitable habitat. Diurnal bird 2ha area surveys, Swift Parrot 2ha area surveys and Swift Parrot transects within all Woodland and Riparian Forest habitats.	Targeted Bush Stone-curlew surveys: Four sites in Woodland and Riparian Forest habitats over five nights by two people. 12 Diurnal bird sites. Four Swift Parrot area search sites. 10 Swift Parrot transect sites. 20 minutes by two people per diurnal/Swift Parrot 2ha area search site.	Targeted Bush Stone-curlew surveys: 22 August 2018 23 August 2018 27 August 2018 28 August 2018 29 August 2018 Diurnal bird surveys: 23 May 2017 21 August 2017 22 August 2017 24 August 2017 12 October 2017 30 October 2017 9 November 2017	Surveys considered adequate to determine presence/absence within the study area.

Species	Minimum survey requirements	Seasonal survey requirements	Survey techniques used	Survey effort	Survey timing	Survey adequacy
				One hour by two people per Swift Parrot transect survey. Total 640 person hours 2ha area searches. Total 20 person hours transect surveys.	1 August 2018 2 August 2018 Targeted Swift Parrot surveys: 24 May 2017 25 May 2017 17 July 2017 10 July 2017 21 July 2017 22 July 2017 24 August 2017 26 July 2018 1 August 2018 2 August 2018	
Owls Barking Owl Masked Owl Powerful Owl	Barking Owl – five nights. Powerful Owl – five nights. Masked Owl – eight nights.	All year.	Nocturnal call detection, call playback and observation followed by spotlighting surveys while traversing habitat to detect birds within all suitable habitat.	Four sites in Woodland and Riparian Forest habitats over five nights by two people for one hour per site.	22 August 2018 23 August 2018 27 August 2018 28 August 2018 29 August 2018	Surveys considered adequate to determine presence/absence of Barking Owl and Powerful Owl within the study area. Targeted surveys alone not considered adequate to determine presence/absence of Masked Owl within the study area. This species required a minimum of eight nights of targeted survey. Habitat assessments undertaken during all surveys determined

Species	Minimum survey requirements	Seasonal survey requirements	Survey techniques used	Survey effort	Survey timing	Survey adequacy
						that Masked Owl should be considered a 'low' likelihood to occur within the study area.
Diurnal raptors Black Falcon Little Eagle Spotted Harrier Square-tailed Kite White-bellied Sea-Eagle	Targeted diurnal bird survey per stratification unit.	All year.	Diurnal bird 2ha area surveys, Swift Parrot 2ha area surveys and Swift Parrot transects within all Woodland and Riparian Forest habitats. Incidental searches for diurnal raptors perched or flying overhead within grassland habitat.	12 Diurnal bird sites. Four Swift Parrot area search sites. 10 Swift Parrot transect sites. 20 minutes by two people per diurnal/Swift Parrot 2ha area search site. One hour by two people per Swift Parrot transect survey. Total 640 person hours 2ha area searches. Total 20 person hours transect surveys.	Diurnal bird surveys: 23 May 2017 21 August 2017 22 August 2017 24 August 2017 12 October 2017 30 October 2017 9 November 2017 1 August 2018 2 August 2018 Targeted Swift Parrot surveys: 24 May 2017 25 May 2017 17 July 2017 10 July 2017 21 July 2017 22 July 2017 24 August 2017 26 July 2018 1 August 2018 2 August 2018	Surveys considered adequate to determine presence/absence within the study area.
Woodland birds Gang-gang Cockatoo Glossy Black-cockatoo Little Lorikeet	Targeted diurnal bird survey per stratification unit.	All year.	Diurnal bird 2ha area surveys, Swift Parrot 2ha area surveys and Swift Parrot transects within all Woodland and Riparian Forest habitats. Incidental searches within grassland habitat.	12 Diurnal bird sites. Four Swift Parrot area search sites. 10 Swift Parrot transect sites.	Diurnal bird surveys: 23 May 2017 21 August 2017 22 August 2017 24 August 2017	Surveys considered adequate to determine presence/absence within the study area.

Species	Minimum survey requirements	Seasonal survey requirements	Survey techniques used	Survey effort	Survey timing	Survey adequacy
Turquoise Parrot Black-chinned Honeyeater Dusky Woodswallow Speckled Warbler Varied Sittella Flame Robin Hooded Robin Scarlet Robin Diamond Firetail				20 minutes by two people per diurnal/Swift Parrot 2ha area search site. One hour by two people per Swift Parrot transect survey. Total 640 person hours 2ha area searches. Total 20 person hours transect surveys.	12 October 2017 30 October 2017 9 November 2017 1 August 2018 2 August 2018 Targeted Swift Parrot surveys: 24 May 2017 25 May 2017 17 July 2017 10 July 2017 21 July 2017 22 July 2017 24 August 2017 26 July 2018 1 August 2018 2 August 2018	
Koala	Survey effort should be determined on a case-by-case basis and can include both direct and indirect survey methods.	All year (scat searches). August to January (searches for individuals).	Nocturnal call detection, call playback and observation followed by spotlighting surveys while traversing habitat to detect birds within all suitable habitat. Diurnal searches of trees for Koalas during all diurnal surveys in Woodland and Riparian Forest habitats. Targeted scat searches using the Spot Assessment Technique (SAT) throughout Woodland and Riparian Forest habitats.	Nocturnal surveys: Four sites in Woodland and Riparian Forest habitats over five nights by two people for one hour per site. Scat searches: 14 sites in Woodland and Riparian habitats.	Nocturnal surveys: 22 August 2018 23 August 2018 27 August 2018 28 August 2018 29 August 2018 Scat searches: 15 June 2017 28 September 2017 30 October 2017 9 November 2017 13 November 2017 1 August 2018	Surveys considered adequate to determine presence/absence within the study area.

Species	Minimum survey requirements	Seasonal survey requirements	Survey techniques used	Survey effort	Survey timing	Survey adequacy
Grey-headed Flying-fox	Spotlighting transects 100 m apart.	All year.	Nocturnal call detection and observation followed by spotlighting surveys while traversing habitat to detect individuals within all suitable habitat. Habitat assessment and searches for flying-fox camps during all diurnal surveys in Woodland and Riparian Forest habitats.	Nocturnal surveys: Four sites in Woodland and Riparian Forest habitats over five nights by two people for one hour per site.	Nocturnal surveys: 22 August 2018 23 August 2018 27 August 2018 28 August 2018 29 August 2018	Surveys considered adequate to determine presence/absence within the study area.
Large-eared Pied Bat	Ultrasonic call detectors for minimum four nights. Minimum total effort of 16 detector nights in areas < 50ha.	October to March.	Nocturnal ultrasonic call detection devices (Anabat) deployed within suitable Woodland and Riparian Forest habitat, and near dams and watercourses. Diurnal searches for caves or culverts.	Three detectors at six sites for two nights per site. Total 12 detector nights.	9 November 2017 13 November 2017 16 November 2017 20 November 2017	Targeted surveys alone not considered adequate to determine presence/absence of the Large-eared Pied Bat within the study area. This species required a minimum of 16 detector nights targeted survey. Habitat assessments undertaken during all surveys determined that Large-eared Pied Bat should be considered a 'low' likelihood to occur within the study area.
Other microbats Eastern Bentwing-bat Eastern False Pipistrelle Eastern Freetail-bat Greater	Two ultrasonic call detectors for minimum two nights per 100ha of stratification unit.	October to March.	Nocturnal ultrasonic call detection devices (Anabat) deployed within suitable Woodland and Riparian Forest habitat, and near dams and watercourses. Diurnal searches for caves, culverts and hollow-bearing trees.	Three detectors at six sites for two nights per site. Total 12 detector nights.	9 November 2017 13 November 2017 16 November 2017 20 November 2017	Surveys considered adequate to determine presence/absence within the study area.

Species	Minimum survey requirements	Seasonal survey requirements	Survey techniques used	Survey effort	Survey timing	Survey adequacy
Broad-nosed Bat Little Bentwing-bat Southern Myotis Yellow-bellied Sheathtail-bat						

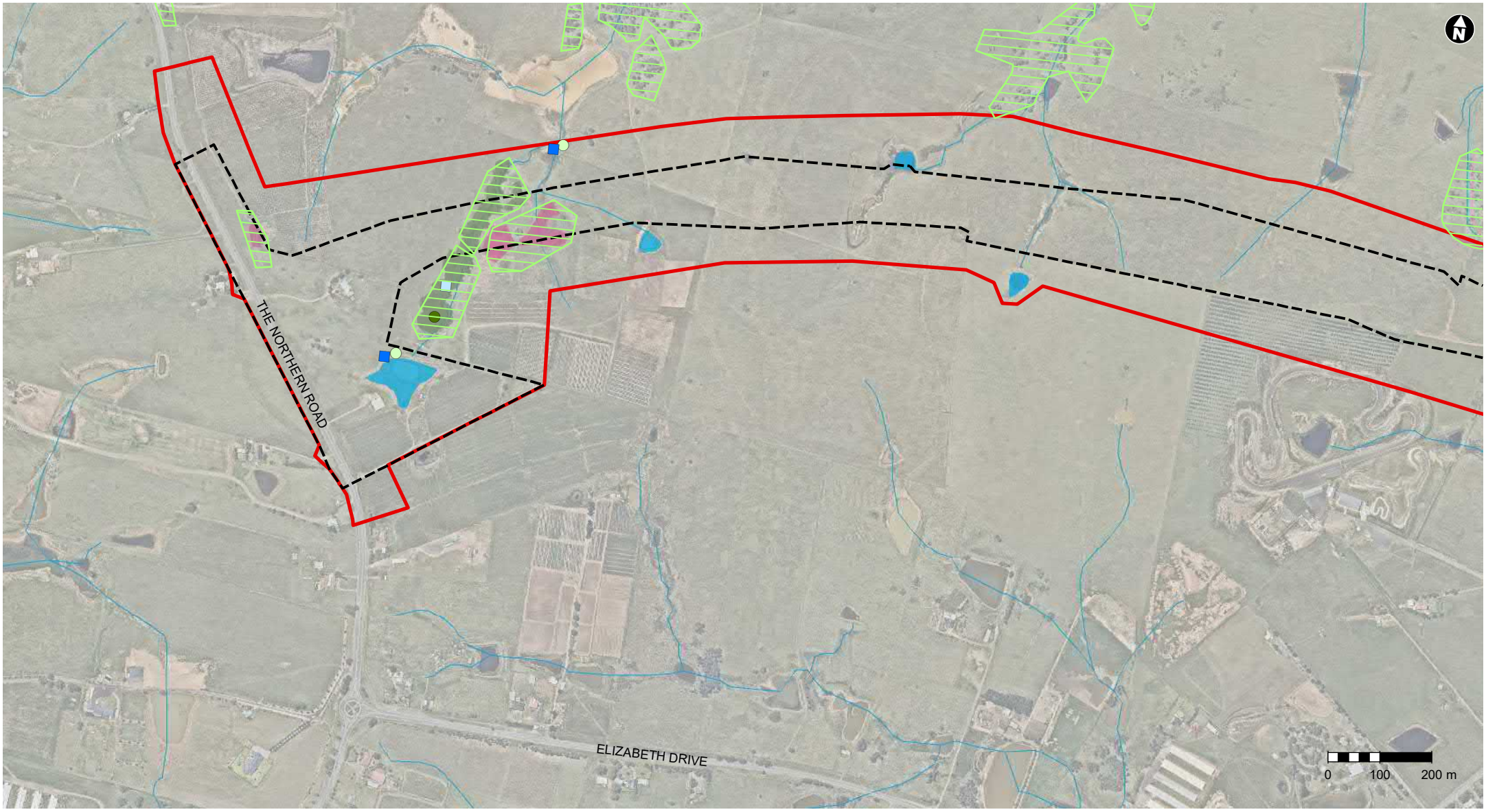

Figure 4-1 Threatened species survey locations

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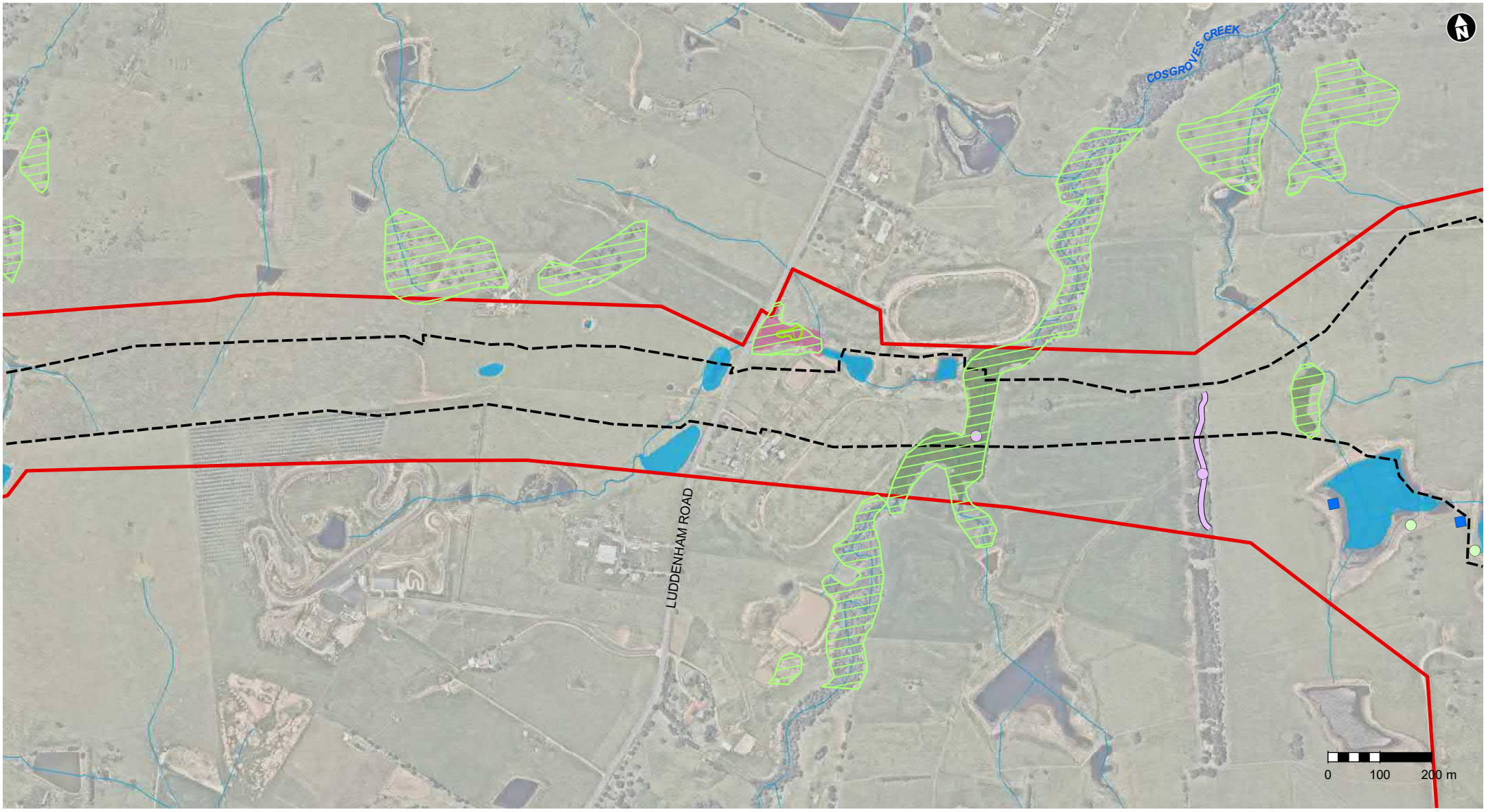

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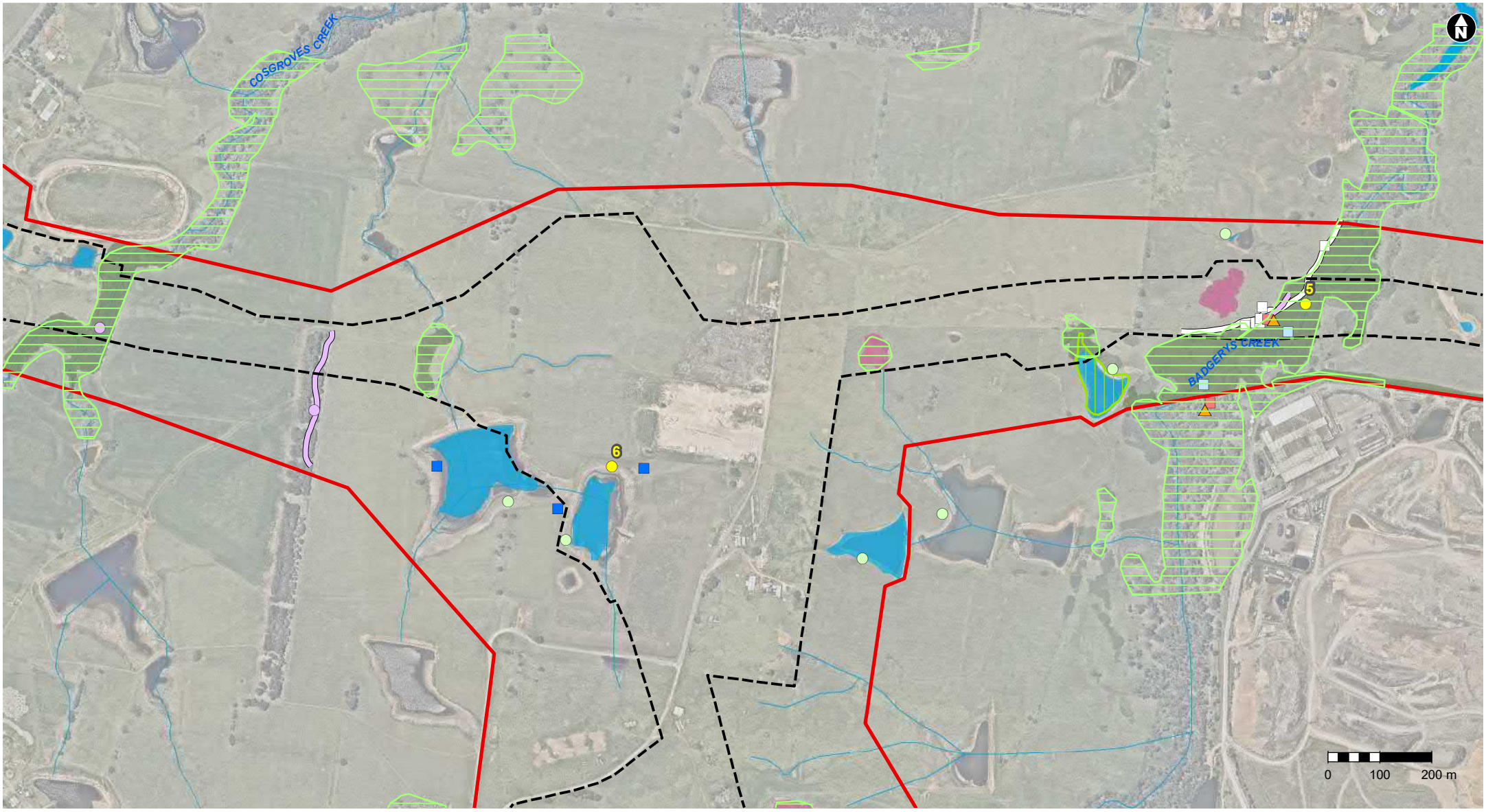

Study area corridor
The project construction footprint
Western Sydney Parklands
NPWS Reserves
Biodiversity certified land
Waterways

Fauna surveys
Anabats (location #)
Threatened snail survey
Koala SAT
Swift Parrot - Area search
Swift Parrot - Habitat assessment
Swift Parrot - Transect

Terrestrial habitat assessment
Wetland habitat assessment
Nocturnal survey - Call playback
Nocturnal survey - Spotlight transect
Bird survey - Diurnal
Bird survey - Wetland
Green and Golden Bell Frog Survey

Fauna habitat stratification unit
Woodland
Riparian Forest
Wetlands and watercourses
Grassland (cleared land)

Figure 4-1 Threatened species survey locations

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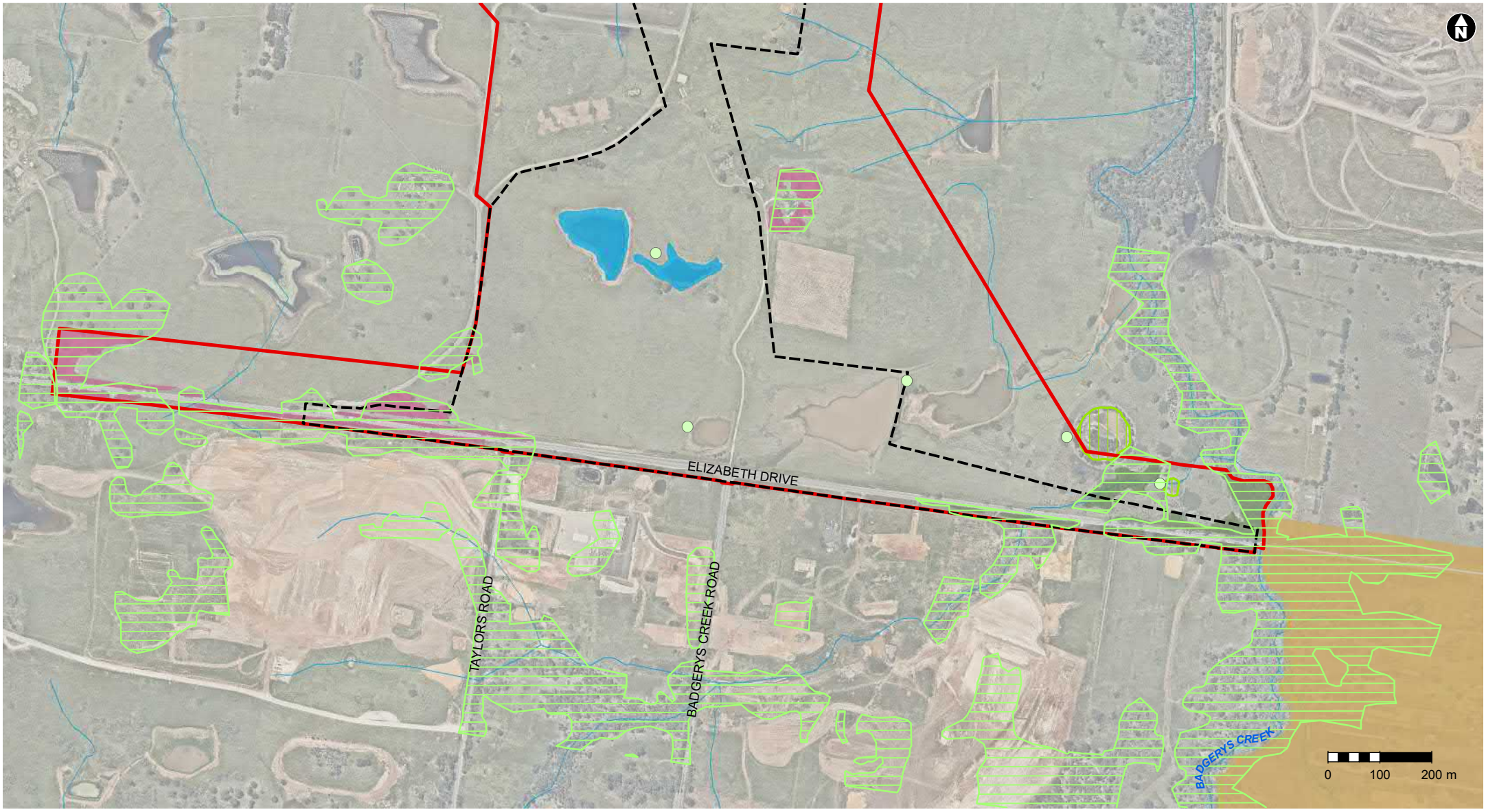

Figure 4-1 Threatened species survey locations

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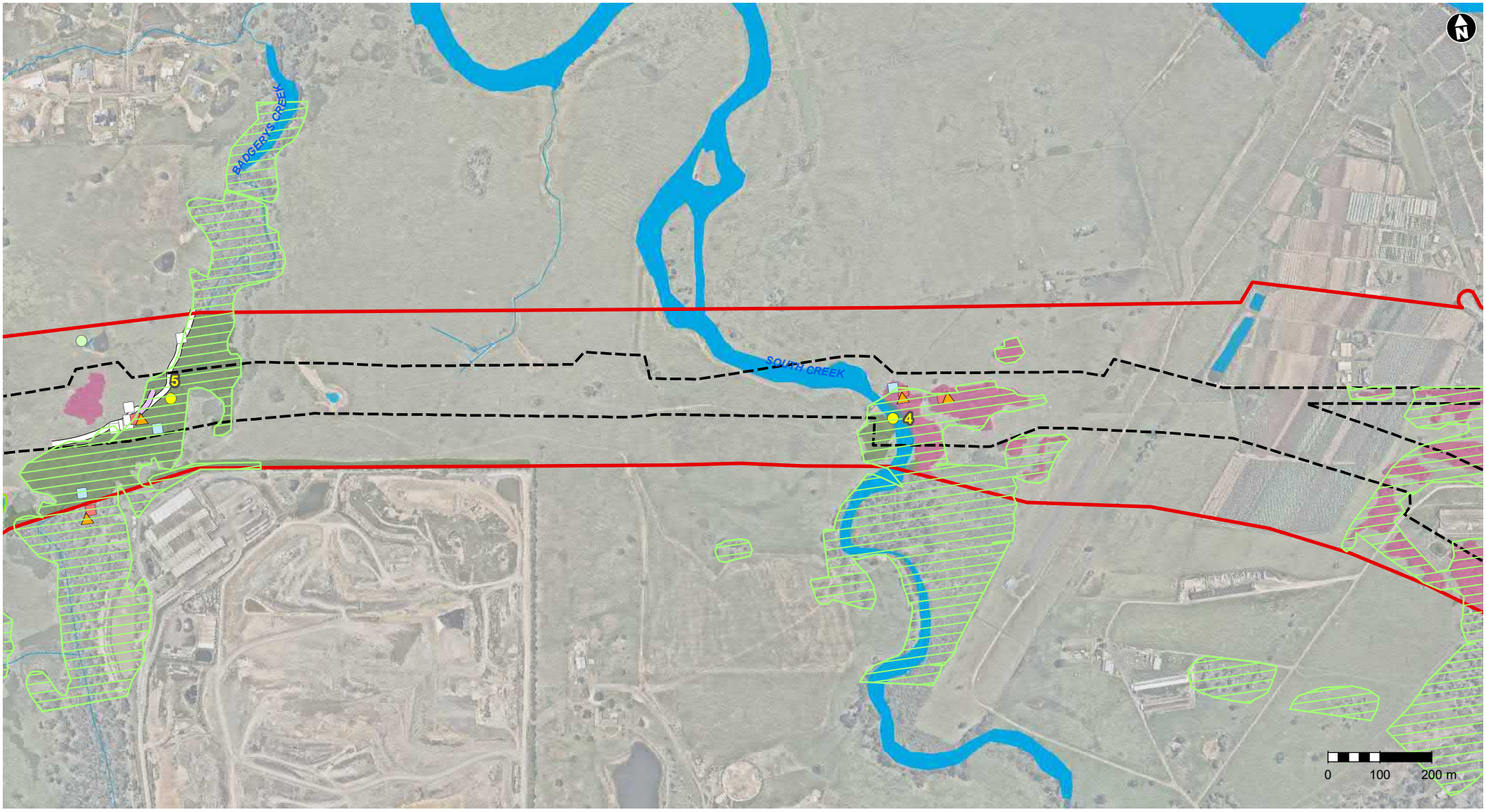

Figure 4-1 Threatened species survey locations

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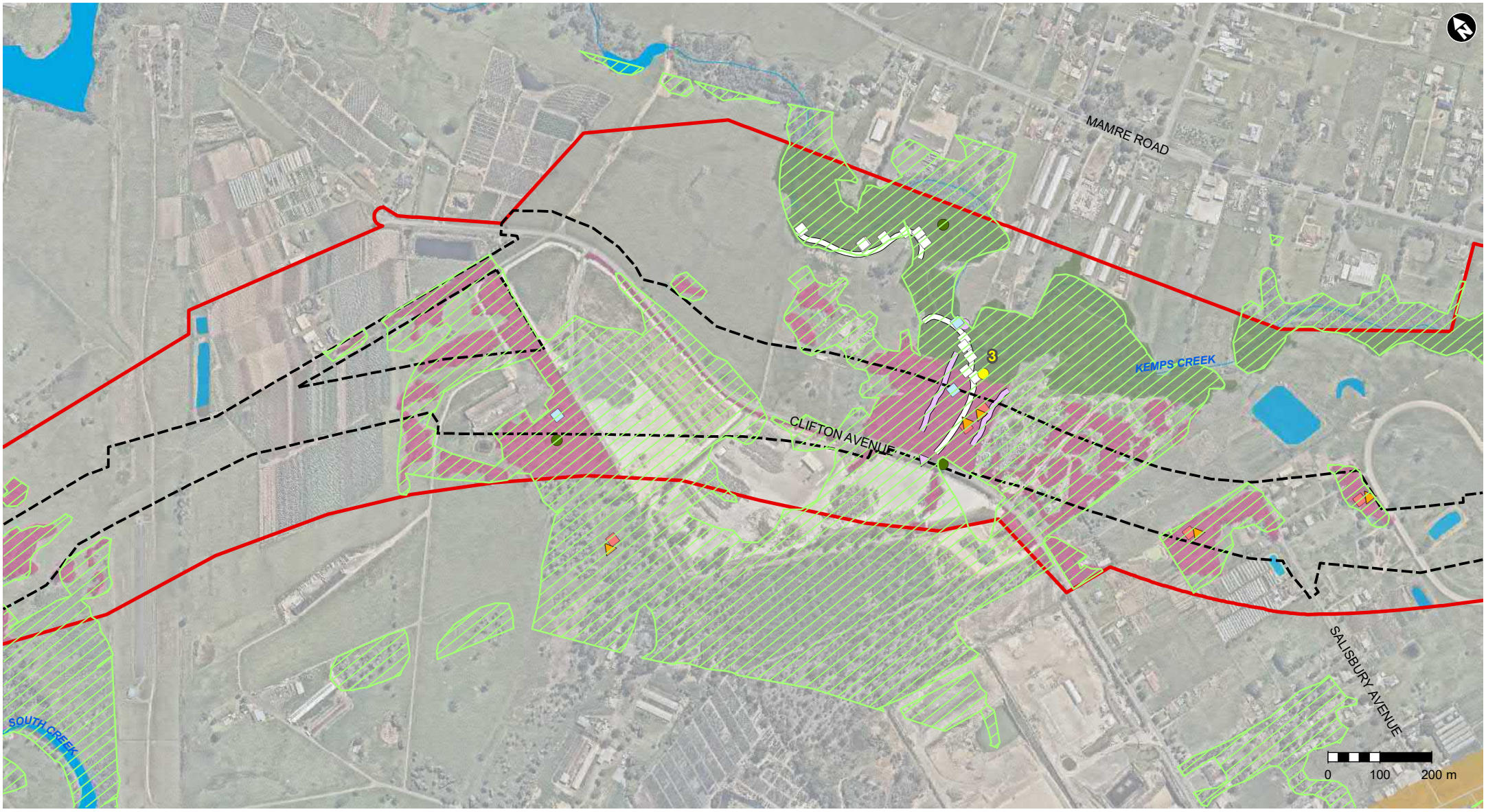

Study area corridor
The project construction footprint
Western Sydney Parklands
NPWS Reserves
Biodiversity certified land
Waterways

Fauna surveys
Anabats (location #)
Threatened snail survey
Koala SAT
Swift Parrot - Area search
Swift Parrot - Habitat assessment
Swift Parrot - Transect

Terrestrial habitat assessment
Wetland habitat assessment
Nocturnal survey - Call playback
Nocturnal survey - Spotlight transect
Bird survey - Diurnal
Bird survey - Wetland
Green and Golden Bell Frog Survey

Fauna habitat stratification unit
Woodland
Riparian Forest
Wetlands and watercourses
Grassland (cleared land)

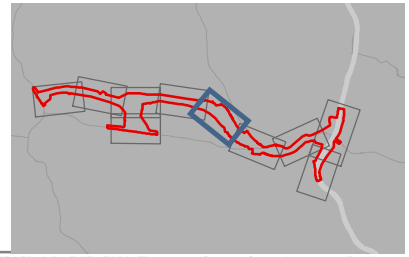

Figure 4-1 Threatened species survey locations

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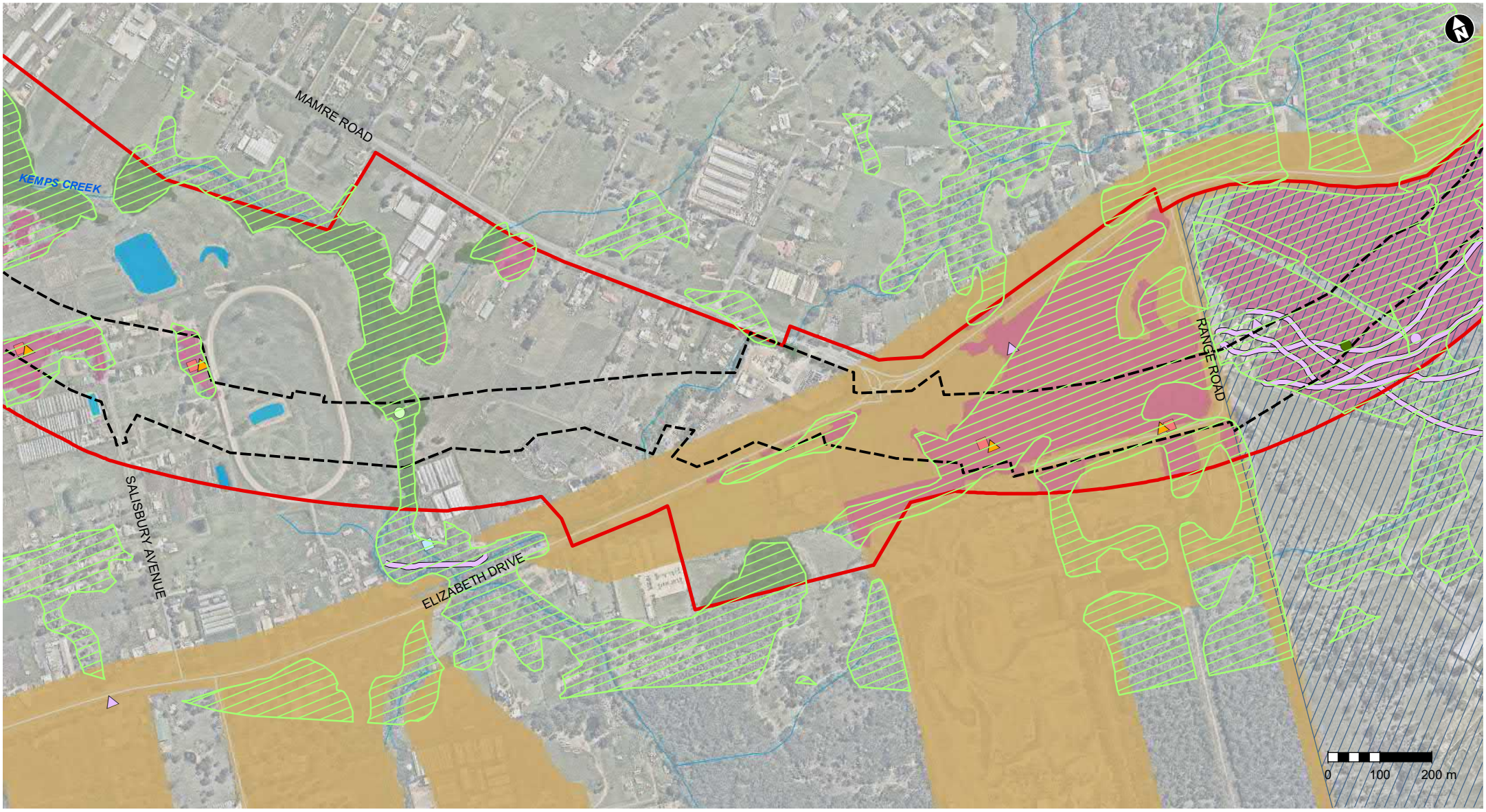

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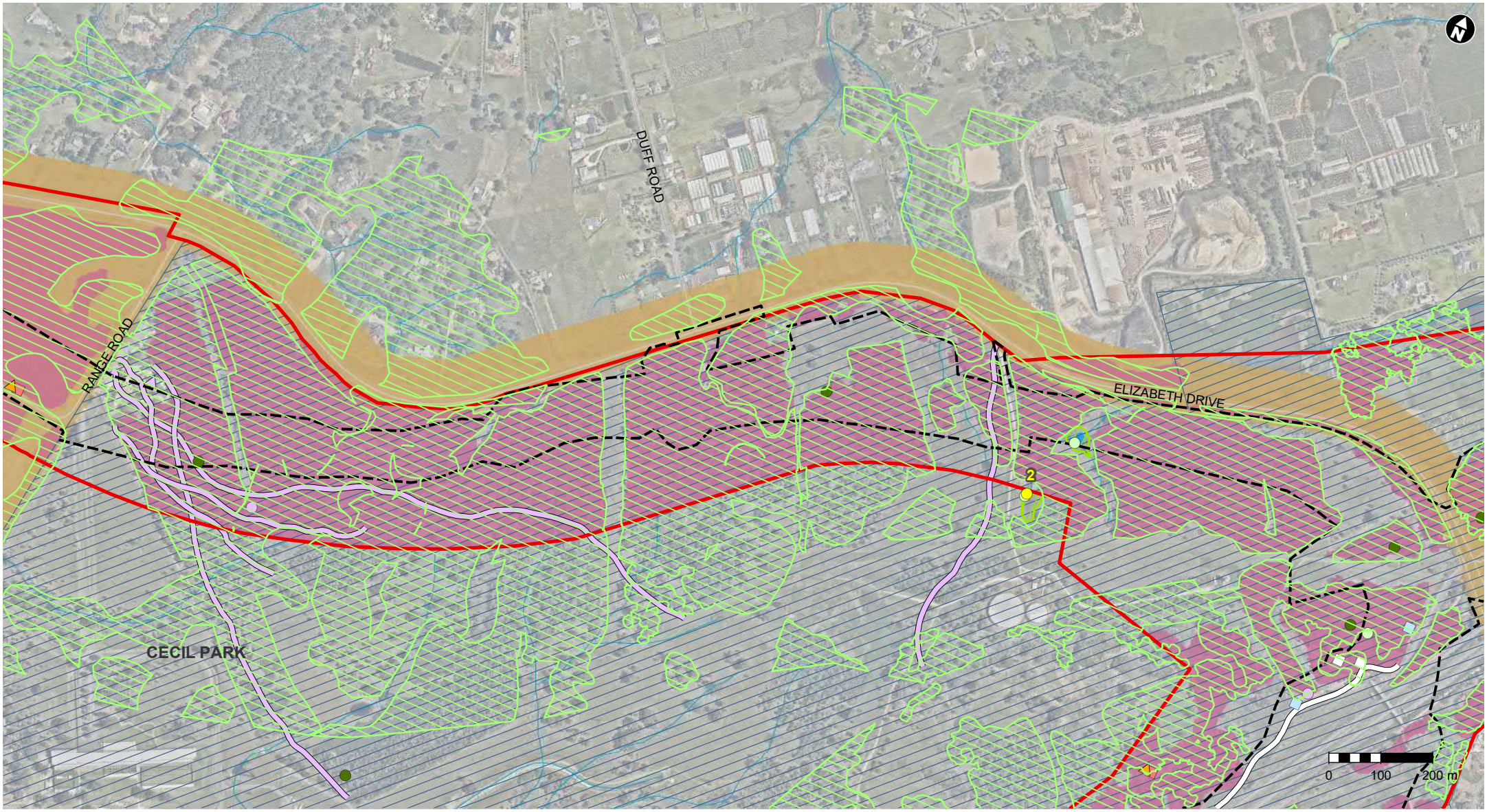

Figure 4-1 Threatened species survey locations

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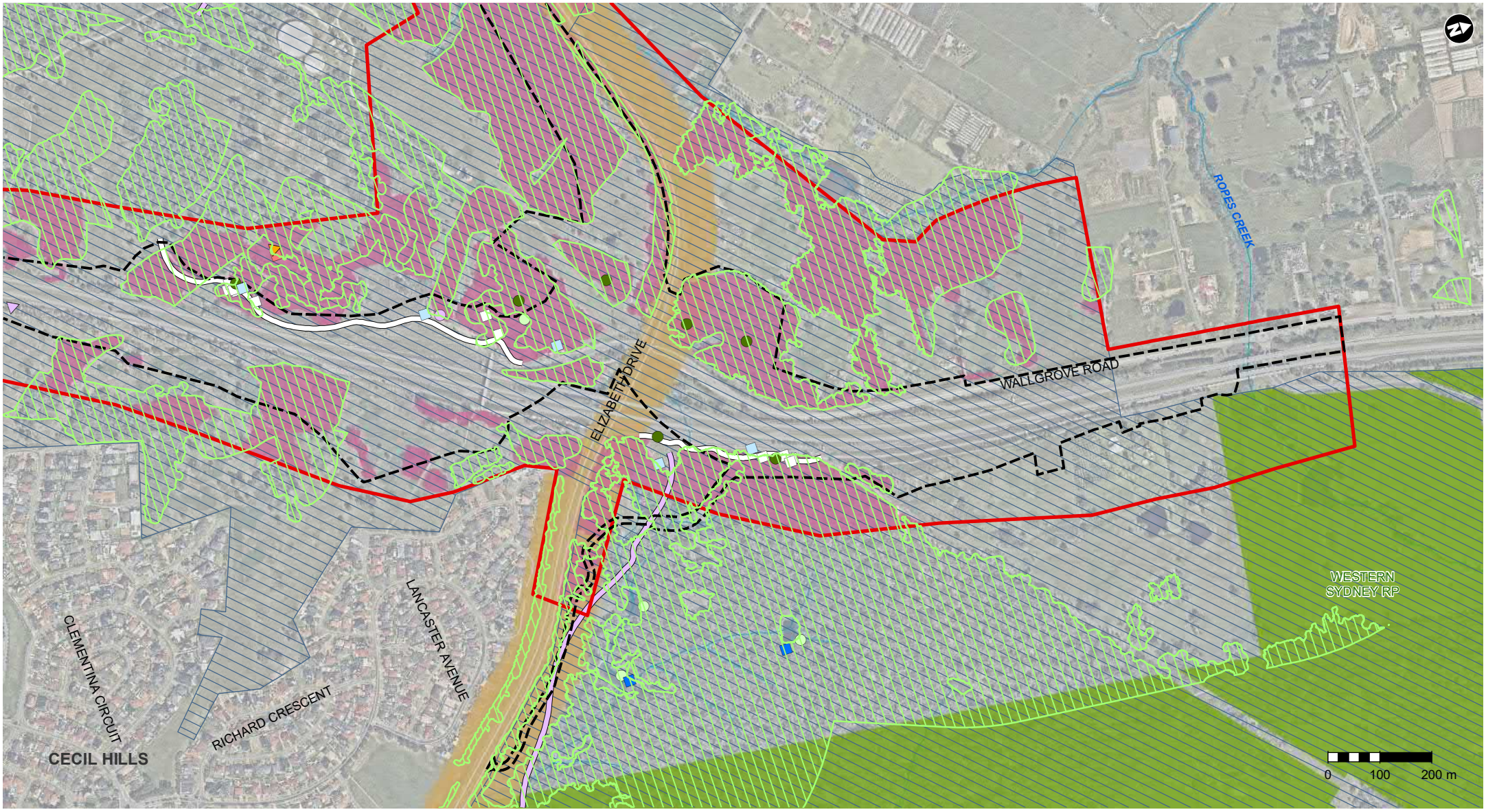

Figure 4-1 Threatened species survey locations

Date: 27/06/2019 Path: \\10.10.25.32\data\GIS\MXDs\Figures\Technical_reports\BAR\JAJV_BAR_F009_ThreatenedSpeciesSurveyLocations_R5V4.mxd
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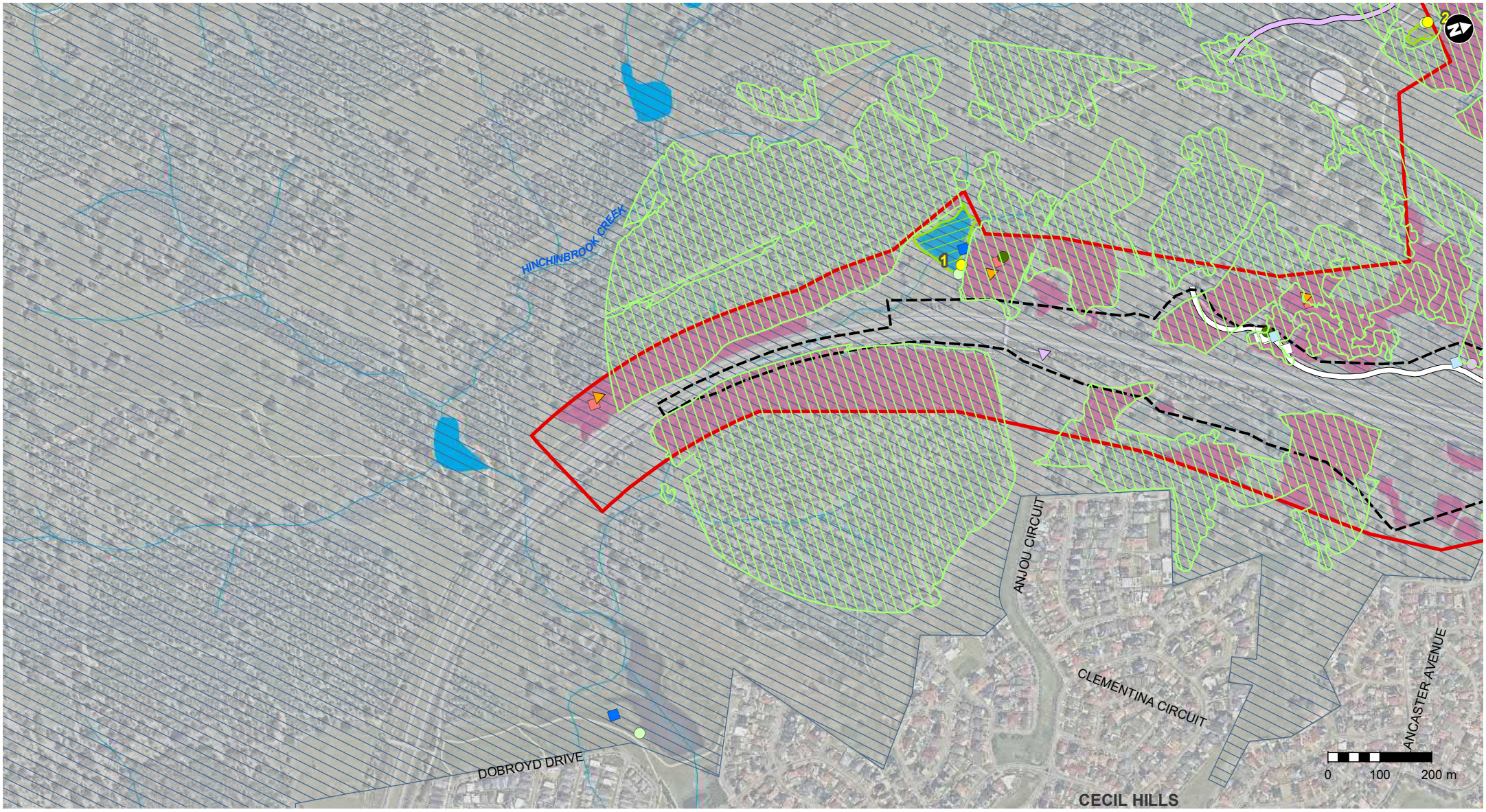

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Created by : CA | QA by : RB

As some species are only present or apparent at certain times of the year (eg migratory birds), species recorded in the study area should be treated as an indication of species presence at the time of field surveys; not a fully comprehensive list. Further, some species require specific weather conditions for optimum detection. For example, Green and Golden Bell Frog detection is correlated with high levels of rainfall and seasonality. As such, the optimal seasonal timing for Green and Golden Bell Frog is between September and March, during their calling period and peak activity period, and following periods of high rainfall. As this species can also remain cryptic throughout the year, reference sites and populations were visited where possible to determine the possibility of detection within the study area, and ensure surveys were conducted at the optimal time of year.

For one species of owl, the Masked Owl, the minimum survey requirements were not met (**Table 4-5**). Five nights were completed, out of a recommended eight nights. These guidelines are recommendations only and can be varied, depending on the quality and extent of the potential habitat.

The conclusions of this report are based upon available data and field surveys and are therefore indicative of the environmental condition of the study area at the time of the survey. It should be recognised that conditions, including the presence of threatened species, could change with time. To address this limitation, a precautionary approach has been used which aimed to identify the presence and suitability of the habitat for threatened species (**Annexure B**). If surveys were completed in sub-optimal conditions or not able to be completed, threatened fauna were assumed to be present.

4.2.4 Threatened flora species results

Five threatened flora species were recorded within and adjacent to the study area during targeted surveys. **Table 4-6** identifies the threatened flora species recorded within the study area and within the construction footprint. All threatened flora species recorded within and adjacent to the study area are located outside areas subject to biodiversity certification under the strategic assessment.

Dillwynia tenuifolia

Dillwynia tenuifolia is listed as vulnerable under the TSC Act. The species also forms the *Dillwynia tenuifolia,* Kemps Creek endangered population under the TSC Act, however the final determination for the endangered population specifies that it occurs in the area bounded by Western Road, Elizabeth Drive, Devonshire Road and Cross Street, Kemps Creek; this area is outside the study area.

Dillwynia tenuifolia is a low spreading pea-flower shrub that grows to one metre high. The species is locally abundant in western Sydney, with a core distribution on the Cumberland Plain from Windsor and Penrith east to Dean Park near Colebee. Other populations in western Sydney are recorded from Voyager Point and Kemps Creek, Luddenham and South Maroota (OEH, 2017). The species occurs within scrubby/dry heath areas within Castlereagh Ironbark Forest (PCT 725) and Shale Gravel Transition Forest (PCT 724) on tertiary alluvium or laterised clays. It may also occur in transitional areas where these communities adjoin Castlereagh Scribbly Gum Woodland (PCT 883) (OEH, 2018).

Dillwynia tenuifolia was recorded in the central region of the study area, along Clifton Avenue. A total of 464 individuals were recorded in the road reserve and adjacent properties at 81 Clifton Avenue, 316 Clifton Avenue and 382-393 Clifton Avenue. Due to access restrictions, targeted surveys were not carried out at 364-372 Clifton Avenue and 373-381 Clifton Avenue. However, it is likely that individuals of *Dillwynia tenuifolia* would also be present in the areas of similar habitat within these properties.

The individuals of *Dillwynia tenuifolia* around Clifton Avenue are located mainly within areas mapped as Broad-leaved Ironbark – Grey Box – Melaleuca decora grassy open forest on clay/gravel soils of the Cumberland Plain, Sydney Basin Bioregion (PCT 724), with some plants also found in fragmented patches of Hard-leaved Scribbly Gum – Parramatta Red Gum heathy woodland of the Cumberland Plain, Sydney Basin Bioregion (PCT 883) and Broad-leaved Ironbark – Melaleuca decora shrubby open forest on clay soils of the Cumberland Plain, Sydney Basin Bioregion (PCT 725). Numerous plants were identified in the cleared and disturbed road verges, some within areas with no PCTs mapped.

Table 4-6 Threatened flora species recorded within the study area and construction footprint

Threatened species	Status		Identification method	Can the species withstand further loss[1]?	Number of plants recorded in the study area	Number of plants recorded within the construction footprint excluding certified areas	Approximate distance (m) of closest plant from construction footprint	Area of occupancy (based on 30 m buffer around recorded individuals) within the construction footprint excluding certified areas
	TSC Act	EPBC Act						
Dillwynia tenuifolia	V	-	Recorded	No	464	244	N/A	3.63 ha
Grevillea juniperina subsp. juniperina	V	-	Recorded	No	32	0	90	0
Marsdenia viridiflora subsp. viridiflora in the Bankstown, Blacktown, Camden, Campbelltown, Fairfield, Holroyd, Liverpool and Penrith Local Government Areas	EP	-	Recorded	No	3	0	70	0
Pimelea spicata	E	E	Recorded	No	0 (recorded 15 m to east of study area)	0	70	0
Pultenaea parviflora	E	V	Recorded	No	278	90	N/A	1.65 ha

EP = Endangered Population, E = Endangered, V = Vulnerable

[1] As defined in DECC (2011) a species that cannot withstand further loss is one that is either naturally very rare, is critically endangered, has few populations or a restricted distribution, and/or the species or habitat needs are poorly known

The population of *Dillwynia tenuifolia* overlaps the patch of *Pultenaea parviflora* but is more widely distributed, extending further east towards Kemps Creek and further west toward the transition with shale communities. Individuals of *Dillwynia tenuifolia* were recorded along the western fenced boundary of the recently cleared area west of Clifton Avenue, which previously supported Hard-leaved Scribbly Gum – Parramatta Red Gum heathy woodland of the Cumberland Plain, Sydney Basin Bioregion (PCT 883) in Moderate/Good condition.

Of the 464 individuals recorded around Clifton Avenue, 244 are within the construction footprint. The area of occupancy of the species within the construction footprint, based on a 30 metre buffer around each record of the species, is about 3.63 hectares.

Grevillea juniperina subsp. juniperina

Grevillea juniperina subsp. juniperina is listed as vulnerable under the TSC Act. The species is a broadly spreading to erect shrub to 2.5 metres high that is endemic to western Sydney. Its distribution is centred on an area bounded by Blacktown, Erskine Park, Londonderry and Windsor, with outlier populations at Kemps Creek and Pitt Town (OEH, 2018). The species occurs on reddish clay to sandy soils derived from Wianamatta Shale and Tertiary alluvium and has been recorded from Cumberland Plain Woodland (PCTs 849 and 850), Castlereagh Ironbark Forest (PCT 725), Castlereagh Scribbly Gum Woodland (PCT 883) and Shale/Gravel Transition Forest (PCT 724) (OEH, 2018).

Grevillea juniperina subsp. juniperina was recorded during targeted surveys in Western Sydney Parklands, within vegetation bordering a transmission line easement. *Grevillea juniperina subsp. juniperina* was recorded in Grey Box – Forest Red Gum grassy woodland on shale of the southern Cumberland Plain, Sydney Basin Bioregion (PCT 850) including revegetated areas.

Thirty two individuals of the *Grevillea juniperina subsp. juniperina* were recorded in the study area. None of the recorded individuals are within the construction footprint.

Marsdenia viridiflora subsp. viridiflora

Marsdenia viridiflora subsp. *viridiflora* in the Bankstown, Blacktown, Camden, Campbelltown, Fairfield, Holroyd, Liverpool and Penrith Local Government Areas is listed as an endangered population under the TSC Act.

Marsdenia viridiflora subsp. *viridiflora* is a climber with twining stems to four metres high. The species occurs north from the Razorback Range. The endangered population of the species has recently been recorded around Prospect, Bankstown, Smithfield, Cabramatta Creek and St Marys. *Marsdenia viridiflora* subsp. *viridiflora* grows in vine thickets and open shale woodland (OEH, 2018).

Three individuals of *Marsdenia viridiflora* subsp. *viridiflora* were identified in the far north eastern section of the study area within Forest Red Gum – Grey Box shrubby woodland on shale of the southern Cumberland Plain, Sydney Basin Bioregion (PCT 830), within Western Sydney Parklands. None of the recorded individuals of this species are within the construction footprint.

Pimelea spicata

Pimelea spicata is listed as endangered under the TSC Act and EPBC Act. The species is a shrub to 50 centimetres tall that may be erect or somewhat spreading in habit. This species is endemic to NSW and is known from two disjunct areas, the Cumberland Plain west of Sydney and coastal Illawarra south of Sydney. In western Sydney, the species is associated with Grey Box communities, particularly Cumberland Plain Woodland variants (PCTs 849 and 850) and Moist Shale Woodland (PCT 830) and in areas of ironbark (OEH, 2018).

A total of 26 individuals of *Pimelea spicata* were identified in Grey Box – Forest Red Gum grassy woodland on shale of the southern Cumberland Plain, Sydney Basin Bioregion (PCT 850) to the east of the far north-eastern extent of the study area, within Western Sydney Parklands. These individuals lie just outside the study area and are over 70 metres from the construction footprint.

Pultenaea parviflora

Pultenaea parviflora is listed as endangered under the TSC Act and vulnerable under the EPBC Act. The species is a small erect branching shrub that grows to one metre in height but can reach up to 1.8 metres when in competition with other shrubs. The species is endemic to the Cumberland Plain, with a core distribution from Windsor to Penrith and east to Dean Park, and outlier populations at Kemps Creek and Wilberforce (OEH, 2018).

In total, 278 individuals of *Pultenaea parviflora* were recorded from two locations in the study area. A total of 260 individuals were recorded in the road reserve and adjacent properties at 316 Clifton Avenue and 382-393 Clifton Avenue. Due to access restrictions, targeted surveys were not carried out at 364-372 Clifton Avenue and 373-381 Clifton Avenue. However, it is likely that individuals of *Pultenaea parviflora* would also be present in these properties.

The individuals of *Pultenaea parviflora* around Clifton Avenue are located mainly at the edges of areas mapped as Broad-leaved Ironbark – Grey Box – Melaleuca decora grassy open forest on clay/gravel soils of the Cumberland Plain, Sydney Basin Bioregion (PCT 724), with some plants also found in fragmented patches of Hard-leaved Scribbly Gum – Parramatta Red Gum heathy woodland of the Cumberland Plain, Sydney Basin Bioregion (PCT 883). Numerous plants were identified in the cleared and disturbed road verges, some within areas with no PCTs mapped.
A second patch of *Pultenaea parviflora* was recorded in Western Sydney Parklands. Here, 18 individuals were identified in a small area of Grey Box – Forest Red Gum grassy woodland on shale of the southern Cumberland Plain, Sydney Basin Bioregion (PCT 850) just south of Elizabeth Drive.

Of these 278 individuals of *Pultenaea parviflora* recorded at both Clifton Avenue and Western Sydney Parklands, 90 are within the construction footprint. The area of occupancy of the species within the construction footprint, based on a 30 metre buffer around each record of the species, is about 1.65 hectares.

4.2.5 Threatened fauna species results

Threatened fauna recorded or assumed present

Seven threatened fauna species were recorded within the study area during surveys and a further three species are assumed to be present (see **Table 4-7** overleaf). The Cumberland Plain Land Snail was not recorded within the study area during surveys but was recorded 135 metres adjacent to the study area during subsequent surveys for a separate project. Given the connectivity and similarity of habitat the Cumberland Plain Land Snail is therefore assumed to be present within the study area in all riparian forest fauna habitat along Badgerys Creek.

'Possible' calls of Southern Myotis and Eastern False Pipistrelle were recorded during surveys. These two microbat species cannot therefore be confidently discounted based on the results of surveys and are assumed to be present within the study area, within suitable habitat, as a precautionary approach.

Table 4-7 Threatened fauna survey results

Species	Occurrence within the study area	Can the species withstand further loss?	Habitat feature/ component	Habitat present within study area	Habitat present within construction footprint excluding certified areas
Species credit species					
Cumberland Plain Land Snail	Assumed	Yes	All riparian forest fauna habitat along Badgerys Creek within the study area.	6.00 ha	1.86 ha

Species	Occurrence within the study area	Can the species withstand further loss?	Habitat feature/ component	Habitat present within study area	Habitat present within construction footprint excluding certified areas
Cave-dependent microbats: Eastern Bentwing-bat (breeding) Little Bentwing-bat (breeding)	Recorded (Anabat, foraging only) No breeding habitat recorded	 Yes No	0 caves or culverts	0 ha	0 ha
Hollow-dependent microbats: Southern Myotis (breeding)	Assumed Potential breeding habitat recorded	 Yes	Hollow-bearing trees within 200m of riparian zones	1.54 ha (area surrounding 52 hollow-bearing trees	0.92 ha (area surrounding 35 hollow-bearing trees)
Grey-headed Flying-fox (breeding)	Recorded (foraging only) No breeding habitat recorded	No	0 camps recorded	0 ha	0 ha
Ecosystem credit species					
White-bellied Sea-Eagle	Recorded	No	Nest site (breeding) Wetland and waterways (foraging)	One nest (breeding) 11.98 ha (foraging)	One nest (breeding) 3.69 ha (foraging)
Microbats (terrestrial foragers): Yellow-bellied Sheathtail-bat Eastern Freetail-bat Greater Broad-nosed Bat Eastern Bentwing-bat (foraging habitat) Little Bentwing-bat (foraging habitat) Eastern False Pipistrelle	 Recorded (Anabat) Recorded (Anabat) Recorded (Anabat) Recorded (Anabat) Recorded (Anabat) Assumed	 Yes Yes Yes Yes No Yes	PCT 724, PCT 830, PCT 835, PCT 849, PCT 850, PCT 1800	197.14 ha	55.58 ha
Microbats (aquatic			Wetland and	11.98 ha	3.69 ha

Species	Occurrence within the study area	Can the species withstand further loss?	Habitat feature/ component	Habitat present within study area	Habitat present within construction footprint excluding certified areas
foragers): Southern Myotis (foraging habitat)	Assumed	Yes	waterways (foraging)	(foraging)	(foraging)
Grey-headed Flying-fox (foraging habitat)	Recorded	No	PCT 724, PCT 830, PCT 835, PCT 849, PCT 850, PCT 1800	195.71 ha	55.20 ha

Grey-headed Flying-fox

The Grey-headed Flying-fox was recorded in the study area during nocturnal spotlighting surveys (**Figure 4-2**). In addition, individuals were opportunistically observed flying over several sites within the study area or foraging within flowering *Eucalyptus moluccana* in Western Sydney Parklands. The species is likely to forage throughout the study area as foraging habitat is widespread and fly across cleared land to move between habitat patches. Foraging habitat for this species is also prevalent throughout the wider locality, with regular foraging patches usually located within 20 kilometres of roosting camps (OEH, 2018).

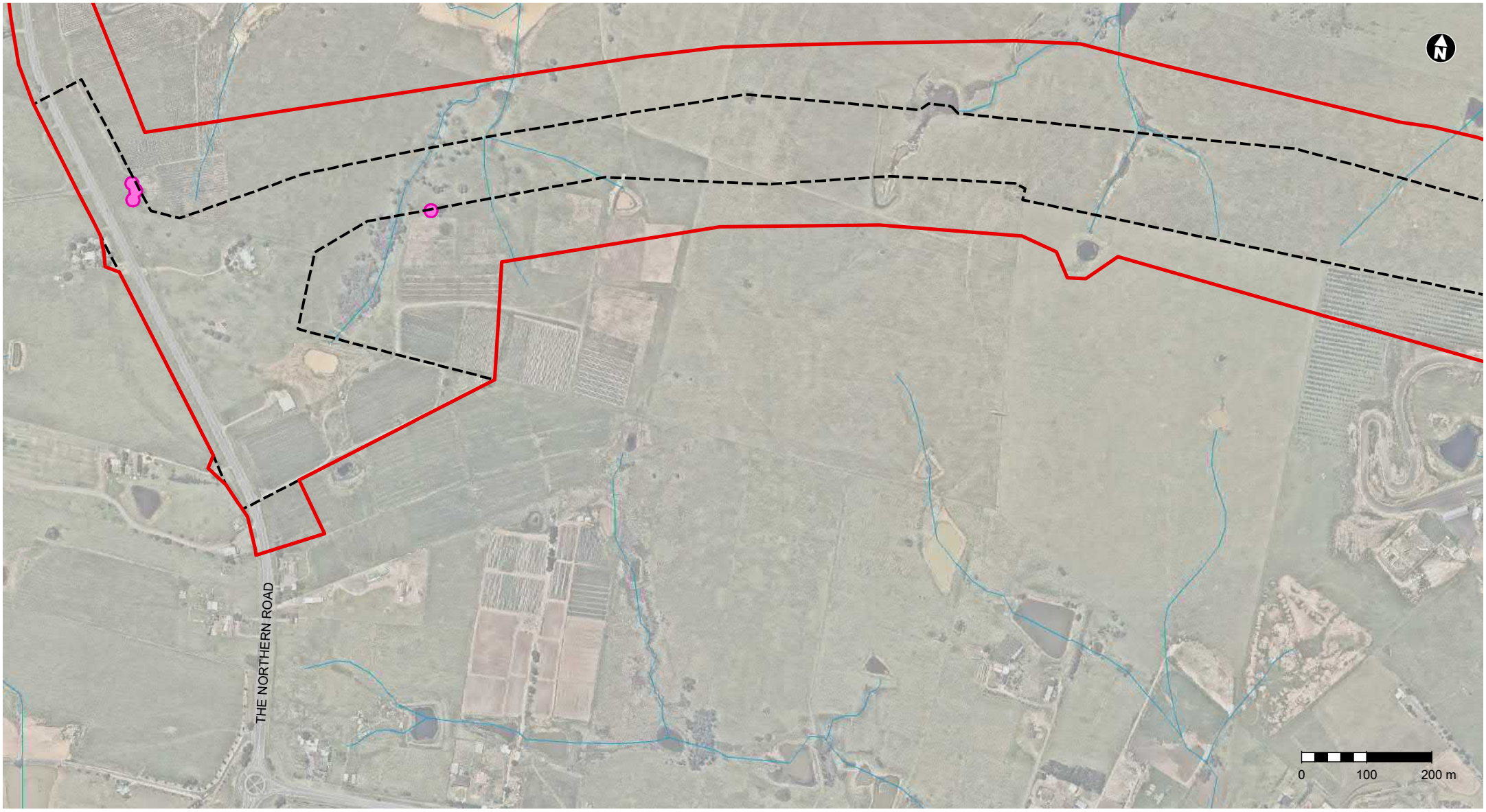
Under the FBA, the Grey-headed Flying-fox is a dual ecosystem/species credit species (OEH, 2014). Foraging habitat for this species is assumed as ecosystem credits. Species credits are required where roosting or breeding habitat for this species is likely to be impacted.

In accordance with the requirements of the FBA the assessment is required to assess all land within 40 metres of riparian communities within the study area as potential 'breeding' habitat for the Grey-headed Flying-fox. No camps have been recorded within the study area and the study area does not support suitable roosting or breeding habitat for the Grey-headed Flying-fox. The nearest camp location is about seven kilometres from the study area in Wetherill Park. It is therefore considered highly unlikely that the Grey-headed Flying-fox roosts or breeds within the area. As such, no species credit species habitat polygons have been generated for the Grey-headed Flying-fox. As this species is also listed as vulnerable under the EPBC Act, further assessment is provided in **Section 5.4.2.2** and **Section 8.4.2**.

White-bellied Sea-Eagle

The White-bellied Sea-Eagle was recorded in the study area during diurnal bird surveys and nocturnal spotlighting surveys (**Figure 4-2**). A breeding pair were recorded at an active nest within the University of Sydney land and also opportunistically observed flying over several sites within the study area. These birds are likely to forage throughout the wider locality within a large home range encompassing numerous large dams and natural water bodies, such as Prospect Reservoir and the associated Nature Reserve located about 12 kilometres north-east of the nest site. With regards to potential impacts, it is important to note that nests may be abandoned if disturbed (Debus *et al.*, 2014, DoE, 2015).

The White-bellied Sea-Eagle is an ecosystem credit species. As such all known or potential habitat for this species is assumed as ecosystem credits.



Study area corridor
The project construction footprint
Western Sydney Parklands
Biodiversity certified land
NPWS Reserves
Waterways

Threatened Flora

Dilwynia tenuifolia
Grevillea junipera subsp. juniperina
Marsdenia viridiflora subsp. viridiflora
Pimelea spicata
Pultenaea parviflora
Dillwynia tenuifolia area of occupancy
Pultenaea parviflora area of occupancy

Threatened Fauna Records

Grey-headed Flying-fox
White-bellied Sea-Eagle nest
Eastern Bentwing-bat
Eastern Freetail-bat
Greater Broad-nosed Bat
Little Bentwing-bat
Yellow-bellied Sheathtail-bat
Cumberland Plain Land Snail

Threatened fauna habitat

Hollow Bearing Tree (HBT)
Southern Myotis breeding habitat
White-bellied Sea-Eagle nesting habitat
Cumberland Plain Land Snail habitat

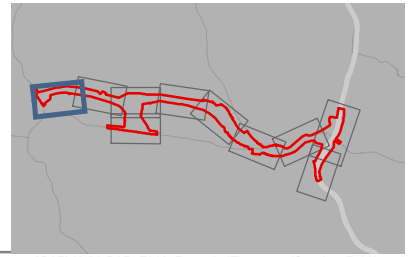


Figure 4-2 Recorded threatened species

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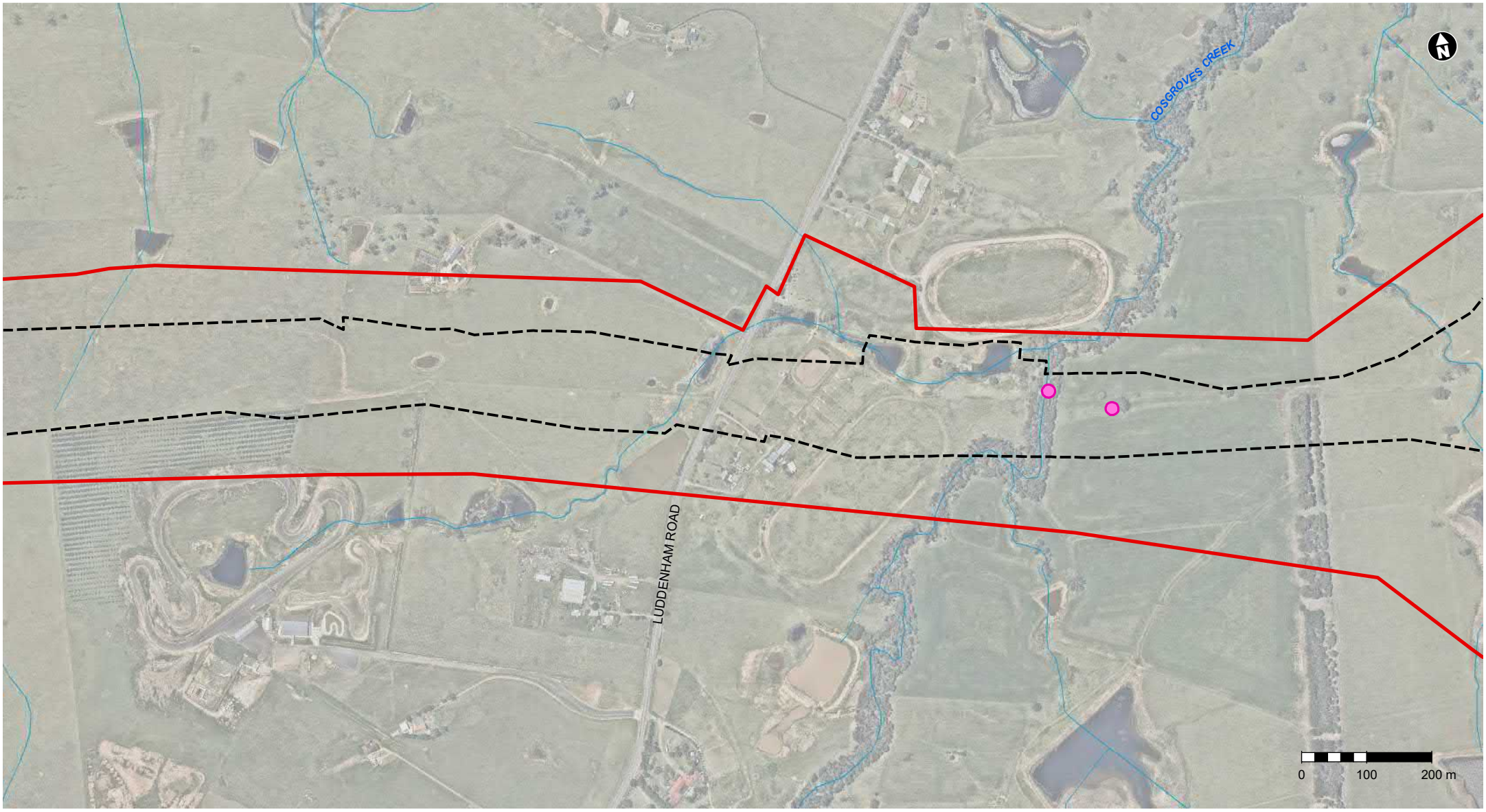

Study area corridor
The project construction footprint
Western Sydney Parklands
Biodiversity certified land
NPWS Reserves
Waterways

Threatened Flora

Dilwynia tenuifolia
Grevillea juniperina subsp. juniperina
Marsdenia viridiflora subsp. viridiflora
Pimelea spicata
Pultenaea parviflora
Dillwynia tenuifolia area of occupancy
Pultenaea parviflora area of occupancy

Threatened Fauna Records

Grey-headed Flying-fox
White-bellied Sea-Eagle nest
Eastern Bentwing-bat
Eastern Freetail-bat
Greater Broad-nosed Bat
Little Bentwing-bat
Yellow-bellied Sheathtail-bat
Cumberland Plain Land Snail

Threatened fauna habitat

Hollow Bearing Tree (HBT)
Southern Myotis breeding habitat
White-bellied Sea-Eagle nesting habitat
Cumberland Plain Land Snail habitat

Figure 4-2 Recorded threatened species

Date: 27/06/2019 Path: \\10.10.25.32\data\GIS\MXDs\Figures\Technical_reports\BAR\JAJV_BAR_F010_RecordedThreatenedSpecies_R5V4.mxd
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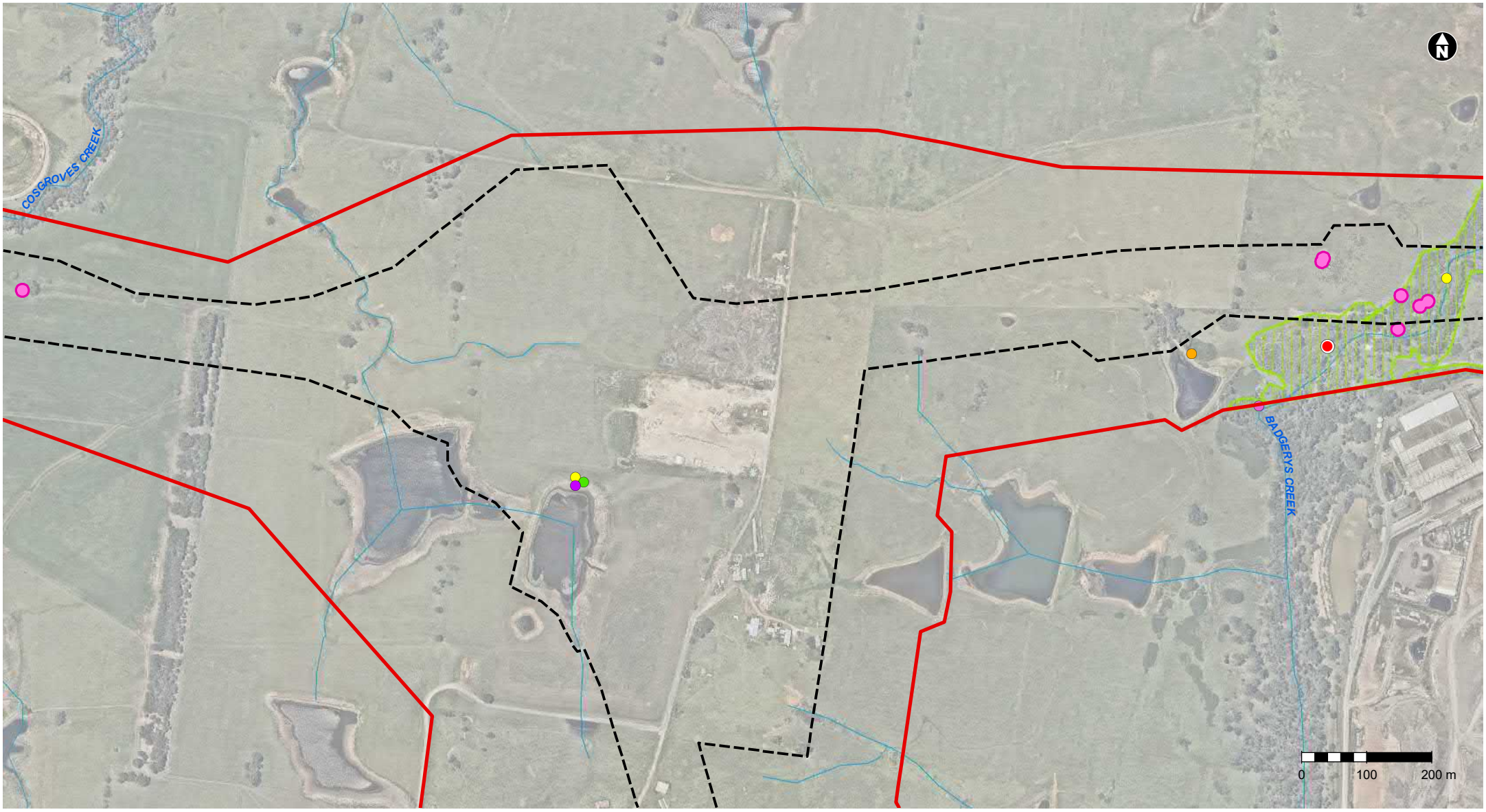

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Yellow-bellied Sheathtail-bat
Cumberland Plain Land Snail

Threatened fauna habitat

Hollow Bearing Tree (HBT)
Southern Myotis breeding habitat
White-bellied Sea-Eagle nesting habitat
Cumberland Plain Land Snail habitat

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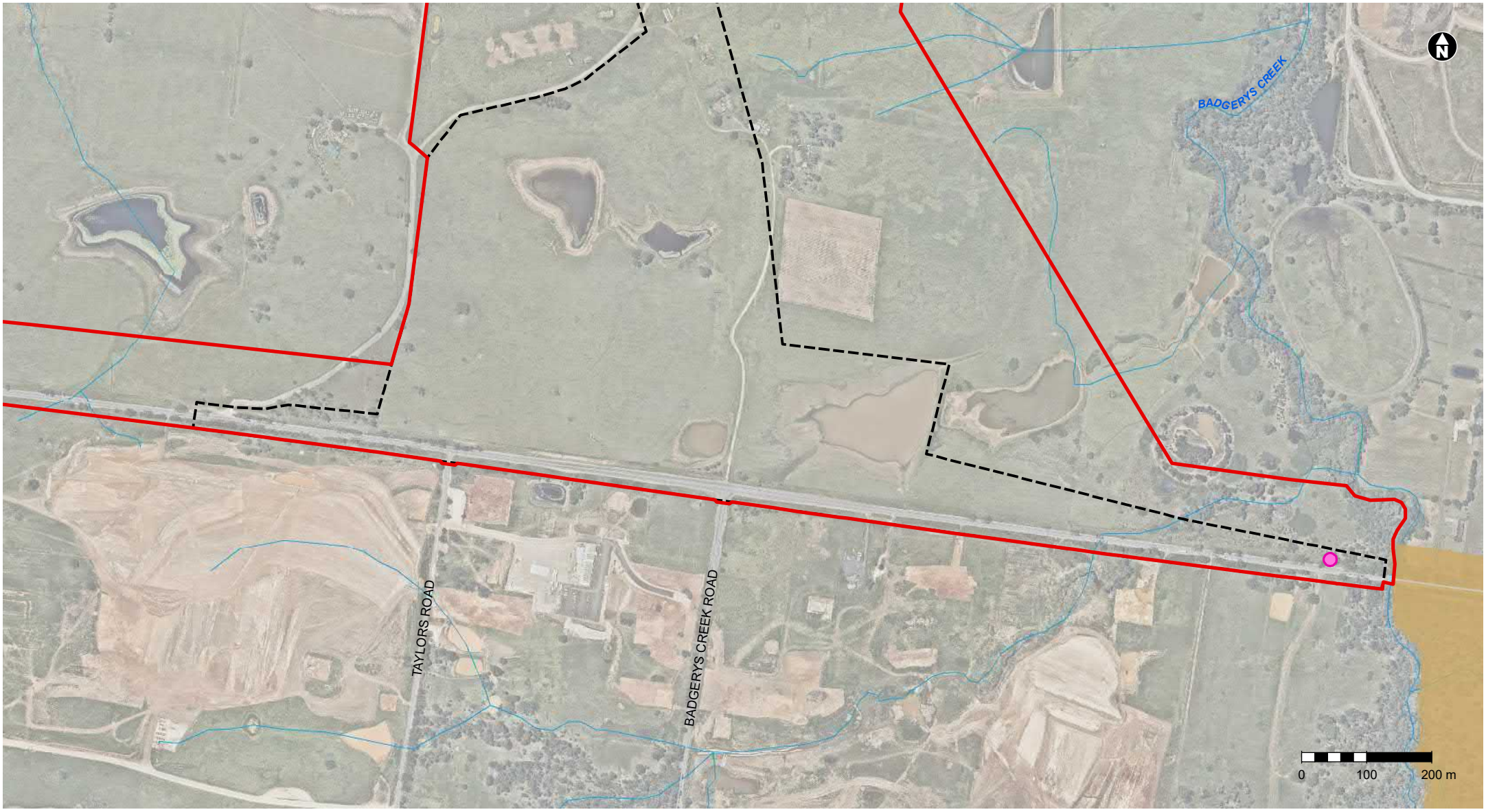

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Cumberland Plain Land Snail

Threatened fauna habitat

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Southern Myotis breeding habitat
White-bellied Sea-Eagle nesting habitat
Cumberland Plain Land Snail habitat

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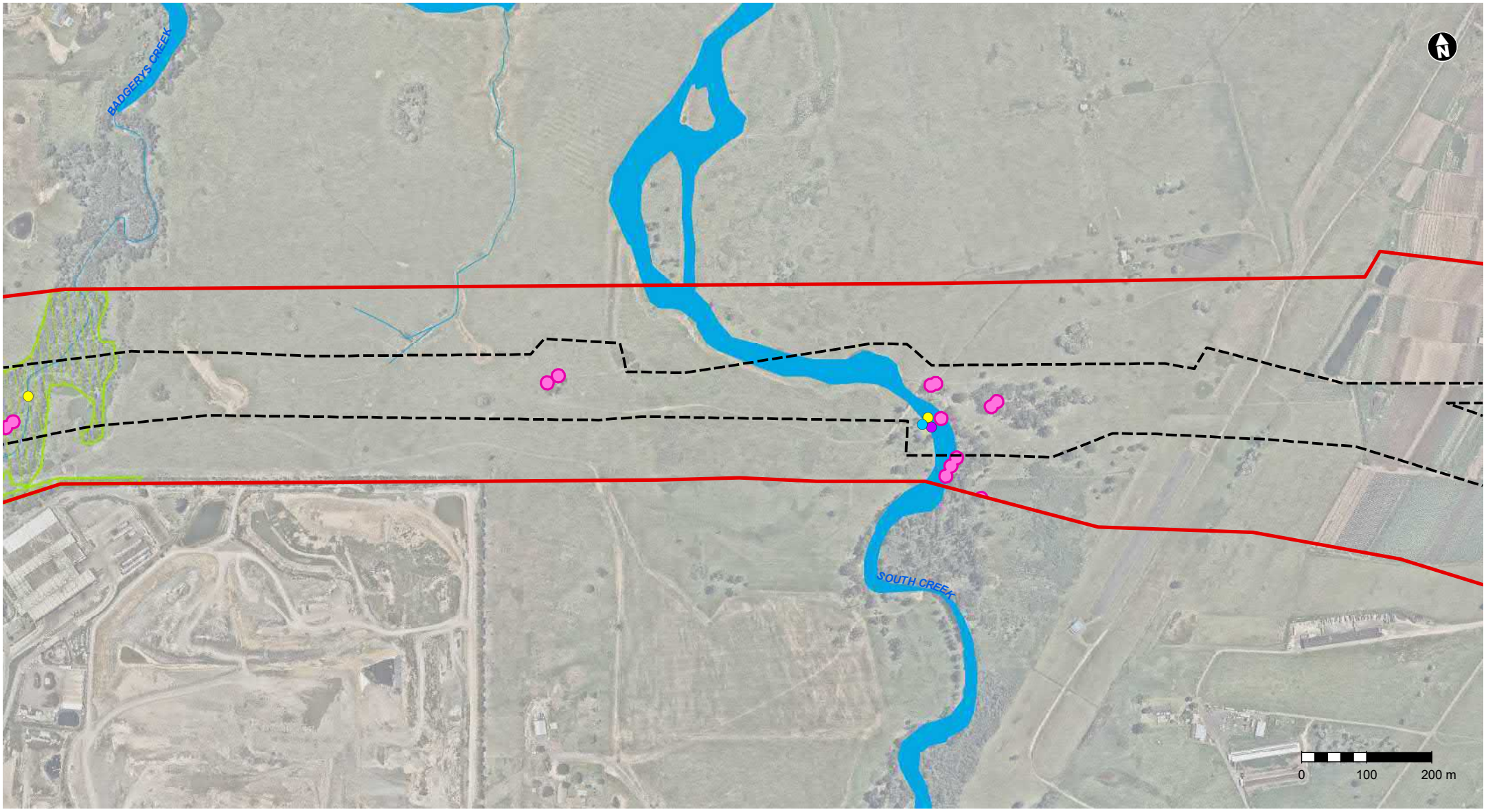

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Threatened fauna habitat

Hollow Bearing Tree (HBT)
Southern Myotis breeding habitat
White-bellied Sea-Eagle nesting habitat
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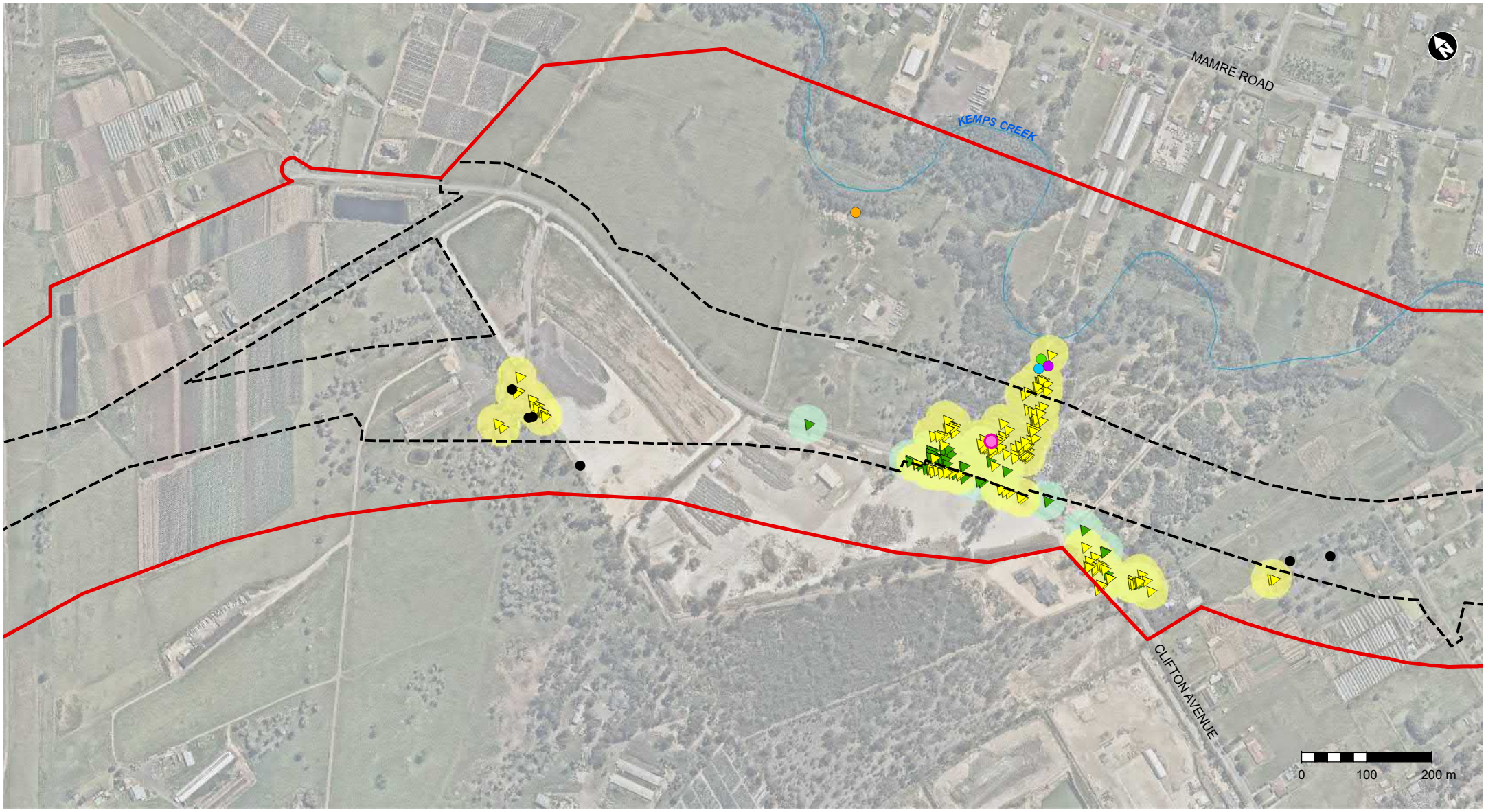

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Cumberland Plain Land Snail

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Southern Myotis breeding habitat
White-bellied Sea-Eagle nesting habitat
Cumberland Plain Land Snail habitat

Figure 4-2 Recorded threatened species

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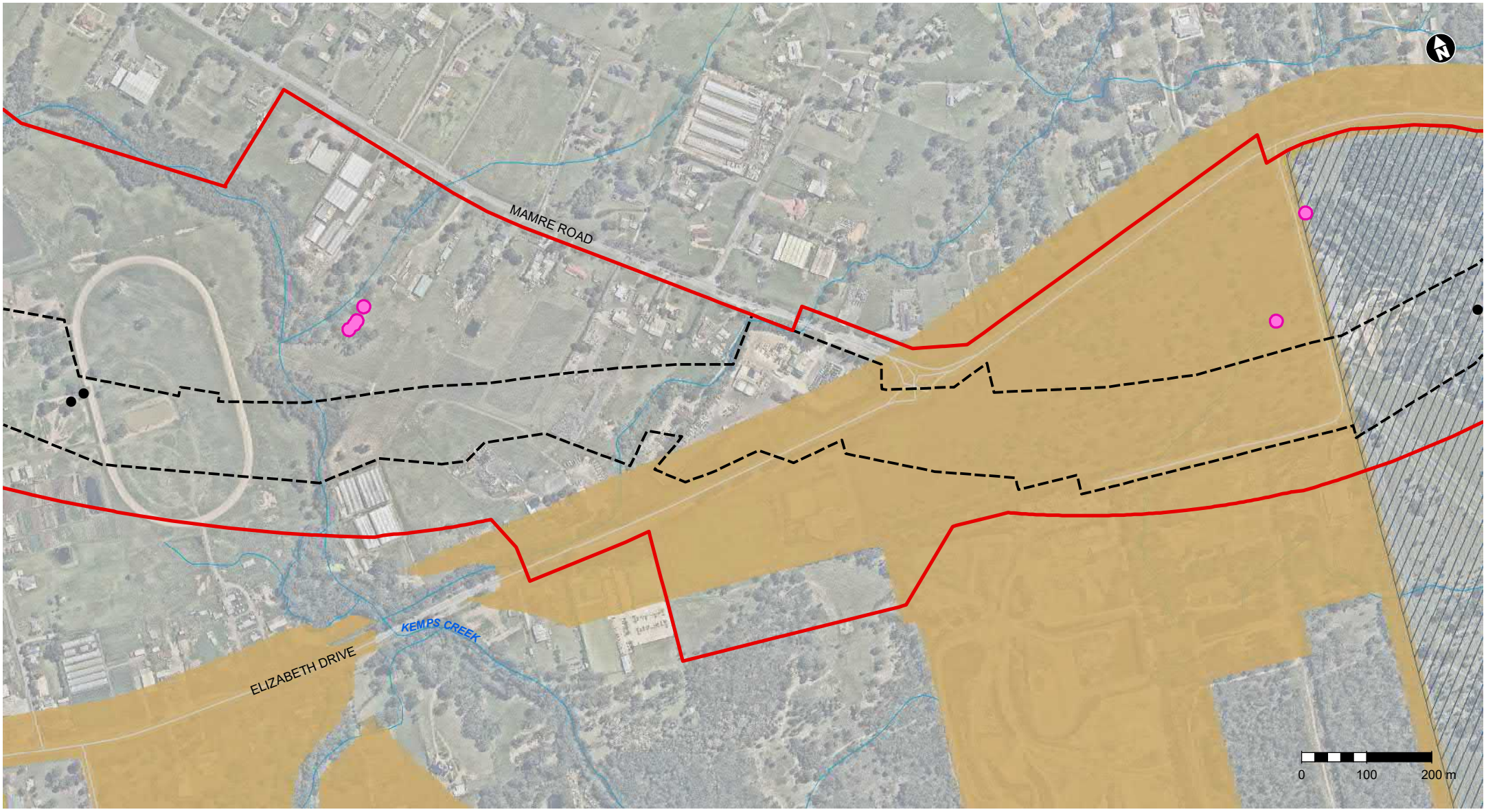

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Threatened fauna habitat

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Southern Myotis breeding habitat
White-bellied Sea-Eagle nesting habitat
Cumberland Plain Land Snail habitat

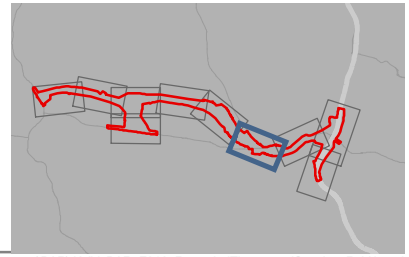

Figure 4-2 Recorded threatened species

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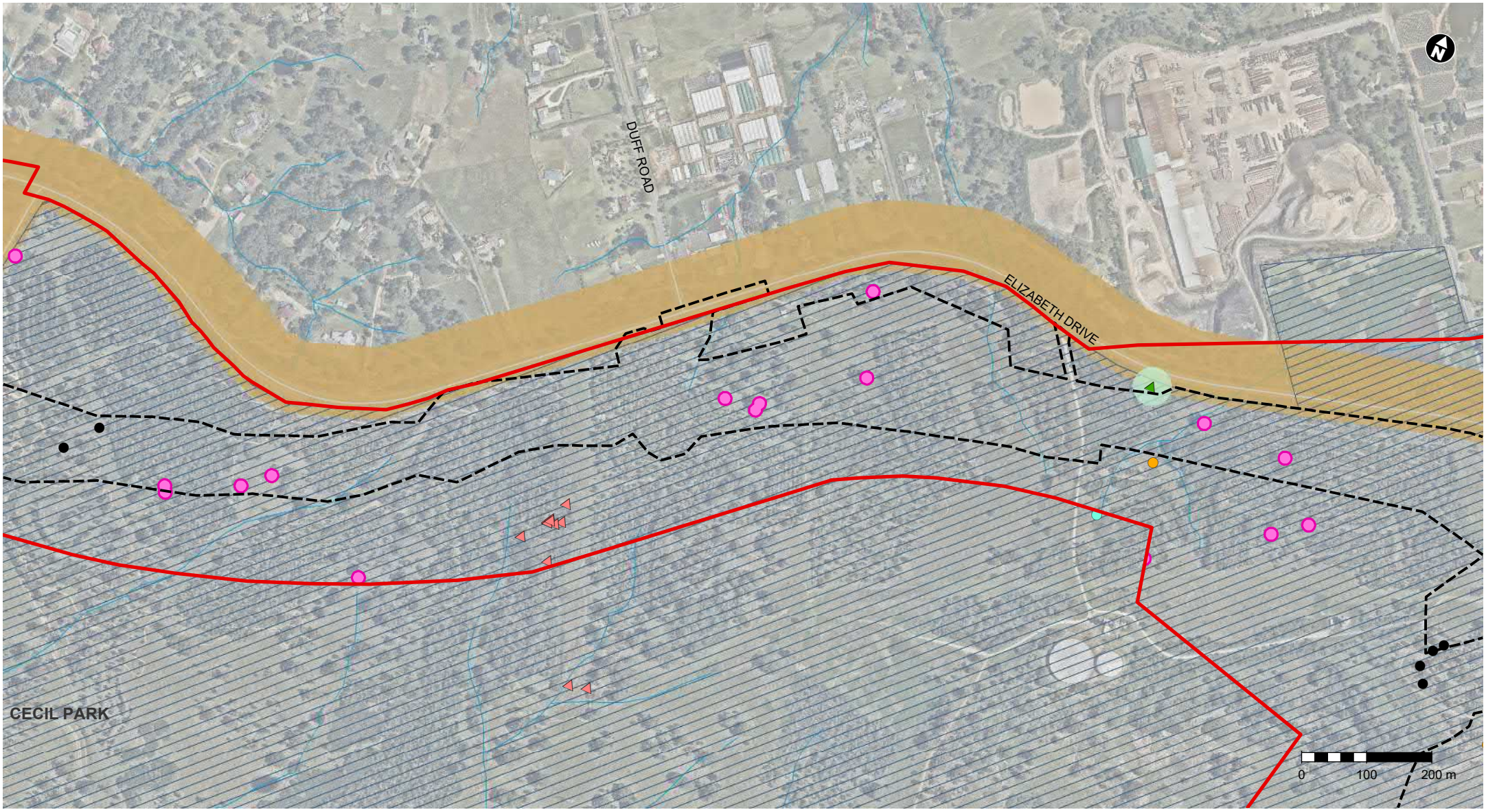

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Threatened fauna habitat

Hollow Bearing Tree (HBT)
Southern Myotis breeding habitat
White-bellied Sea-Eagle nesting habitat
Cumberland Plain Land Snail habitat

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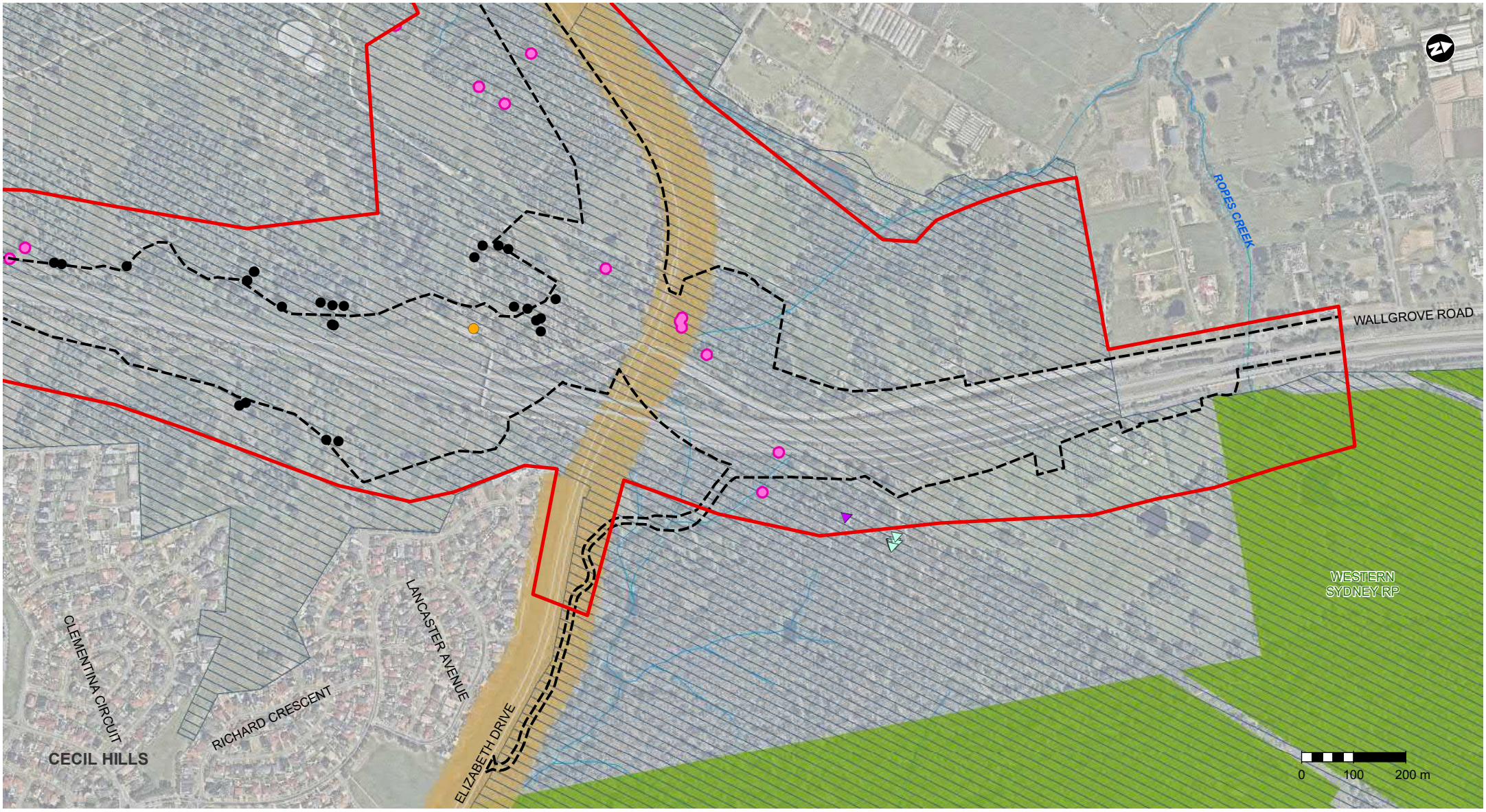

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- *Pultenaea parviflora*
- Dillwynia tenuifolia area of occupancy
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- Yellow-bellied Sheathtail-bat
- Cumberland Plain Land Snail

Threatened fauna habitat

- Hollow Bearing Tree (HBT)
- Southern Myotis breeding habitat
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- Cumberland Plain Land Snail habitat

Figure 4-2 Recorded threatened species

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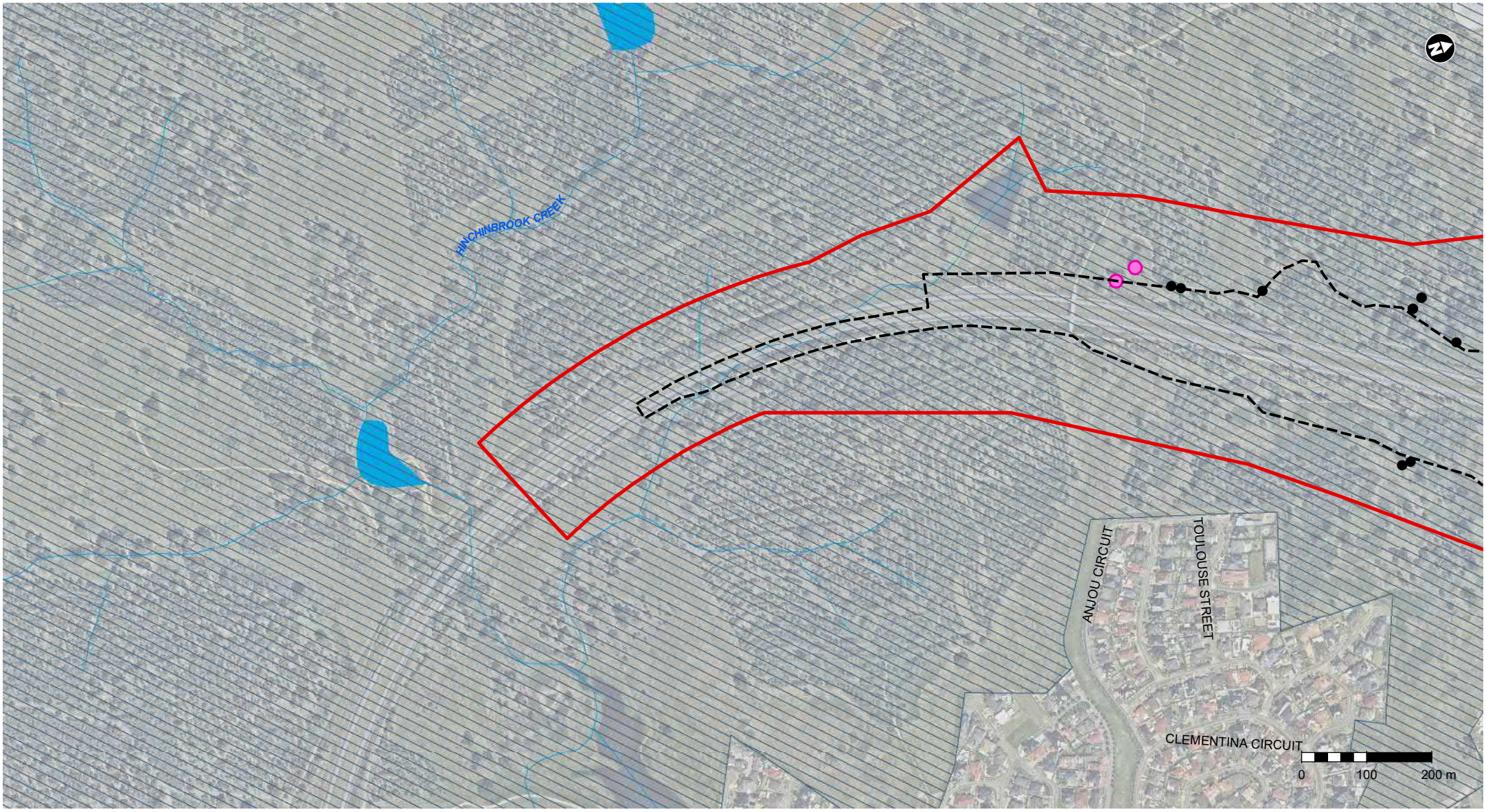

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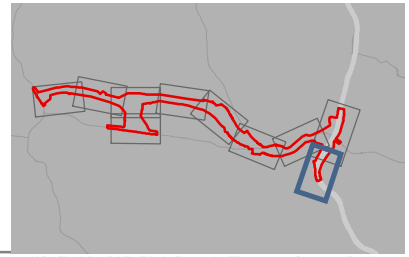

Figure 4-2 Recorded threatened species

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Microbats

The following microbats have been recorded within 10 kilometres of the study area:

- Eastern Bentwing-bat: 101 records, most recent record 2018
- Eastern False Pipistrelle: 19 records, most recent record 2017
- Eastern Free-tail bat: 85 records, most recent record 2017
- Greater Broad-nosed Bat: 53 records, most recent record 2017
- Little Bentwing-bat: five records, most recent record 2014
- Southern Myotis: 67 records, most recent record 2017
- Yellow-bellied Sheathtail-bat: two records, most recent record 2014.

Five of these threatened microbats were recorded in the study area using ultrasonic call detection (Anabat) devices (**Figure 4-2**). These species (and certainty of identification of calls) were:

- Eastern Bentwing-bat – definite
- Eastern Freetail-bat – probable
- Greater Broad-nosed Bat – probable
- Little Bentwing-bat – probable
- Yellow-bellied Sheathtail-bat – probable.

In addition, the Eastern False Pipistrelle and Southern Myotis were assumed to be present within the study area as 'possible' calls were recorded (see **Annexure F**).

The Eastern Bentwing-bat and the Little Bentwing-bat are cave-breeding species. The study area does not support any suitable caves, culverts, mine adits or other natural or artificial structures that would provide significant roosting or breeding habitat for the Eastern Bentwing-bat or the Little Bentwing-bat. It is therefore considered highly likely that these species do not roost or breed within the study area.

The Southern Myotis is known to occasionally use tree hollows as roosting habitat (OEH, 2018). In accordance with the requirements of the FBA the assessment has considered all hollow-bearing trees within 200 metres of riparian zones within the study area to provide potential 'breeding' habitat for the Southern Myotis.

The Eastern Bentwing-bat, Little Bentwing-bat and Southern Myotis are dual ecosystem/species credit species. Foraging habitat for these species is assumed as ecosystem credits. Species credits are required where known or potential breeding habitat for these species is likely to be impacted.

Cumberland Plain Land Snail

Potential habitat for the Cumberland Plain Land Snail was predicted within the study area during desktop assessment and this species was therefore considered as a candidate species for targeted surveys. A total of 541 records of the species exists within a 10 kilometre radius of the study area, with the most recent record from 2017. As such, targeted searches for the species were conducted at 14 sites shown in **Figure 4-1**. At each site searches were undertaken around the bases of trees, beneath fallen bark, leaves and debris for live snails and empty shells.

The condition of the habitat for this species was determined based on the presence of important habitat features, including density of sheltering habitat, density of leaf litter and/or tussock grasses, patch size, connectively, shrub-layer and ground cover.

The Cumberland Plain Land Snail was not recorded at any survey sites within the study area during targeted surveys. However, one individual of this species was recorded from one site within riparian forest fauna habitat along Badgerys Creek 135 metres south of the study area during subsequent surveys for a separate project in October 2018. It is therefore assumed that the Cumberland Plain Land Snail is highly likely to occur in riparian forest fauna habitat along Badgerys Creek within the study area given the proximity of the current record, similarity of habitat type and condition and habitat connectivity.

Habitat assessments determined that all potential habitat for this species within the remainder of the study area is in poor condition and heavily impacted by historical and current disturbance, fragmentation and isolation. As such, the remainder of the study area does not provide suitable habitat for the species.

Threatened fauna removed as candidate species

The following threatened fauna were initially considered potentially likely to occur during desktop surveys. However, habitat assessments and targeted surveys did not record individuals or suitable habitat in the study area. Surveys were considered adequate to assume a 'low' likelihood of occurrence for all of these species and no further assessments are considered necessary for any of these species. Further detailed justification for this removal for each potential candidate species is provided below.

Green and Golden Bell Frog

Twenty-three records of the Green and Golden Bell Frog exists within a 10 kilometre radius of the study area. Most of these records are more than twenty years old, and the most recent record is from 1999. Numerous farm dams, of various depths and dimensions, exist in the study area. Many are in isolated locations with some occurring along drainage lines. The presence of emergent and surrounding vegetation also varies considerably, from completely absent and unshaded dams to ones with abundant emergent vegetation and surrounding tree canopy with grassy understorey. Farm dams may provide potential habitat for the Green and Golden Bell Frog. As such, a preliminary habitat assessment was conducted target dams that were most likely to contain Green and Golden Bell Frogs. Habitat suitability was determined by background research, and Pyke and White (1996) was predominately used as a source.

These authors document the criteria found most consistently at sites that support both breeding and non-breeding populations of Green and Golden Bell Frog, this included:

- Presence of emergent vegetation providing shelter sites
- Moderate to high level disturbance
- Presence of aquatic plant species (especially *Typha* spp.)
- Still or low flowing water
- Run-off urban / industrial / grazing or parkland
- Substrate sand, or rock
- Shallow water depth, less than 50 centimetres
- Nearby vegetation low, grassland, or shrubland or woodland
- Unshaded or partial shade
- Nearby grassy areas
- No visible signs of pollution
- Presence of *Crinia signifera* or *Limnodynastes peronii*
- Absence of *Gambusia holbrooki*.

In total, 20 farm dams across the study area were assessed (**Figure 4-1**). Sites without emergent vegetation and those that met few of the above criteria were considered to have a very low chance of supporting a population and as such, no nocturnal surveys to detect frogs were conducted. Of the 20 sites, seven supported a majority of the above criteria and were identified as having suitable habitat for Green and Golden Bell Frog. All potential habitats identified were small dams (<0.3 hectares, <50 metres in length).

Nocturnal surveys were conducted at seven sites across five nights: 22 February, 27 and 28 of February and 8 and 9 March 2018. One site was re-assessed during targeted surveys as unlikely to provide suitable habitat for the Green and Golden Bell Frog given the small size, isolation and poor quality of habitat present. The six remaining potential sites were surveyed for an additional two nights on 16 and 17 October 2018. All dams were surveyed for Green and Golden Bell Frog and soaks and channel habitats on each site were also identified and presence of other frog species recorded (**Annexure A**).

Conditions prior to and during the survey 22 February 2018 were not suitable for detecting the Green and Golden Bell Frog. No rainfall fell during the survey and only 2.4 millimetres of rain fell during the week prior to the survey (see **Table 4-8**). Conditions leading up to surveys undertaken 27 and 28 February were suitable for detecting this species, given 62.8 millimetres of rain fell on the day before the surveys. Conditions leading up to surveys 8 and 9 March 2018 are not considered to be suitable, given only 10.8 millimetres of rain fell during the week prior to the surveys. Conditions leading up to surveys undertaken 16 and 17 October were suitable for detecting this species, given 55.6 millimetres of rain fell within one week prior to and during the surveys.

The Green and Golden Bell Frog was not detected within the study area during targeted surveys. Conditions prior to and during three of the seven survey dates were dry and did not meet guideline criteria (NSW NPWS, 2003a). Conditions were suitable on four of the survey nights which is considered adequate for detecting the Green and Golden Bell Frog. This species is therefore considered unlikely to occur within the study area.

Table 4-8 Weather conditions during Green and Golden Bell Frog surveys

Date	Min Temp (°C)	Max Temp (°C)	Wind (3pm)	Rainfall (mm, 24 hours)	Total rainfall (mm, one week prior to survey)
22 February 2018	16.4	28.1	NE 11 km/h	0	2.4
27 February 2018	15.6	25.7	ESE 13 km/h	2.8	62.8
28 February 2018	13.7	34.2	NNW 6 km/h	0	62.8
8 March 2018	15.9	25.8	SE 13 km/h	0	10.8
9 March 2018	16.8	26.1	ESE 15 km/h	0	10.8
16 October 2018	15.4	24.7	E 35 km/h	8.8	55.6
17 October 2018	14.7	23.1	NNE 22 km/h	0	55.6

Black Bittern

There are two records of the Black Bittern within a 10 kilometre radius of the study area, with the most recent record from 2016. Targeted surveys for the species included wetland bird surveys and dusk surveys, which involved spotlighting and call playback. Wetland bird surveys were conducted over three days, at six sites. The Black Bittern was also targeted during all diurnal bird surveys undertaken in Riparian Forest habitat (see **Table 4-5**).

The Black Bittern was not recorded at any survey sites within the study area during targeted surveys. Habitat assessments determined that most potential habitat for this species within the study area is in poor condition and heavily impacted by historical and current disturbance, fragmentation and isolation. As such, the study area does not provide suitable habitat for the species.

Bush Stone-curlew

There are four records of the Bush Stone-curlew within a 10 kilometre radius of the study area, with the most recent record from 1996. Targeted surveys for the species included diurnal surveys and nocturnal surveys, which involved spotlighting and call playback (see **Table 4-5**).

The Bush Stone-curlew was not recorded at any survey sites within the study area during targeted surveys. Habitat assessments determined that most potential habitat for this species within the study area is in poor condition and heavily impacted by historical and current disturbance, fragmentation and isolation. As such, the study area does not provide suitable habitat for the species.

Regent Honeyeater

Five records of Regent Honeyeater occur within 10 kilometres of the study area. Four of these records are more than 30 years old, however a recent record from 2009 exists about seven kilometres south-west of the study area. The Regent Honeyeater comprises a single national population, estimated in 2010 at 350-400 mature individuals (Garnett *et al.*, 2011). Areas regularly used by these birds are Bundarra-Barraba, Hunter Valley/Central Coast, Capertee Valley and Chiltern (CoA, 2016). Individuals or groups of birds are known to disperse from these four areas to forage throughout the distribution of the Regent Honeyeater. Foraging occurs opportunistically across their range, depending on flowering of eucalypts, but they prefer moister, fertile areas along creek flats or river valleys (OEH, 2018).

The Regent Honeyeater was not recorded within the study area during surveys. The study area is not within or near any of the areas regularly used by this species. The very low number of local records indicates that the Regent Honeyeater is only an occasional nomadic occurrence in the locality.

Swift Parrot

There are 26 records of the Swift Parrot within a 10 kilometre radius of the study area. The most recent record is from 2014. The Woodland and Riparian Forest habitats of the study area were considered to provide potential foraging habitat for the Swift Parrot given the occurrence of preferred blossom trees Spotted Gum and Forest Red Gum. Initial habitat assessments were performed throughout the study area to identify key foraging trees and identify blossoming events.

The Swift Parrot was not recorded within the study area during surveys. The study area is not within or near any of the areas regularly used by this species. The low number of Swift Parrot records from the immediate surrounds of the study area indicates that this species is only an occasional nomadic occurrence in the locality.

Koala

There are 15 records of the Koala within a 10 kilometre radius of the study area. The most recent record is from 2018. Targeted surveys for the species included the SAT method (Phillips & Callaghan, 2011), which was undertaken at 14 sites, and nocturnal surveys. Nocturnal surveys were conducted at four sites, over five nights. At each nocturnal survey site, call playback was performed alongside spotlighting to detect the species. This involved two ecologists walking a transect of about 500 metres using 50W spotlights. Call playback was used at the start of each transect, where Koala calls were played for about five minutes from a Bluetooth speaker/megaphone. Searches were also undertaken for individual Koalas during all diurnal surveys.

The Koala was not recorded within the study area during surveys. The study area is not within or near any of the areas regularly used by this species. The low number of records from the immediate surrounds of the study area indicates that the Koala is only an occasional nomadic occurrence in the locality.

Woodland Birds

The following woodland bird species have been recorded within 10 kilometres of the study area:

- Black-chinned Honeyeater: one record, 2013
- Diamond Firetail: three records, most recent record 2012
- Dusky Woodswallow: 39 records, most recent record 2017
- Flame Robin: seven records, most recent record 2004
- Gang-gang Cockatoo: nine records, most recent record 2015
- Glossy Black-cockatoo: 17 records, most recent record 2006
- Hooded Robin: two records, most recent record 2004
- Little Lorikeet: 12 records, most recent record 2017
- Scarlet Robin: two records, most recent record 2006
- Speckled Warbler: 16 records, most recent record 2013
- Turquoise Parrot: one record, 2009
- Varied Sittella: 63 records, most recent record 2017.

None of the woodland birds listed above were recorded during surveys. Habitat assessments determined that most potential habitat for these species within the study area is in poor condition and heavily impacted by historical and current disturbance, fragmentation and isolation. As such, the study area does not provide suitable habitat for any of these species.

Large-eared Pied Bat

There are six records of the Large-eared Pied Bat from within 10 kilometres of the study area, with the most recent record from 2008. The Large-eared Pied Bat was not recorded within the study area during surveys. The combined results of targeted surveys and habitat assessments determined that the study area does not provide suitable habitat for this species.

Owls

The following owl species have been recorded within 10 kilometres of the study area:

- Barking Owl: three records, most recent record 2017
- Masked Owl: 15 records, most recent record 2017
- Powerful Owl: 20 records, most recent record 2016.

None of these owl species were recorded within the study area during surveys. The combined results of targeted surveys and habitat assessments determined that the study area does not provide suitable habitat for any of these species.

Diurnal raptors

The following diurnal raptor species have been recorded within 10 kilometres of the study area:

- Black Falcon: two records, most recent record 2000
- Little Eagle: 31 records, most recent record 2016
- Spotted Harrier: two records, most recent record 2015
- Square-tailed Kite: five records, most recent record 2012.

None of these diurnal raptor species were recorded within the study area during surveys. The combined results of targeted surveys and habitat assessments determined that the study area does not provide suitable habitat for any of these species.

4.3 Aquatic habitat and threatened species

4.3.1 Aquatic surveys

Aquatic habitat assessments were undertaken on 18 and 19 June 2018 at 10 waterway locations and on 11 March 2019 at four waterway locations listed in **Table 4-9** and mapped in **Figure 4-3.** Each assessment covered an area about 100 metres in length and was within 500 metres downstream of the proposed Motorway/waterway crossing or within a sensitive receiving environment further downstream of the construction footprint.

At each aquatic survey location, a general description of the waterway was undertaken which included channel width, substrate, riparian and instream vegetation and instream features such as coarse woody debris, pools, riffles (where present). Aquatic habitat was assessed against the RIAR Policy and Guidelines for Fish Habitat Conservation and Management (DPI, 2013) and *Fish Passage Requirements for Waterway Crossings* (Fairfull & Witheridge, 2003).

Sensitive receiving environments were identified based on proximity to the following:

- Key fish habitat field assessment in accordance with RIAR (DPI, 2013)
- Key Fish Habitat Mapping (DPI, 2018)
- Waterway classification (Fairfull & Witheridge, 2003)
- Threatened aquatic species listed under the FM Act and/or EPBC Act
- Groundwater and surface water dependent vegetation and fauna communities listed under the BC Act and EPBC Act
- Drinking water catchment
- Areas that contribute to aquaculture and commercial fishing
- Proximity to matters listed in the State Environmental Planning Policy (Coastal Management) 2018 (Coastal Management SEPP).

Table 4-9 Aquatic habitat assessment locations

Survey point	Waterway name	Description	Location
AQ1	Unnamed tributary of South Creek	About 50 m downstream of the construction footprint (within the study area).	287283 m E 6251633 m S
AQ2	Cosgroves Creek	About 50 m upstream of the study area.	289865 m E 6251080 m S
AQ3	Unnamed tributary of Cosgroves Creek	Within the construction footprint.	290783 m E 6251120 m S
AQ4	Unnamed tributary of Badgerys Creek	Within the construction footprint.	291990 m E 6249633 m S
AQ5	Badgerys Creek	Within the construction footprint.	292543 m E 6292543 m S
AQ6	South Creek	Within the construction footprint.	293777 m E 6251030 m S
AQ7	Kemps Creek	Within the construction footprint.	296360 m E 6249257 m S
AQ8	Unnamed tributary of Kemps Creek	Within the construction footprint.	296876 m E 6249052 m S
AQ9	Ropes Creek	About 100 m downstream of the construction footprint (within the study area).	300776 m E 6250599 m S
AQ10	Unnamed tributary of Ropes Creek	Within the construction footprint.	300453 m E 6249586 m S
AQ11	Unnamed tributary of Hinchinbrook Creek	About 350 m downstream of the construction footprint.	300117 m E 6247439 m S
AQ12	Doujon Lake	Upstream of confluence with Hinchinbrook Creek	300959 m E 6248250 m S
AQ13	Hinchinbrook Creek	About 720 m downstream of the construction footprint.	3004889 m E 6247456 m S
AQ14	Hinchinbrook Creek downstream of SEPP Coastal Wetland	About 1.8 km downstream of the construction footprint.	301321 m E 6246868 m S

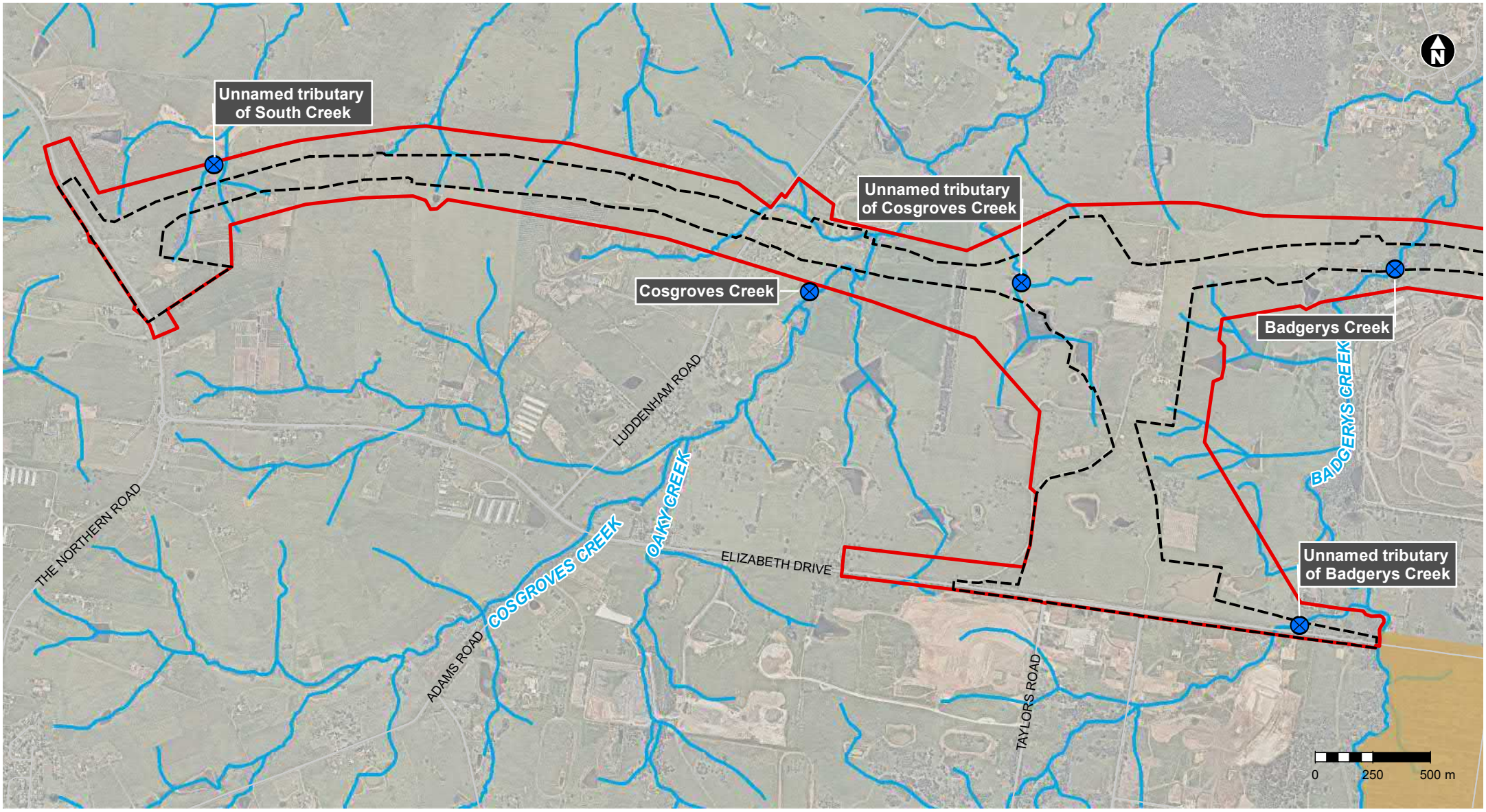

Figure 4-3 Aquatic survey locations

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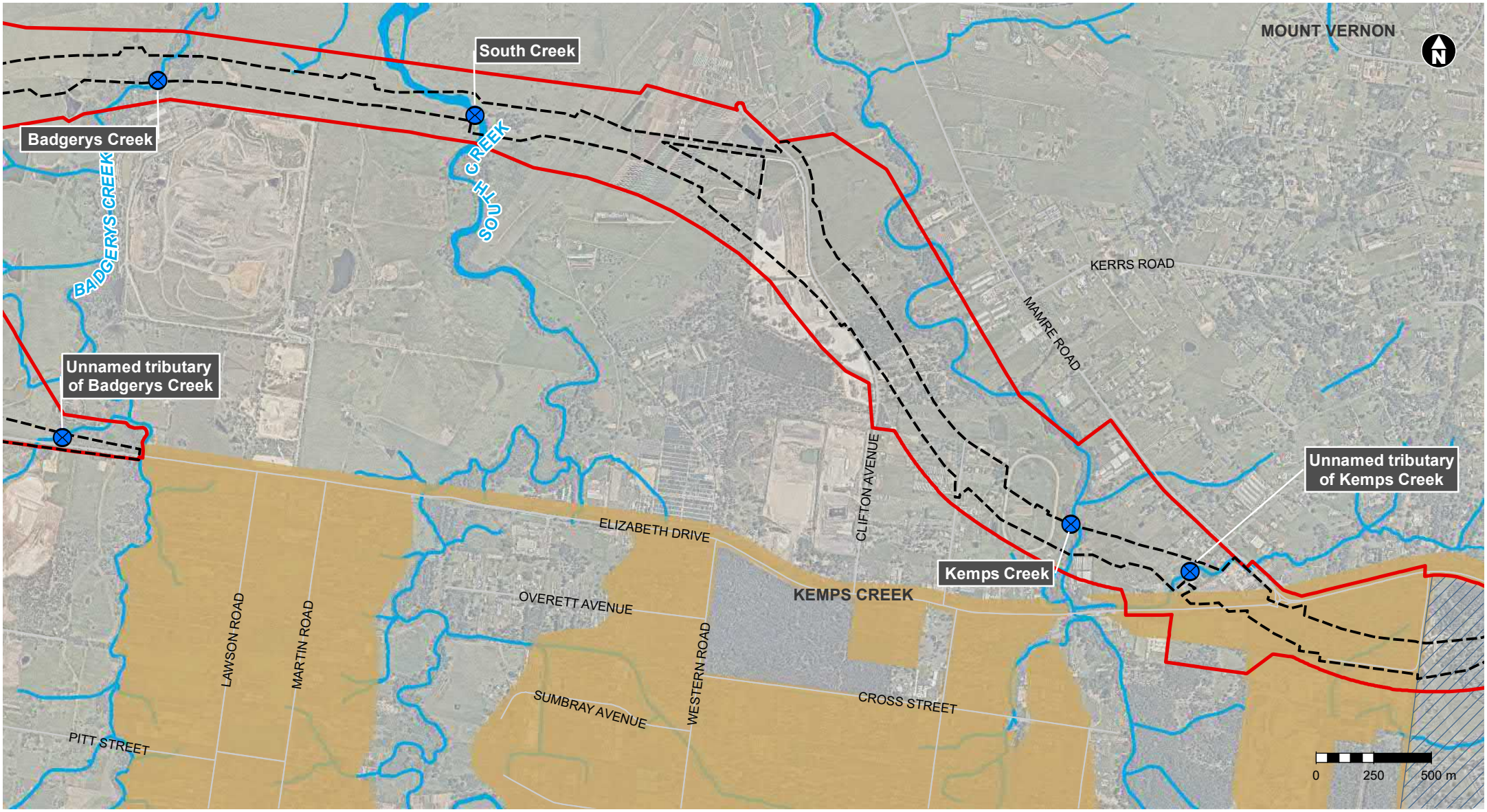

Figure 4-3 Aquatic survey locations

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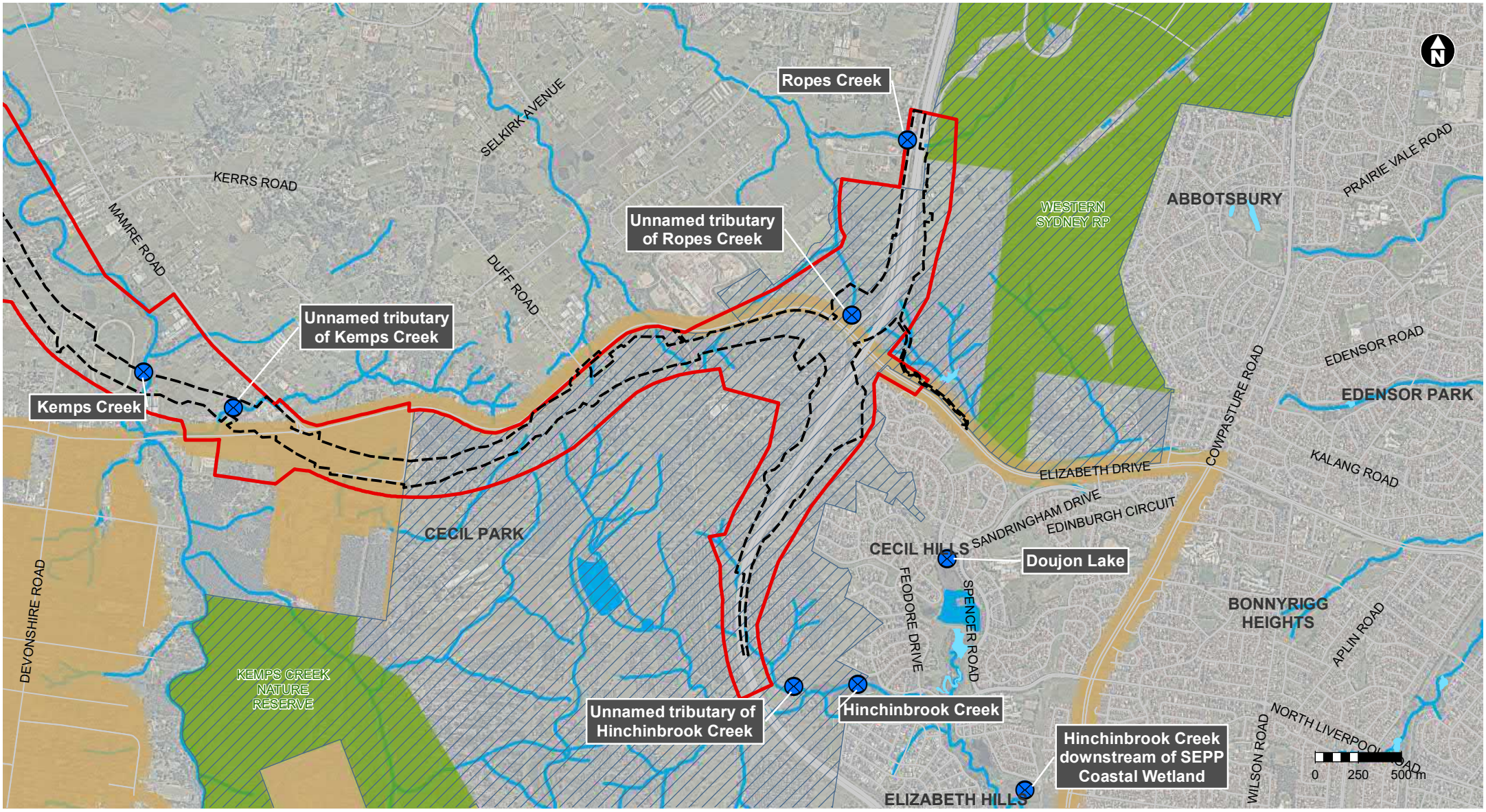

Figure 4-3 Aquatic survey locations

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4.3.2 Aquatic results

Table 4-10 outlines the aquatic habitat values at each assessed waterway. A search of RIAR Spatial Data Portal found none of the waterways contain mapped habitat for threatened fish listed under the FM Act, based on predicted occupancy extents (DPI, 2019). Stream orders ranged from first order streams unlikely to provide fish habitat to fourth order streams with moderate fish habitat.

The following waterways are mapped as key fish habitat by RIAR (DPI, 2018) (**Figure 4-4**) and/or meet the definition of key fish habitat under the Policy and Guidelines for Fish Habitat Conservation and Management (DPI, 2013):

- Cosgroves Creek
- Badgerys Creek
- South Creek
- Kemps Creek
- Hinchinbrook Creek (including downstream of SEPP Coastal Wetland)
- Unnamed tributary of Hinchinbrook Creek
- Doujon Lake.

An additional three waterways (Unnamed tributary of South Creek, Unnamed tributary of Kemps Creek and Unnamed tributary of Ropes Creek) are also mapped as key fish habitat by RIAR (DPI, 2018) but do not meet the definition of key fish habitat in accordance with the Policy and Guidelines for Fish Habitat Conservation and Management (DPI, 2013) as they are first order streams.

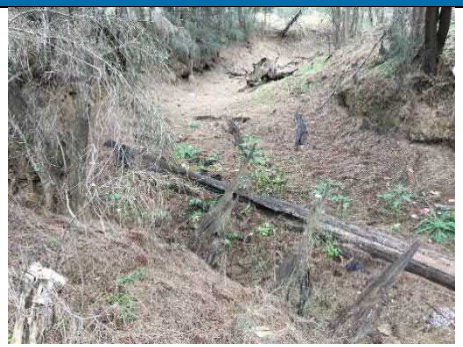
Table 4-10 Aquatic habitat values for each waterway within the study area

Survey point	Waterway name	Photo	Stream order (Strahler, 1952)	Waterway class (Fairfull & Witheridge, 2003)	Key fish habitat	Habitat description
AQ1	Unnamed tributary of South Creek	 Plate 25: Upstream view of Unnamed tributary of South Creek  Plate 26: Downstream of Unnamed tributary of South Creek	1st	4 – unlikely fish habitat	The waterway is not classified as key fish habitat based on RIAR mapping (DPI, 2018), and the creek is an ephemeral, first order stream with no aquatic habitat. It has not been identified as key fish habitat based on field assessments (DPI, 2013).	The unnamed tributary of South Creek, is an ephemeral stream which was dry at the time of inspection. The channel is narrow, averaging one metre wide. The substrate is a silty clay, and no evidence of active erosion was observed during site inspections. No instream aquatic habitat was present such as instream woody debris. Instream macrophytes were restricted to rushes along the banks. Threatened fish are not predicted to occur (DPI, 2019). The riparian habitat is largely cleared for grazing. The water-dependent EEC Swamp Oak Floodplain Forest occurs within the riparian corridor of this waterway. The unnamed tributary of South Creek has not been identified as a sensitive receiving environment.

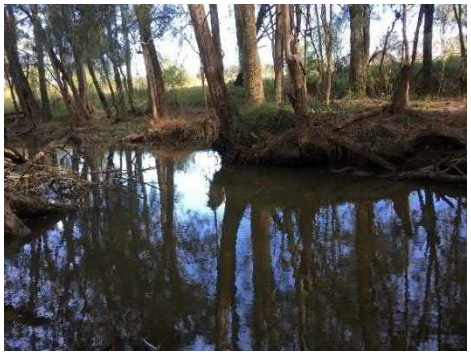
Survey point	Waterway name	Photo	Stream order (Strahler, 1952)	Waterway class (Fairfull & Witheridge, 2003)	Key fish habitat	Habitat description
AQ2	Cosgroves Creek	 Plate 27: Upstream view of Cosgroves Creek  Plate 28: Downstream view of Cosgroves Creek	4th	2 – moderate fish habitat	Based on field assessments Cosgroves Creek has been identified as 'Type 2' moderately sensitive key fish habitat due to the variety of habitat present (DPI, 2013). The creek is also currently mapped by RIAR as key fish habitat (DPI, 2018).	Cosgroves Creek is an ephemeral stream, which was mostly dry at the time of inspection. A shallow residual pool was located upstream at the site. The average channel width was five metres consisting of a silty clay substrate. Active erosion and undercutting occurred along the banks, particularly within channel meanders, suggesting a high potential for erosion at this site. A variety of aquatic habitat is present, with woody snags greater than three meters and the aquatic macrophyte *Typha orientalis* present throughout the site. Threatened fish are not predicted to occur however, the water dependent EEC Swamp Oak Floodplain Forest is within the riparian corridor. Cosgroves Creek has been identified as a sensitive receiving environment as it has been identified as Type 2 key fish habitat however, it is unlikely to be sensitive to the project operation due to its ephemeral nature and impacted upstream catchment.

Survey point	Waterway name	Photo	Stream order (Strahler, 1952)	Waterway class (Fairfull & Witheridge, 2003)	Key fish habitat	Habitat description
AQ3	Unnamed tributary of Cosgroves Creek	 Plate 29: Upstream view of Unnamed tributary of Cosgroves Creek  Plate 30: Downstream view of Unnamed tributary of Cosgroves Creek	2nd	4 – unlikely fish habitat	The waterway is not mapped as key fish habitat (DPI, 2018) and was confirmed during field assessments.	The unnamed tributary of Cosgroves Creek is an ephemeral drainage line which was dry at the time of inspection. There was limited channel definition, consisting of a grassed depression between two farm dams. The channel consists of a sandy clay substrate with no areas of active erosion. No aquatic habitat was present, and threatened fish are unlikely to occur (DPI, 2019). The waterway is an ephemeral, first order drainage line with no aquatic habitat. The unnamed tributary of Cosgroves Creek has not been identified as a sensitive receiving environment.

Survey point	Waterway name	Photo	Stream order (Strahler, 1952)	Waterway class (Fairfull & Witheridge, 2003)	Key fish habitat	Habitat description
AQ4	Unnamed tributary of Badgerys Creek	 Plate 31: Upstream view of Unnamed tributary of Badgerys Creek  Plate 32: Downstream view of Unnamed tributary of Badgerys Creek	3rd	4 – unlikely fish habitat	The waterway is not mapped as key fish habitat (DPI, 2018) which was confirmed during field assessments.	The unnamed tributary of Badgerys Creek is an ephemeral stream which was dry at the time of inspection. The creek has limited channel definition, and has not received flows for some time as evidenced by the poor condition *Typha orientalis* and encroaching terrestrial vegetation. The silty clay channel shows no evidence of active erosion. A large fallen tree has fallen over within the reach, however is unlikely to provide aquatic habitat due to low and shallow flows the site receives. Threatened fish are not predicted to occur (DPI, 2019). The waterway is an ephemeral, third order waterway with limited aquatic habitat. The unnamed tributary of Badgerys Creek has not been identified as a sensitive receiving environment.

Survey point	Waterway name	Photo	Stream order (Strahler, 1952)	Waterway class (Fairfull & Witheridge, 2003)	Key fish habitat	Habitat description
AQ5	Badgerys Creek	 Plate 33: Upstream view of Badgerys Creek  Plate 34: Downstream view of Badgerys Creek	4th	2 – moderate fish habitat	Based on field assessments, Badgerys Creek has been classified 'Type 2' moderately sensitive key fish habitat despite its ephemeral nature, due to the presence of large woody debris providing significant fish refuge during wetter seasons (DPI, 2013). The creek is also mapped as key fish habitat (DPI, 2018).	Badgerys Creek is an ephemeral stream which was dry at the time of inspection. The average channel width was five metres and consisted of a silty clay substrate. Active erosion and undercutting occurred along the banks, particularly within channel meanders, suggesting a high potential for erosion at this site. Abundant woody snags greater than three meters were present, however there were no aquatic macrophytes. Threatened fish are not predicted to occur (DPI, 2019) however, the water dependent EEC, River Flat Eucalypt Forest occurs within the riparian corridor. Badgerys Creek has been identified as a sensitive receiving environment as it is Type 2 key fish habitat however it is unlikely to be sensitive to the project operation due to its ephemeral nature and impacted upstream catchment.

Survey point	Waterway name	Photo	Stream order (Strahler, 1952)	Waterway class (Fairfull & Witheridge, 2003)	Key fish habitat	Habitat description
AQ6	South Creek	 Plate 35: Upstream view of South Creek  Plate 36: Downstream view of South Creek	4th	2 – moderate fish habitat	Based on field assessments, South Creek has been classified as a 'Type 1' highly sensitive key fish habitat. The creek is a fourth order watercourse, containing semi-permanent pools for fish refuge, and large woody snags (DPI, 2013). RIAR mapping also identifies the creek as key fish habitat (DPI, 2018).	South Creek had low flows at the time of inspection. The creek consisted of a series of large, disconnected residual pools about seven metres wide. The water level was very low, with a green algae bloom present on the water's surface. South Creek has a silty clay substrate with active erosion and undercutting along the banks suggesting a high potential for erosion at this site given the limited riparian habitat present. Abundant woody snags greater than three metres are present, however there are no instream aquatic macrophytes. Threatened fish are not likely to occur (DPI, 2019) however, a small area of the water dependent EEC Swamp Oak Floodplain Forest occurs within the riparian corridor. South Creek has been identified as a sensitive receiving environment as it is Type 1 key fish habitat providing important residual pools for fish refuge.

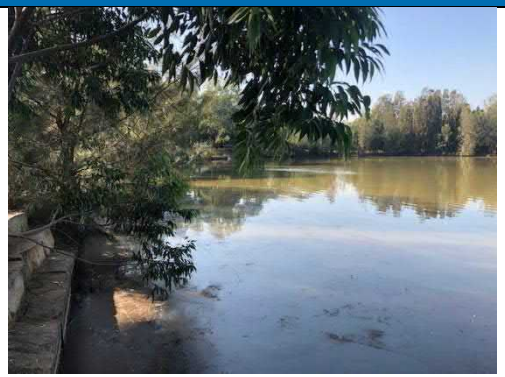
Survey point	Waterway name	Photo	Stream order (Strahler, 1952)	Waterway class (Fairfull & Witheridge, 2003)	Key fish habitat	Habitat description
AQ7	Kemps Creek	 Plate 37: Upstream view of Kemps Creek  Plate 38: Downstream view of Kemps Creek	4th	2 – moderate fish habitat	Based on field assessments, Kemps Creek has been classified as 'Type 1' highly sensitive key fish habitat. The creek is a fourth order watercourse, containing semi-permanent pools for fish refuge, and a variety of aquatic habitats including large woody snags (DPI, 2013). RIAR mapping also identifies the creek as key fish habitat (DPI, 2018).	Kemps Creek had low flows at the time of inspection. The creek consisted of shallow disconnected residual pools each about five metres wide. A variety of aquatic habitat is present, with woody snags greater than three meters, trailing bank vegetation and the aquatic macrophyte *Typha orientalis* present. Threatened fish are not predicted to occur (DPI, 2019) however, the water-dependent EEC Swamp Oak Floodplain Forest occurs within the riparian corridor. Kemps Creek has a silty clay substrate with active erosion and undercutting along the banks, particularly within the channel meanders, suggesting a moderate potential for erosion, especially if the surrounding riparian habitat is removed. Kemps Creek has been identified as a sensitive receiving environment as it is Type 1 key fish habitat providing important residual pools for fish refuge.

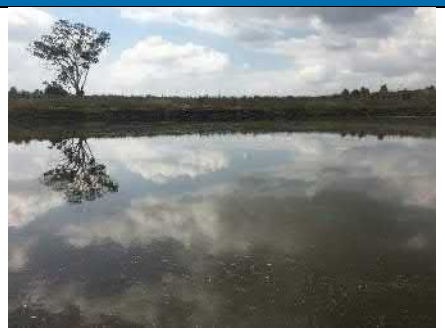
Survey point	Waterway name	Photo	Stream order (Strahler, 1952)	Waterway class (Fairfull & Witheridge, 2003)	Key fish habitat	Habitat description
AQ8	Unnamed tributary of Kemps Creek	 Plate 39: Upstream view of Unnamed tributary of Kemps Creek  Plate 40: Downstream view of Unnamed tributary of Kemps Creek	3rd	4 – unlikely fish habitat	The creek is classified as key fish habitat based on RIAR mapping (DPI, 2018). However, field assessments found that the waterway is an ephemeral, third order waterway with limited aquatic habitat, and therefore has not been identified as key fish habitat (DPI, 2013).	The unnamed tributary of Kemps Creek is an ephemeral waterway which was dry at the time of inspection. The channel is narrow, averaging less than one metre wide and filled with the aquatic macrophyte *Typha orientalis*. The substrate is a silty clay, and no evidence of active erosion observed. The unnamed tributary of Kemps Creek has not been identified as a sensitive receiving environment. The unnamed tributary of Kemps Creek is also crossed further 500m upstream at Elizabeth Drive, however given the limited aquatic habitat and water present at the downstream site, the upstream site is unlikely to contain water and is not considered to be a sensitive receiving environment.
AQ9	Ropes Creek	 Plate 41: Upstream view of Ropes Creek	1st	4 – unlikely fish habitat	As the waterway is an ephemeral, first order waterway with no aquatic habitat, it is not identified as key fish habitat (DPI, 2013). Within the construction and operational footprint Ropes Creek is not mapped as key fish habitat, however	Ropes Creek is an ephemeral waterway which was dry at the time of inspection. There is minimal channel definition, with the downstream extents dominated by a weedy vegetation. The substrate is a silty clay, and no evidence of active erosion was observed during site inspections. No instream aquatic habitat was present, with no instream woody debris or residual pools. However

Survey point	Waterway name	Photo	Stream order (Strahler, 1952)	Waterway class (Fairfull & Witheridge, 2003)	Key fish habitat	Habitat description
		 Plate 42: Downstream view of Ropes Creek			about 600 m downstream the creek becomes mapped as key fish habitat (DPI, 2018).	some aquatic macrophytes may be present in the densely vegetated channel. Threatened fish are not predicted to occur (DPI, 2019). Ropes Creek has not been identified as a sensitive receiving environment.
AQ10	Unnamed tributary of Ropes Creek	 Plate 43: Upstream view of Unnamed tributary of Ropes Creek	1st	4 – unlikely fish habitat	RIAR mapping classifies the tributary as key fish habitat (DPI, 2018). However, field assessments confirm the waterway is an ephemeral, first order drainage line with no aquatic habitat, and therefore it has not been classified as key fish habitat (DPI, 2013).	The unnamed tributary of Ropes Creek is a first order ephemeral drainage line with limited channel definition. No water was present and the time of inspection. No aquatic habitat was present, and the drainage line is dominated by terrestrial weeds (blackberry). Threatened fish are not likely to occur (DPI, 2019). The unnamed tributary of Ropes Creek has not been identified as a sensitive receiving environment.

Survey point	Waterway name	Photo	Stream order (Strahler, 1952)	Waterway class (Fairfull & Witheridge, 2003)	Key fish habitat	Habitat description
		 Plate 44: Downstream view of Unnamed tributary of Ropes Creek				
AQ11	Unnamed tributary of Hinchinbrook Creek	 Plate 45: Upstream view of Unnamed tributary of Hinchinbrook Creek	2nd	3 – minimal fish habitat	Based on field assessments the unnamed tributary of Hinchinbrook Creek has been identified as 'Type 3' minimally sensitive key fish habitat as it is a second order stream with limited aquatic habitat (DPI, 2013). The creek is currently mapped as key fish habitat (DPI, 2018).	The channel had been dry for some time when surveyed, dominated by *Juncus sp.* and with exotic grasses encroaching the channel bed. Threatened fish are not predicted to occur (DPI, 2019). About 1.5 km downstream is a Coastal Wetland listed under the Coastal Management SEPP. As such, the site has been identified as a sensitive receiving environment.

Survey point	Waterway name	Photo	Stream order (Strahler, 1952)	Waterway class (Fairfull & Witheridge, 2003)	Key fish habitat	Habitat description
		 Plate 46: Downstream view of Unnamed tributary of Hinchinbrook Creek				
AQ12	Doujon Lake	 Plate 47: Doujon Lake looking towards right bank	N/A (lake)	2 – moderate fish habitat	Based on field assessments Doujon Lake has been identified as 'Type 2' moderately sensitive key fish habitat as it provides fish refuge and a variety of aquatic habitats (DPI, 2013).	Doujon Lake is located upstream of a SEPP Coastal Wetland (within 500 m). A variety of aquatic habitat was present including overhanging vegetation, undercut banks and a small patch of aquatic macrophytes (*Phragmites australis*). Doujon lake is considered a sensitive receiving environment as it is directly upstream of a Coastal Wetland.

Survey point	Waterway name	Photo	Stream order (Strahler, 1952)	Waterway class (Fairfull & Witheridge, 2003)	Key fish habitat	Habitat description
		 Plate 48: Doujon Lake looking towards left bank				
AQ13	Hinchinbrook Creek	 Plate 49: Upstream view of Hinchinbrook Creek	4th	2 – moderate fish habitat	Based on field assessments, Hinchinbrook Creek has been classified 'Type 1' highly sensitive key fish habitat (DPI, 2013). The creek is also mapped as key fish habitat (DPI, 2018).	Hinchinbrook Creek is a fourth order stream consisting of a series of disconnected pools. This section of the creek contains a rock wall which forms a significant barrier to creek connectivity. Threatened fish are not predicted to occur, however the pools may provide refuge habitat for fish (DPI, 2013). A variety of aquatic habitat was present including aquatic macrophytes *Triglochin sp.*, *Persicaria sp*. and *Typha orientalis*. Hinchinbrook is considered a sensitive receiving environment as it contains Type 1 key fish habitat, and is located about 1.1 km upstream of a SEPP Coastal Wetland.

Survey point	Waterway name	Photo	Stream order (Strahler, 1952)	Waterway class (Fairfull & Witheridge, 2003)	Key fish habitat	Habitat description
		 Plate 50: Downstream view of Hinchinbrook Creek				
AQ14	Hinchinbrook Creek downstream of SEPP Coastal Wetland	 Plate 51: Upstream view of Hinchinbrook Creek  Plate 52: Downstream view of Hinchinbrook Creek	4th	1 – key fish habitat	Based on field assessments, Hinchinbrook Creek has been classified 'Type 1' highly sensitive key fish habitat (DPI, 2013). The creek is also mapped as key fish habitat (DPI, 2018).	Hinchinbrook Creek downstream wetland is fourth order stream which is made up of a series of disconnected pools. Threatened fish are not predicted to occur (DPI, 2013). A variety of aquatic habitat was present including overhanging vegetation, undercut banks and dense macrophytes. Hinchinbrook Creek is considered a sensitive receiving environment as it contains Type 1 key fish habitat and is located directly upstream of a SEPP Coastal Wetland.

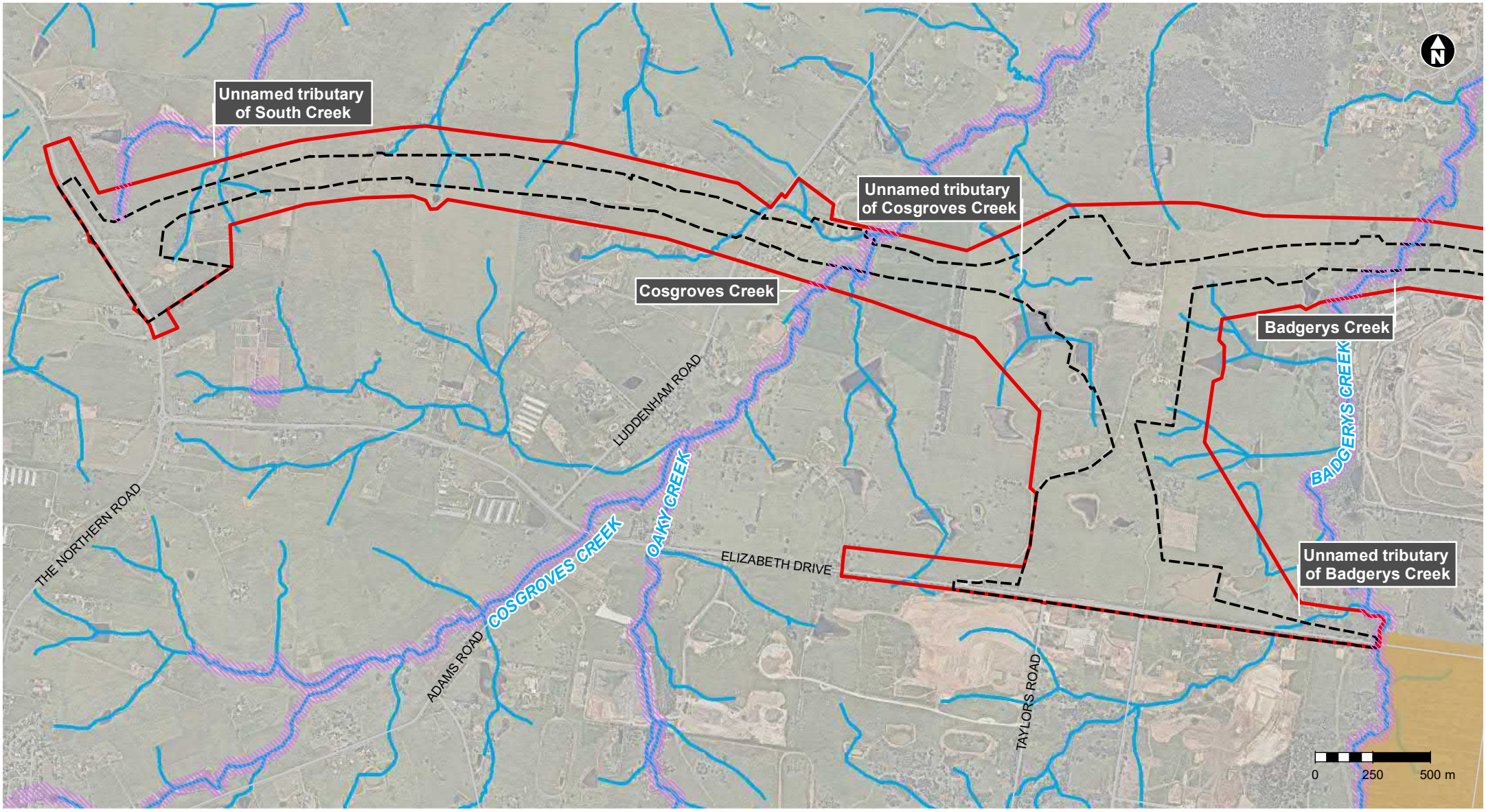


Figure 4-4 Aquatic survey results

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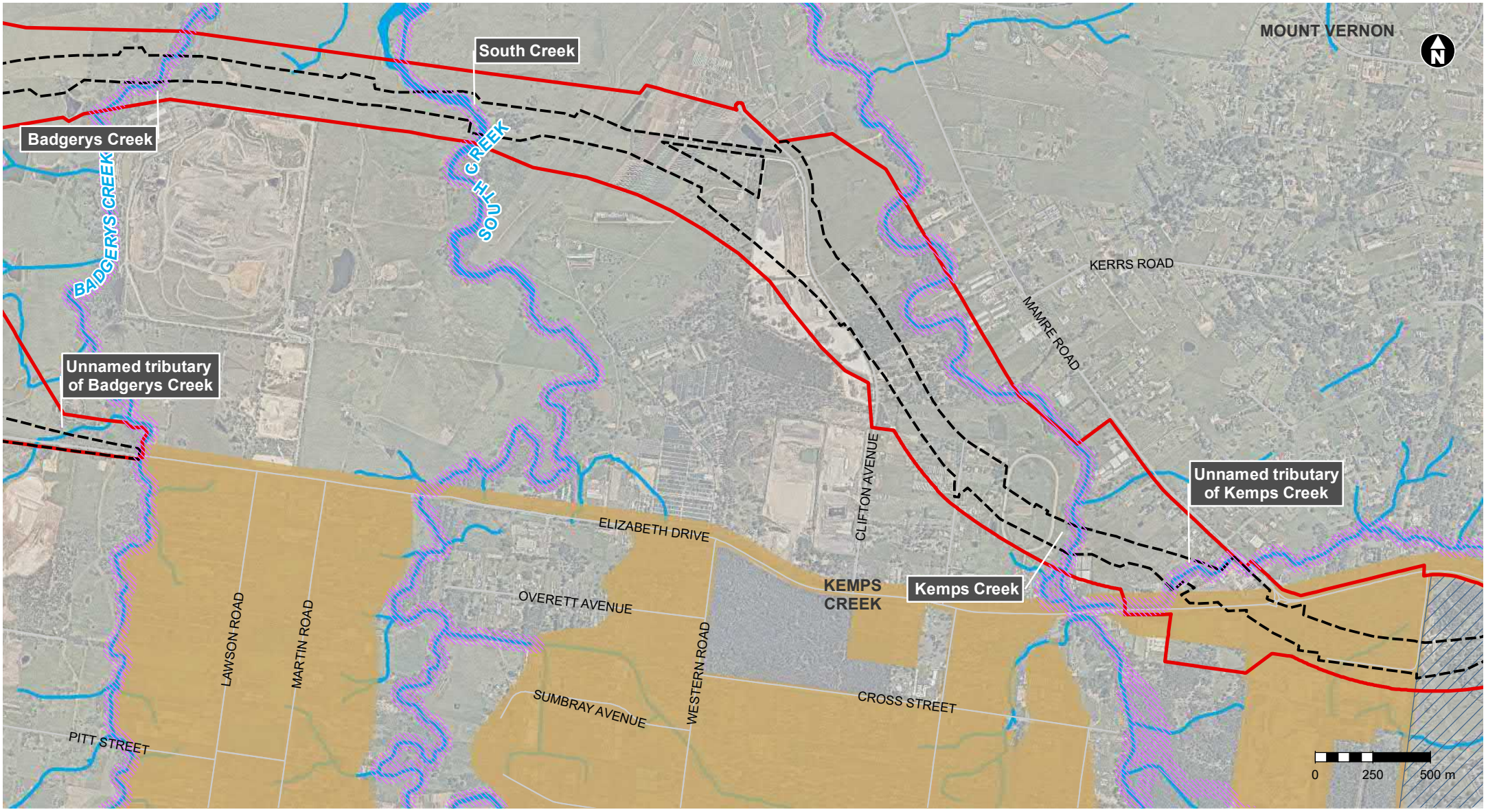

Figure 4-4 Aquatic survey results

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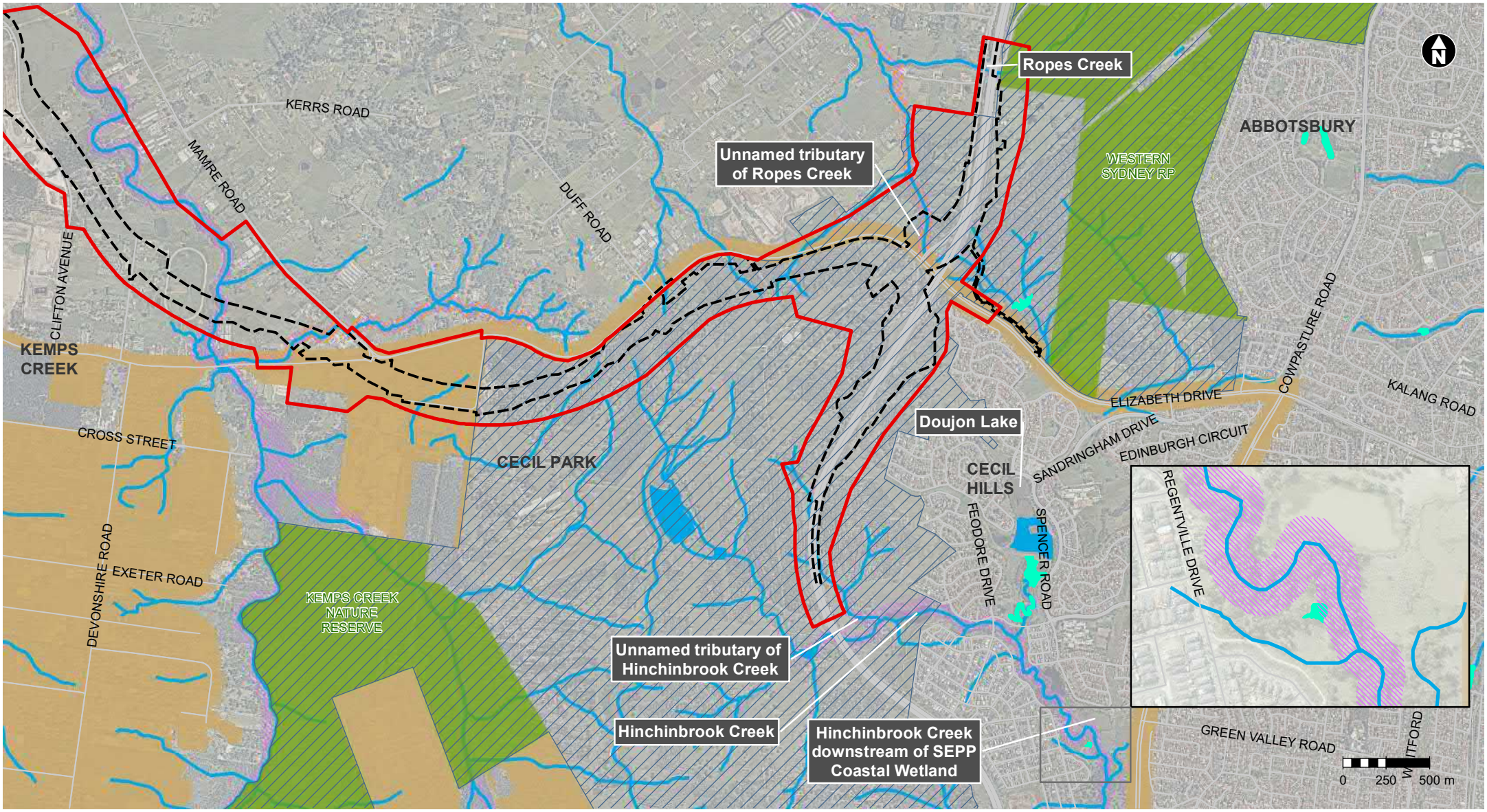

Figure 4-4 Aquatic survey results

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5 Matters of National Environmental Significance

5.1 Overview

Matters of National Environmental Significance (MNES) are environmental values that require approval from the Commonwealth Minister for the Environment if an action that may have a significant impact on one or more of these values is proposed. There are nine MNES listed under the EPBC Act:

- 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.

The EPBC Act also applies to actions outside of Commonwealth land that may impact on it (Sections 26 and 27 A of the EPBC Act).

The following section describes each MNES within the project area. All MNES relevant to the project are mapped below in **Figure 5-1**.

5.2 World heritage properties

There is one world heritage locations within 10 km of the study area. The Greater Blue Mountains Area is located approximately seven kilometres from the western most point of the study area. It is highly unlikely that this area will be impacted by the project and for this reason World Heritage properties are not considered further in this report.

5.3 National heritage places

There is one national heritage locations within 10 kilometres of the study area. The Greater Blue Mountains Area is located approximately seven kilometres from the western most point of the study area. It is highly unlikely that this area will be impacted by the project and for this reason World Heritage properties are not considered further in this report.

5.4 Listed threatened species and ecological communities

5.4.1 EPBC listed ecological communities

Details about the methods for investigation of EPBC Act listed ecological communities, including targeted surveys are included in **Section 3.1** and **Section 4.2**.

The Protected Matters Search Tool (PMST) report identified eight EPBC listed TECs with the potential to occur within the study area, including:

- Castlereagh Scribbly Gum and Agnes Banks Woodlands of the Sydney Basin Bioregion (Endangered);
- Coastal Swamp Oak (*Casuarina glauca*) Forest of New South Wales and South East Queensland ecological community (Endangered)
- Cooks River/Castlereagh Ironbark Forest of the Sydney Basin Bioregion (Critically Endangered)
- Cumberland Plain Shale Woodlands and Shale-Gravel Transition Forest (Critically Endangered)
- Shale Sandstone Transition Forest of the Sydney Basin Bioregion (Critically Endangered)
- Turpentine-Ironbark Forest of the Sydney Basin Bioregion (Critically Endangered)
- Upland Basalt Eucalypt Forests of the Sydney Basin Bioregion (Endangered)
- Western Sydney Dry Rainforest and Moist Woodland on Shale (Critically Endangered).

The presence, extent and condition of these communities was further investigated using a combination of GIS analysis, site inspection and field data collection (**Section 4.2.1**). The outcome of this investigation was that of the eight TSC Act listed TECs recorded within the study area, only two meet the condition and extent criteria required to be listed under the EPBC Act. These communities are: Cumberland Plain Shale Woodlands and Shale-Gravel Transition Forest and Western Sydney Dry Rainforest and Moist Woodland on Shale.

While some components of both Coastal Swamp Oak (*Casuarina glauca*) Forest of New South Wales and South East Queensland ecological community and Castlereagh Scribbly Gum and Agnes Banks Woodlands of the Sydney Basin Bioregion (PCT 1800 and 883 respectively) are present within the study area, they do not meet diagnostic criteria, and are therefore not considered to be part of an EPBC listed TEC (see **Table 5-1**).

Table 5-1 Potentially occurring TECs assessed against EPBC TEC criteria

TEC Name (EPBC Act)	EPBC Act Status	PCT Name	Summary of EPBC condition criteria	Meets criteria?
Castlereagh Scribbly Gum and Agnes Banks Woodlands of the Sydney Basin Bioregion	Endangered	Hard-leaved Scribbly Gum - Parramatta Red Gum heathy woodland of the Cumberland Plain, Sydney Basin Bioregion (PCT 883)	All the following conditions must be met: • Patch size ≥0.5 ha. • ≥30% of the perennial understory vegetation cover is made up of native species. • The patch is contiguous with a native vegetation remnant (any native vegetation where cover in each layer present is dominated by native species) >1 ha in area (DoE, 2015).	**No.** All areas mapped as PCT 883 within the study area were assessed against these criteria. These patches are situated in the central region of the study area along Clifton Avenue and are the remnant vegetation from recent clearing. All patches are <0.5 ha in size and are not contiguous with a native vegetation remnant >1 ha in area. They therefore do not meet the condition threshold criteria to be classified as Castlereagh Scribbly Gum and Agnes Banks Woodlands of the Sydney Basin Bioregion under the EPBC Act.
Cumberland Plain Shale Woodlands and Shale-Gravel Transition Forest	Critically Endangered	Grey Box - Forest Red Gum grassy woodland on shale of the southern Cumberland Plain, Sydney Basin Bioregion (PCT 849) Grey Box - Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin Bioregion (PCT 850) Broad-leaved Ironbark - Grey Box - Melaleuca decora grassy open forest on clay/gravel soils of the Cumberland Plain, Sydney Basin Bioregion PCT 724)	• Native tree species present with a minimum projected foliage cover of 10 per cent. • Patch 0.5 ha or greater in size. • One of the below applies: - Over 50 per cent of perennial understorey vegetative cover is made up of native species. - Patch greater than 5 ha in size and has over 30 per cent native perennial understorey vegetative cover. - Patch contiguous with a native vegetation patch greater than 5 ha in size and has over 30 per cent native perennial understorey vegetative cover. - Patch contains at least one tree per ha that is large (>80 cm dbh) or has a hollow and has over 30 per cent native perennial understorey vegetative cover (CoA, 2010).	**Yes.** All areas mapped as PCTs 724, 849 and 850 in the study area were assessed against these criteria. The majority of areas within the Western Sydney Parklands, including revegetated areas, fall within the condition threshold criteria to be classified as Cumberland Plain Shale Woodlands and Shale-Gravel Transition Forest as defined under the EPBC Act. Although these areas tend to have relatively low native species diversity, native tree cover is greater than 10 per cent, patches are mostly large and contiguous, and the perennial understorey native vegetation cover in most areas is over 50%.
Western Sydney Dry	Critically	Forest Red Gum - Grey Box	All the following conditions must be met:	**Yes.**

TEC Name (EPBC Act)	EPBC Act Status	PCT Name	Summary of EPBC condition criteria	Meets criteria?
Rainforest and Moist Woodland on Shale	Endangered	shrubby woodland on shale of the southern Cumberland Plain, Sydney Basin Bioregion (PCT 830)	• Patch 0.1 ha or greater in size. • At least 20 native species present in a 0.04 ha sample plot. • Non-native perennial plants account for no more than 50% of the total vegetation cover in the patch (Department of Sustainability, 2013).	All areas mapped as PCT 830 in the study area were assessed against the condition criteria. These patches are situated within the Western Sydney Parklands and each patch meets the condition threshold criteria to be classified as Western Sydney Dry Rainforest and Moist Woodland on Shale under the EPBC Act. Each patch is greater than 0.1 ha and has high native species diversity and greater than 50% native species cover.
Coastal Swamp Oak (*Casuarina glauca*) Forest of New South Wales and South East Queensland ecological community	Endangered	Swamp Oak open forest on riverflats of the Cumberland Plain and Hunter valley (PCT 1800)	• Patch size ≥ 0.5 ha and < 2 ha, meets key diagnostics and has a predominantly native understory OR; • Patch size ≥ 5 ha, meets key diagnostics and has some native understory (DoEE, 2018).	**No.** All areas mapped as PCT 1800 within the study area were assessed against the condition criteria. Many of the patches do not meet a key diagnostic for the community (having an elevation up to 50m ASL and usually below 20m ASL). They can therefore not be considered for EPBC listing. Patches which do meet all key diagnostics do not meet the condition threshold criteria as the patch size is too small and/or the understorey is not predominantly native. Therefore, the patches do not meet the condition threshold criteria to be classified as Coastal Swamp Oak (*Casuarina glauca*) Forest of New South Wales and South East Queensland ecological community under the EPBC Act.

5.4.2 Threatened species

5.4.2.1 Flora

Database searches of EPBC Act listed threatened flora predicted to occur within the study area identified 26 species (**Annexure E**). This was refined to seven species during desktop research based on available information on the PCTs on the site and other microhabitat information (detailed in Annexure B). Flora species identified by DoEE for further consideration in Attachment A of the SEARS were also targeted. A summary of survey effort and likelihood of occurrence for these species is shown in **Table 5-2**.

Table 5-2 EPBC listed flora species identified by EPBC in Attachment A of SEARS

Species name	Status under the EPBC Act	Compliance with EPBC guidelines	Summary of likelihood of occurrence (see Annexure B for details)
Pultenaea parviflora	Vulnerable	There are no specific EPBC guidelines for survey of this species. Targeted surveys for *Pultenaea parviflora* were conducted in October and November 2017, during the known flowering season of the species, and in August 2018. Surveys for this species comprised random meanders, 10 m spaced parallel transects and quadrats (30 minutes for each quadrat sampled).	Recorded in Shale Gravel Transition Forest in the study area, in areas adjoining Clifton Avenue, and also in the Western Sydney Parklands.
Pimelea spicata Spiked Rice-flower	Endangered	The recovery plan for *Pimelea spicata* (DEC, 2005b) notes that this species is cryptic and difficult to detect, particularly when not in flower, and may not be apparent aboveground during drought conditions. Any potential habitat should be subject to targeted survey during the species flowering period. The flowering period may vary, hence survey of other known nearby sites supporting *P. spicata* should be used as an indicator of flowering time. Targeted surveys for *Pimelea spicata* comprised random meanders, 10 m spaced parallel transects and quadrats (30 minutes for each quadrat sampled). *Pimelea spicata* was recorded in flower at the reference site (Lizard Log carpark in Western Sydney Parklands) at the time of targeted surveys for this species.	A population of *Pimelea spicata* has been recorded about 15 metres outside the study area. Habitat for the species is present in the Cumberland Plain Woodland vegetation and the Moist Shale Woodland vegetation, however targeted searches did not identify any further populations.
Acacia pubescens Downy Wattle	Vulnerable	The Environmental Impact Assessment guidelines in Appendix 3 of the approved recovery plan for *Acacia pubescens* (NPWS, 2003b) specifies that surveys for *Acacia pubescens* can be conducted at any time of year, as it can be distinguished by its conspicuously hairy branchlets. As it is a clonal species, counting the number of individuals at a	*Acacia pubescens* was considered to have a high likelihood of occurrence in the study area, given suitable potential habitat in Shale/Gravel Transition Forest and on the fringes of Cumberland Plain Woodland, and the presence of previous nearby records (most

Species name	Status under the EPBC Act	Compliance with EPBC guidelines	Summary of likelihood of occurrence (see Annexure B for details)
		site can be difficult. Alternative survey methods include counting the number of stems or clumps of stems or estimating the extent of the population. Targeted surveys for *Acacia pubescens* comprised random meanders, 10 m spaced parallel transects and quadrats (30 minutes for each quadrat sampled).	recent 2017). *Acacia pubescens* was not detected in the study area during targeted surveys, therefore the likelihood of it occurring in the study area is reduced to low to moderate.
Acacia bynoeana Bynoe's Wattle	Vulnerable	While there are no specific EPBC survey guidelines for *Acacia bynoeana,* the species is small and inconspicuous, and is best detected when in flower, from September to March (DoE, 2019a). Targeted surveys for *Acacia bynoeana* were conducted in October and November 2017, during the known flowering season of the species, and in August 2018. Surveys for this species comprised random meanders, 10 m spaced parallel transects and quadrats (30 minutes for each quadrat sampled).	*Acacia bynoeana* is considered to have a moderate likelihood of occurrence in the study area; although there is only marginal potential habitat present in Shale/Gravel Transition Forest (PCT 724), the species is known to occur in disturbed ground and road edges. There are no records of this species in the locality, with the closest records over 11 kilometres to the south-east. *Acacia bynoeana* was not detected in the study area during targeted surveys.
Allocasuarina glareicola	Endangered	There are no specific EPBC guidelines for survey of this species (DoE, 2019b). Although this species was not specifically targeted during surveys, the only areas of potential marginal habitat in Shale Gravel Transition Forest (PCT 724) were subject to detailed targeted threatened flora surveys for a range of other threatened flora species, and it is likely that, if present, *Allocasuarina glareicola* would have been detected.	*Allocasuarina glareicola* is considered to have a low likelihood of occurrence in the study area, given the lack of records in the locality – the closest record of the species is an isolated individual about 11 kilometres north of the study area, and the core population of the species is in the Castlereagh area in north-west Sydney, about 18 kilometres north of the study area. There is potential marginal habitat for the species in Shale Gravel Transition Forest (PCT 724) in the study area.
Cynanchum elegans White-flowered Wax Plant	Endangered	Surveys for *Cynanchum elegans* can be undertaken at any time of the year (DoE, 2019c). Mature individuals can be readily identified by the deeply fissured, corky bark present on mature stems. Care must be taken when identifying juvenile plants as leaf morphology is highly variable and the species can be easily confused with other vines in the same family (especially the invasive Moth Vine, *Araujia sericifera,* which was recorded in the study area). Low stem numbers and/or highly	*Cynanchum elegans* is considered to have a moderate likelihood of occurrence in the study area; while there are no recent records of this species in the locality (the most recent is dated from 1993), the species could occur in the Moist Shale Woodland that is present in the study area. *Cynanchum elegans* was not

Species name	Status under the EPBC Act	Compliance with EPBC guidelines	Summary of likelihood of occurrence (see Annexure B for details)
		localised distributions are characteristic of White-flowered Wax Plant sites. The search effort required confirming presence or absence of the species is high, and surveyors should not exclude previously disturbed areas, particularly areas overgrown with weeds (DoE 2019c). Targeted surveys for *Cynanchum elegans* comprised random meanders, 10 m spaced parallel transects and quadrats (30 minutes for each quadrat sampled).	detected in the study area during targeted surveys.
Grevillea parviflora subsp. *parviflora* Small-flower Grevillea	Vulnerable	*Grevillea parviflora* subsp. *parviflora* is best surveyed during the main flowering period between July and December when it is easier to identify by its flowers (DoE, 2019d). Targeted surveys for *Grevillea parviflora* subsp. *parviflora* were conducted in October and November 2017 and in August 2018, during the known flowering season of the species, Surveys for this species comprised random meanders, 10 m spaced parallel transects and quadrats (30 minutes for each quadrat sampled).	*Grevillea parviflora* subsp. *parviflora* is considered to have a moderate likelihood of occurrence in the study area. There are multiple records of this species in close proximity to the study area, and suitable habitat is present in the study area within the Shale Gravel Transition Forest (PCT 724). *Grevillea parviflora* subsp. *parviflora* was not detected in the study area during targeted surveys.
Persoonia nutans Nodding Geebung	Endangered	*Persoonia nutans* flowers from November to April, with peak flowering in December and January. Surveys are best conducted during the summer months when the species is in peak flowering. Such surveys should include enough effort to effectively capture seedlings as the species often occurs as scattered individuals at low density. Survey sites that have recently been burnt (under 3 years) or have not been burnt for a long period may only contain the species in the soil seedbank (DoE, 2019e). Targeted surveys for *Persoonia nutans* were conducted in October and November 2017 and in August 2018, during the known flowering season of the species but outside the peak summer flowering period. Arcadis ecologists have extensive experience in surveys of this species and would likely have detected it if present above ground, even if not in flower. Surveys for this species comprised random meanders, 10 m spaced parallel transects and quadrats (30 minutes for each quadrat sampled).	*Persoonia nutans* was considered to have a high likelihood of occurrence in the study area, given suitable potential habitat in Shale/Gravel Transition Forest (PCT 724) and the presence of previous nearby records (2013 record about 500 metres outside the study area). *Persoonia nutans* was not detected in the study area during targeted surveys, therefore the likelihood of it occurring in the study area is reduced to low to moderate.

Targeted surveys (detailed in **Section 4.2.1**) identified only one EPBC listed flora species occurring within or adjacent to the study area: Sydney bush-pea *Pultenaea parviflora* (listed as vulnerable under the EPBC Act). In addition, Spiked rice-flower *Pimelea spicata* (listed as endangered under the EPBC Act) occurs about 15 metres to the east of the study area, and 70 metres from the current construction footprint (**Figure 4-2**).

5.4.2.2 Fauna

Twenty one species of fauna listed under the EPBC Act were identified as part of database searches of records or suitable habitat within 10 km of the study area. Habitat assessment (**Annexure B**) was used to determine those with a moderate or higher likelihood of occurrence. Fauna species identified by DoEE for further consideration in Attachment A of the SEARS were also targeted. A summary of survey effort and likelihood of occurrence for these species is shown in **Table 5-3**. Detailed survey effort for all fauna species including those listed under the EPBC Act is shown in **Section 4.2.2**. **Section 4.2.5** shows detailed results for all fauna species.

Table 5-3 EPBC listed fauna species identified by EPBC in Attachment A of SEARS

Species name	Status under the EPBC Act	Compliance with EPBC guidelines	Summary of likelihood of occurrence (see Annexure B for details)
Pteropus poliocephalus Grey-headed Flying-fox	Vulnerable	Survey guidelines for Grey-headed Flying-fox (CoA, 2010a), include a mix of vegetation surveys for foraging resources, daytime camp surveys and nocturnal surveys for feeding and flying bats. All of these surveys were carried out (Detailed in **Table 4-5**).	Recorded foraging during current surveys. No camps present. Further detail in **Chapter 4.**
Phascolarctos cinereus Koala	Vulnerable	Surveys consisted of SATs across suitable habitat within and surrounding the Study Area, nocturnal surveys including spotlighting transects and call-playback. Habitat critical to the survival of the koala was identified, however no koalas have been recorded within 10km since 2003 and no evidence of koalas was detected.	Due to existing barriers and the highly modified nature of the area, it is unlikely that an important population of koalas exists within or in proximity to the study area. Occasional movement through the area may occur. Further details of koala assessment can be found in **Annexures B & G**.
Lathamus discolor Swift Parrot	Critically Endangered	Foraging habitat determined primarily by occurrence of winter flowering eucalypts throughout its mainland range (Saunders and Tzaros, 2011), targeted bird surveys to guideline survey effort (area and targeted searches) (80 hours over 10 days) were carried out in winter 2017 & 2018. Detailed vegetation surveys also carried out.	While foraging resources do occur (Forest Red Gum and Spotted Gum), they are scattered, immature and disturbed and represent marginal habitat. Records of this species occur within 10km of the area, but habitat is unlikely to be important to the survival of the species (**Annexures B & G**).
Anthochaera phrygia Regent Honeyeater	Critically Endangered	Marginal foraging habitat occurs throughout the study area, primarily Forest Red Gum and Spotted Gum, however only five records occur within 10 km of the study area and four of these are more than 30 years old. One, in 2009 was approximately 7 km away. This species was targeted during diurnal bird surveys, as per Swift Parrot survey effort.	Given few recent records, and marginal habitat, this species is considered unlikely to occur. Further details on occurrence and potential impacts are in **Annexures B & G**.

Species name	Status under the EPBC Act	Compliance with EPBC guidelines	Summary of likelihood of occurrence (see Annexure B for details)
Litoria aurea Green and Golden Bell Frog	Vulnerable	Habitat assessment and targeted nocturnal surveys including call detection, call playback and spotlighting were undertaken. Reference site at Olympic Park, Homebush was also surveyed. Survey effort required to be at least four nights (CoA, 2009), we completed seven nights in Feb, March and October 2018.	No Green and Golden Bell Frogs were detected, although common frog species were recorded. The study area is at least 10 km from the closest source population on the Georges River (CoA, 2009). (**Annexures B & G** contain further detailed assessment).
Chalinolobus dwyeri Large-eared Pied Bat	Vulnerable	Habitat assessment including searches for features such as caves and rocky outcrops was undertaken. Echolocation call recording and analysis is the best method for detection (CoA, 2014a) and was carried out for this survey.	Habitat assessment was used to determine a low likelihood of occurrence which was confirmed with passive echolocation call detection. (**Annexures B & G** contain further detailed assessment).

5.4.2.3 Grey-headed Flying-fox

Of the six EPBC listed fauna species identified from desktop research (and identified by DoEE in Attachment A of the SEARS (shown in **Table 1-3**), the Grey-headed Flying-fox is the only EPBC listed species recorded or assumed present within the study area. This species was recorded foraging within the study area during nocturnal surveys. The study area lies within foraging range (about 20 kilometres) of the following known flying-fox camp locations (CoA, 2018):

- Wetherill Park (about seven kilometres from the eastern part of the study area) (500-2,499 individuals at last census in 2017)
- Cabramatta (about 10 kilometres from the eastern part of the study area) (2,500-9,999 for the past five years, latest census in 2017)
- Macquarie Fields (about nine kilometres to the south-east of the study area) (variable over recent years, about 500 in latest census in 2017)
- Ropes Creek (about 15 kilometres to the north of the study area, 500-2,499 in 2017).

All Woodland and Riparian Forest habitats across the study area (**Figure 4-1**) are considered likely to provide foraging habitat for Grey-headed Flying-foxes that roost or breed at these known camps.

No Grey-headed Flying-fox camps were recorded within the study area during targeted surveys. The study area is therefore considered unlikely to provide roosting or breeding habitat for the Grey-headed Flying-fox.

5.5 Listed migratory species

The PMST search for this project identified 16 listed migratory species which have the potential to occur within 10 kilometres of the study area (see **Annexure E**).

Preliminary desktop assessments were used to determine the initial likelihood of occurrence for each listed migratory species. Following this, on site habitat assessments and field surveys were undertaken to determine final likelihoods of occurrence for listed migratory species within the study area (see **Table 4-5** and **Table 5-4**).

Initial likelihoods of occurrence determined that eight migratory species had a moderate likelihood of occurrence, eight had a low likelihood of occurrence, and no species were considered highly likely to occur in the study area. While the White-bellied Sea-Eagle is a listed marine species under the EPBC Act, it is not considered a migratory species and therefore was not assessed as a migratory species. Final likelihoods of occurrence determined that all migratory species had a low likelihood of occurrence.

A summary of likelihoods of occurrence and survey effort for EPBC Act migratory species in the study area is provided below in **Table 5-4**.

5.6 Commonwealth land

The study area is directly adjacent to Commonwealth land at the Western Sydney Airport. However, no work is proposed on this land, and therefore no direct impacts are anticipated from the project. No Commonwealth marine areas are located within 10 km of the study area

Potential indirect impacts from the project on the environment of Commonwealth land include air, noise and visual impacts. These impacts are addressed in **Section 8.5.10** of the BAR and in Section 8.2.4, Section 7.7.6, Section 7.7.7 and Section 7.4.4 respectively of the main EIS document.

5.7 The Great Barrier Reef and nuclear actions

The study area is not located in proximity to the Great Barrier Reef and the project is not a nuclear action, therefore these MNES are not considered any further in this report.

Table 5-4 Summary of likelihoods of occurrence and survey effort for EPBC Act migratory species in the study area

Species name	Distribution and habitat requirements (DoE, 2013)	Likelihood of occurrence		Survey effort
		Desktop	Final (after surveys)	
Marine species				
Apus pacificus Fork-tailed Swift	• Recorded in all regions. • Often occur over cliffs, beaches and islands and sometimes well out to sea. • Mostly occur over dry or open habitats, including riparian woodland and tea-tree swamps, low scrub, heathland or saltmarsh. • Also found at treeless grassland and sandplains covered with spinifex, open farmland and inland and coastal sand-dunes. • Sometimes occur above rainforests, wet sclerophyll forest or open forest or plantations of pines (Higgins, 1999). • Forage aerially, up to hundreds of metres above ground, but also less than one metre above open areas or over water.	Moderate. Potential aerial foraging habitat predicted from desktop assessment.	Low. Species not recorded during targeted surveys.	• Surveys conducted across nine sites on May 23, August 21, 22, 24, October 12, 30, November 9 2017 and August 1 and 2 2018. • Surveys consisted of 20 minute bird surveys and area searches in the first three to four hours after sunrise.
Terrestrial species				
Cuculus optatus Oriental Cuckoo	• Found in eastern New South Wales, eastern Queensland and Cape York Peninsula, and top end of Northern Territory. • Habitat includes forest, woodland, riverside trees.	Low. Very few records from the locality and no suitable habitat recorded from desktop assessment.	Low. Species not recorded during targeted surveys.	• Surveys (diurnal) conducted across nine sites on May 23, August 21, 22, 24, October 12, 30, November 9 2017 and August 1 and 2 2018. • Surveys consisted of 20 minute bird surveys and area searches in the first three to four hours after sunrise.
Hirundapus caudacutus White-throated Needletail	• Recorded in all coastal regions of Queensland and NSW, extending inland to the western slopes of the Great Divide and occasionally onto the adjacent inland plains. • Recorded most often above wooded areas, including open forest and rainforest, and may also fly between trees or in	Moderate. Potential aerial foraging habitat predicted from	Low. Species not recorded during targeted	• Surveys (diurnal) conducted across nine sites on May 23, August 21, 22, 24, October 12, 30, November 9 2017 and August 1 and 2 2018. • Surveys consisted of 20 minute bird

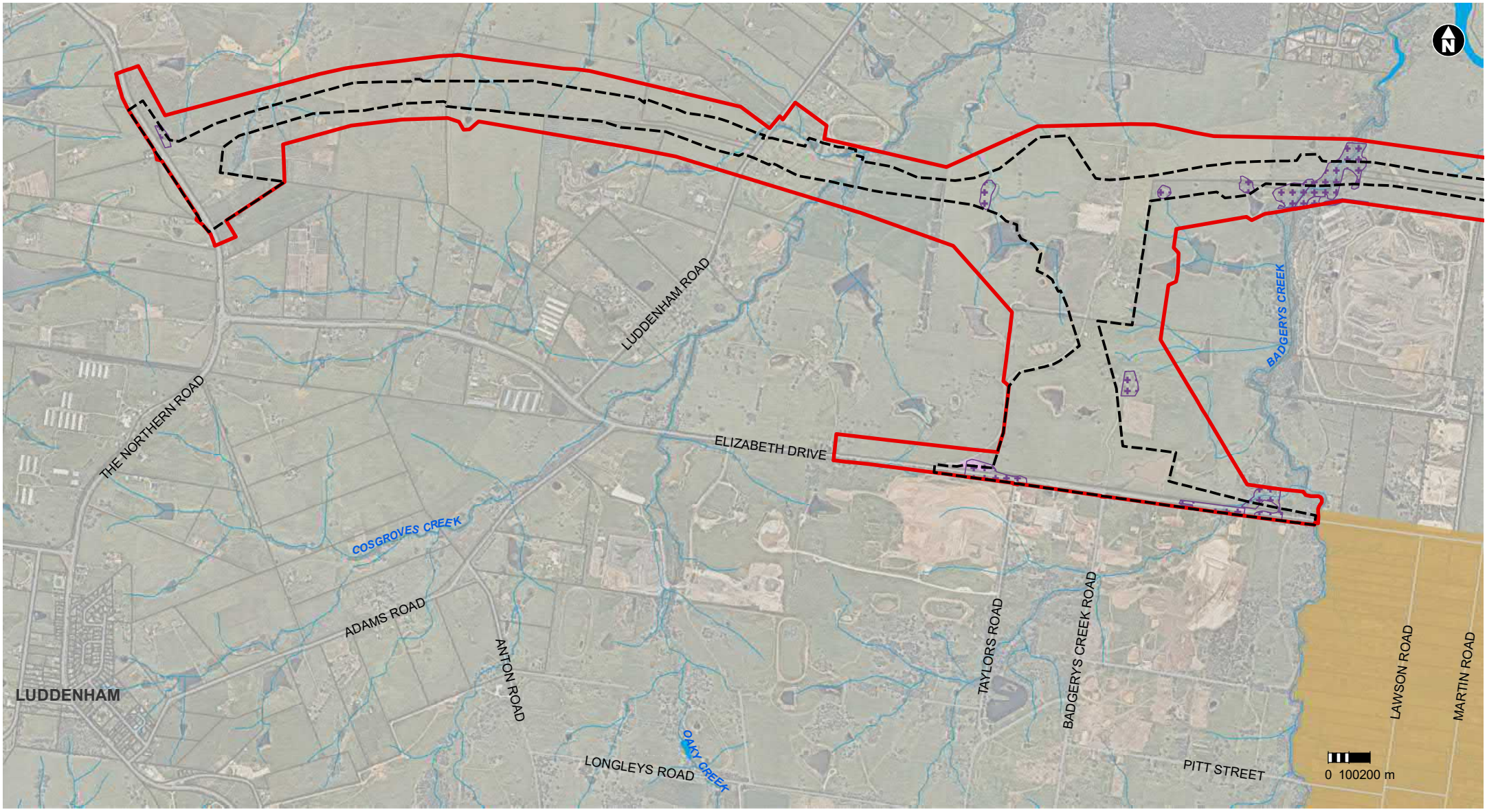
Species name	Distribution and habitat requirements (DoE, 2013)	Likelihood of occurrence		Survey effort
		Desktop	Final (after surveys)	
	clearings, below the canopy. • Also, commonly occur over heathland (Cooper, 1971; Learmonth, 1951; McFarland, 1988), but less often over treeless areas, such as grassland or swamps (Cooper, 1971; Gosper, 1981; Learmonth, 1951).	desktop assessment.	surveys.	surveys and area searches in the first three to four hours after sunrise.
Monarcha melanopsis Black-faced Monarch	• Occurs around the eastern slopes and tablelands of the Great Divide, inland to Coutts Crossing, Armidale, Widden Valley, Wollemi National Park, Wombeyan Caves and Canberra (Morris *et al.*, 1981; Blakers *et al.*, 1984; Ford *et al.*, 1985; Taylor & COG, 1992). • Mainly occurs in rainforest ecosystems, including semi-deciduous vine-thickets, complex notophyll vine-forest, tropical (mesophyll) rainforest, subtropical (notophyll) rainforest, mesophyll (broadleaf) thicket/shrubland, warm temperate rainforest, dry (monsoon) rainforest and (occasionally) cool temperate rainforest (Blakers *et al.*, 1984; Bravery, 1970; Emison *et al*., 1987; Ford *et al*., 1980; Gill, 1970; Gosper, 1992; Laurance *et al*., 1996; Morris *et al*., 1981; Officer, 1969; Schodde & Mason, 1999; Smith, 1984; Storr, 1984c).	Moderate. Potential foraging habitat predicted from desktop assessment.	Low. Species not recorded during targeted surveys.	• Surveys (diurnal) conducted across nine sites on May 23, August 21, 22, 24, October 12, 30, November 9 2017 and August 1 and 2 2018. • Surveys consisted of 20 minute bird surveys and area searches in the first three to four hours after sunrise.
Monarcha trivirgatus Spectacled Monarch	• Found in coastal north-eastern and eastern Australia, including coastal islands, from Cape York, Queensland to Port Stephens, New South Wales. It is much less common in the south. • Prefers thick understorey in rainforests, wet gullies and waterside vegetation, as well as mangroves.	Low. Rare around Sydney and no suitable habitat recorded from desktop assessment.	Low. Species not recorded during targeted surveys.	• Surveys (diurnal) conducted across nine sites on May 23, August 21, 22, 24, October 12, 30, November 9 2017 and August 1 and 2 2018. • Surveys consisted of 20 minute bird surveys and area searches in the first three to four hours after sunrise.
Motacilla flava Yellow Wagtail	• Regular spring-summer visitor in north of Australia, rare vagrant or occasional visitor farther south.	Low.	Low.	• Surveys (diurnal) conducted across nine sites on May 23, August 21,

Species name	Distribution and habitat requirements (DoE, 2013)	Likelihood of occurrence		Survey effort
		Desktop	Final (after surveys)	
	• Found in marshes, damp paddocks, airfields, cultivated fields, lawns and estuaries.	Rare around Sydney and no suitable habitat recorded from desktop assessment.	Species not recorded during targeted surveys.	22, 24, October 12, 30, November 9 2017 and August 1 and 2 2018. • Surveys consisted of 20 minute bird surveys and area searches in the first three to four hours after sunrise.
Myiagra cyanoleuca Satin Flycatcher	• Mainly inhabit eucalypt forests, often near wetlands or watercourses. • Generally, occur in moister, taller forests than the Leaden Flycatcher, Myiagra rubecula, often occurring in gullies (Blakers *et al*., 1984; Emison *et al*., 1987; Officer, 1969). • Also occur in eucalypt woodlands with open understorey and grass ground cover and are generally absent from rainforest (Emison *et al*., 1987; Officer, 1969).	Low. No suitable habitat recorded from desktop assessment.	Low. Species not recorded during targeted surveys.	• Surveys (diurnal) conducted across nine sites on May 23, August 21, 22, 24, October 12, 30, November 9 2017 and August 1 and 2 2018. • Surveys consisted of 20 minute bird surveys and area searches in the first three to four hours after sunrise.
Rhipidura rufifrons Rufous Fantail	• Mainly inhabits wet sclerophyll forests, often in gullies dominated by eucalypts such as Tallow-wood (*Eucalyptus microcorys*), Mountain Grey Gum (*E. cypellocarpa*), Narrow-leaved Peppermint (*E. radiata*), Mountain Ash (*E. regnans*), Alpine Ash (*E. delegatensis*), Blackbutt (*E. pilularis*) or Red Mahogany (*E. resinifera*); usually with a dense shrubby understorey often including ferns. • Also occur in subtropical and temperate rainforests.	Moderate. Potential foraging habitat predicted from desktop assessment.	Low. Species not recorded during targeted surveys.	As above.
Wetland species				
Actitis hypoleucos Common Sandpiper	• Inhabits a wide range of coastal and inland wetlands, often with muddy or rocky margins. • Also known to occur at estuaries, billabongs, dams, pools and lakes, often associated with mangroves.	Low. No suitable habitat recorded from desktop assessment.	Low. Species not recorded during targeted surveys.	• Surveys (diurnal) conducted across nine sites on May 23, August 21, 22, 24, October 12, 30, November 9 2017 and August 1 and 2 2018. • Surveys (wetland) conducted across nine sites on October 19 2017,

Species name	Distribution and habitat requirements (DoE, 2013)	Likelihood of occurrence		Survey effort
		Desktop	Final (after surveys)	
				August 1 and 2 2018. • Both survey types consisted of 20 minute bird surveys and area searches in the first three to four hours after sunrise.
Calidris acuminata Sharp-tailed Sandpiper	• Inhabits inland, coastal waters.	Moderate. Potential foraging habitat predicted from desktop assessment.	Low. Species not recorded during targeted surveys.	• Surveys (diurnal) conducted across nine sites on May 23, August 21, 22, 24, October 12, 30, November 9 2017 and August 1 and 2 2018. • Surveys (wetland) conducted across nine sites on October 19 2017, August 1 and 2 2018. • Both survey types consisted of 20 minute bird surveys and area searches in the first three to four hours after sunrise.
Calidris ferruginea Curlew Sandpiper	• Occurs along the entire coast of NSW and around most of the Australian coastline. • Particularly occurs in the Hunter Estuary and at times in freshwater wetland within the Murray-Darling Basin. • Occupy littoral and estuarine habitats and within NSW is mainly found in intertidal mudflats of sheltered coasts. • Also occur in non-tidal swamps, lakes and lagoons on the coast. • Roosting occurs on shingle, shell or sand beaches; spits or islets on the coast or in wetlands; or sometimes in saltmarsh or on rocky shores.	Low. No suitable habitat recorded from desktop assessment.	Low. Species not recorded during targeted surveys.	• Surveys (diurnal) conducted across nine sites on May 23, August 21, 22, 24, October 12, 30, November 9 2017 and August 1 and 2 2018. • Surveys (wetland) conducted across nine sites on October 19 2017, August 1 and 2 2018. • Both survey types consisted of 20 minute bird surveys and area searches in the first three to four hours after sunrise.
Calidris melanotos Pectoral Sandpiper	• Scarce, but regular visitor, usually recorded in summer from November to March. • Widespread but scattered records in Australia.	Moderate. Potential foraging	Low. Species not	• Surveys (diurnal) conducted across nine sites on May 23, August 21, 22, 24, October 12, 30, November 9

Species name	Distribution and habitat requirements (DoE, 2013)	Likelihood of occurrence		Survey effort
		Desktop	Final (after surveys)	
	• Usually found in fresh to saline wetlands, floodplains, swamps, estuaries and lagoons, sometimes with emergent or fringing vegetation such as grass.	habitat predicted from desktop assessment.	recorded during targeted surveys.	2017 and August 1 and 2 2018. • Surveys (wetland) conducted across nine sites on October 19 2017, August 1 and 2 2018. • Both survey types consisted of 20 minute bird surveys and area searches in the first three to four hours after sunrise.
Gallinago hardwickii Latham's Snipe	• Occurs in permanent and ephemeral wetlands up to 2000 m above sea-level (Chapman, 1969; Naarding, 1981). • Usually inhabit open, freshwater wetlands with low, dense vegetation (eg swamps, flooded grasslands or heathlands, around bogs and other water bodies) (Frith *et. al.*, 1977; Naarding, 1983; Weston, 2006, pers. comm.). • Also occur in habitats with saline or brackish water, in modified or artificial habitats, and in habitats located close to humans or human activity (Frith *et al.*, 1977; Naarding, 1983).	Moderate. Potential foraging habitat predicted from desktop assessment.	Low. Species not recorded during targeted surveys.	• Surveys (diurnal) conducted across nine sites on May 23, August 21, 22, 24, October 12, 30, November 9 2017 and August 1 and 2 2018. • Surveys (wetland) conducted across nine sites on October 19 2017, August 1 and 2 2018. • Both survey types consisted of 20 minute bird surveys and area searches in the first three to four hours after sunrise.
Numenius madagascariensis Eastern Curlew	• Primarily coastal distribution. • Found in all States, particularly in the north, east and south-east regions including Tasmania. • Rarely recorded inland. • Breed in Russia and north-eastern China but spend the non-breeding season in Australia. • Generally, occupies coastal lakes, inlets, bays and estuarine habitats. • Occasionally found on ocean beaches, coral reefs, rock platforms or rocky islets. • Forages in or at the edge of shallow water and roosts on sandy spits and islets.	Low. No suitable habitat recorded from desktop assessment.	Low. Species not recorded during targeted surveys.	• Surveys (diurnal) conducted across nine sites on May 23, August 21, 22, 24, October 12, 30, November 9 2017 and August 1 and 2 2018. • Surveys (wetland) conducted across nine sites on October 19 2017, August 1 and 2 2018. • Both survey types consisted of 20 minute bird surveys and area searches in the first three to four hours after sunrise.

Species name	Distribution and habitat requirements (DoE, 2013)	Likelihood of occurrence		Survey effort
		Desktop	Final (after surveys)	
Pandion haliaetus Eastern Osprey	• Favour coastal areas, especially the mouths of large rivers, lagoons and lakes. • Common around the northern coast, especially on rocky shorelines, islands and reefs.	Low. No suitable habitat recorded from desktop assessment.	Low. Species not recorded during targeted surveys.	• Surveys (diurnal) conducted across nine sites on May 23, August 21, 22, 24, October 12, 30, November 9 2017 and August 1 and 2 2018. • Surveys (wetland) conducted across nine sites on October 19 2017, August 1 and 2 2018. • Both survey types consisted of 20 minute bird surveys and area searches in the first three to four hours after sunrise.
Tringa nebularia Common Greenshank	• Widest distribution of any shorebird in Australia. • Occurs in all types of wetlands. • Breed in Eurasia and spend the non-breeding season across Europe, Africa, Asia, Melanesia and Australasia. • Forages at wetland edges and roosts around wetlands in shallow pools and puddles.	Moderate. Potential foraging habitat predicted from desktop assessment.	Low. Species not recorded during targeted surveys.	• Surveys (diurnal) conducted across nine sites on May 23, August 21, 22, 24, October 12, 30, November 9 2017 and August 1 and 2 2018. • Surveys (wetland) conducted across nine sites on October 19 2017, August 1 and 2 2018. • Both survey types consisted of 20 minute bird surveys and area searches in the first three to four hours after sunrise.



Study area corridor
The project construction footprint
Western Sydney Parklands
NPWS Reserves
Biodiversity certified land
Cadastre
Waterways

Threatened Ecological Communities (EPBC Act)
Cumberland Plain Shale Woodlands and Shale/Gravel Transition Forest
Western Sydney Dry Rainforest and Moist Woodland on Shale

EPBC Habitat
Grey-headed Flying-fox

Threatened Flora Species
Pimelea spicata
Pultenaea parviflora

Figure 5-1 Matters of National Environmental Significance

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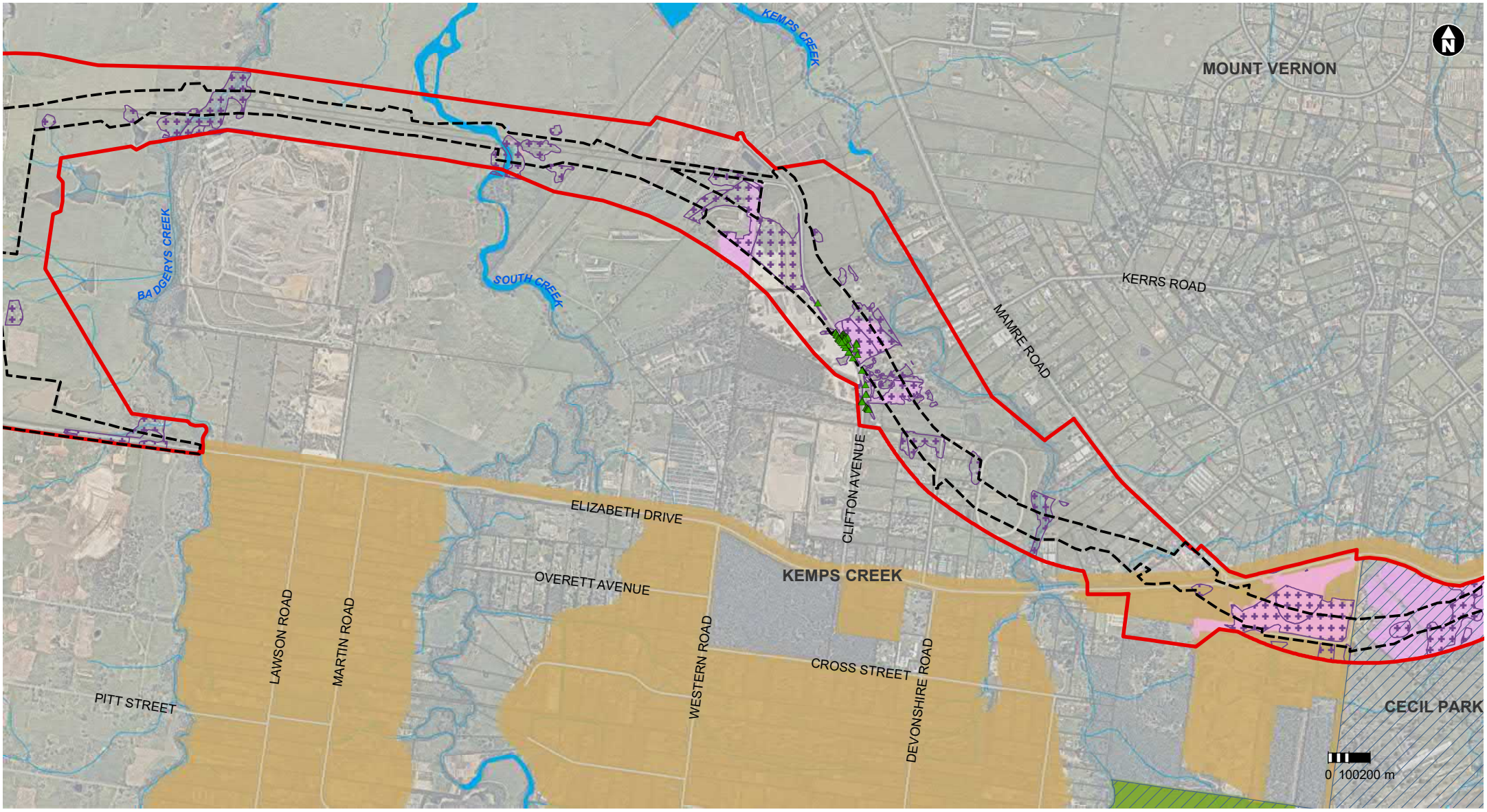

Figure 5-1 Matters of National Environmental Significance

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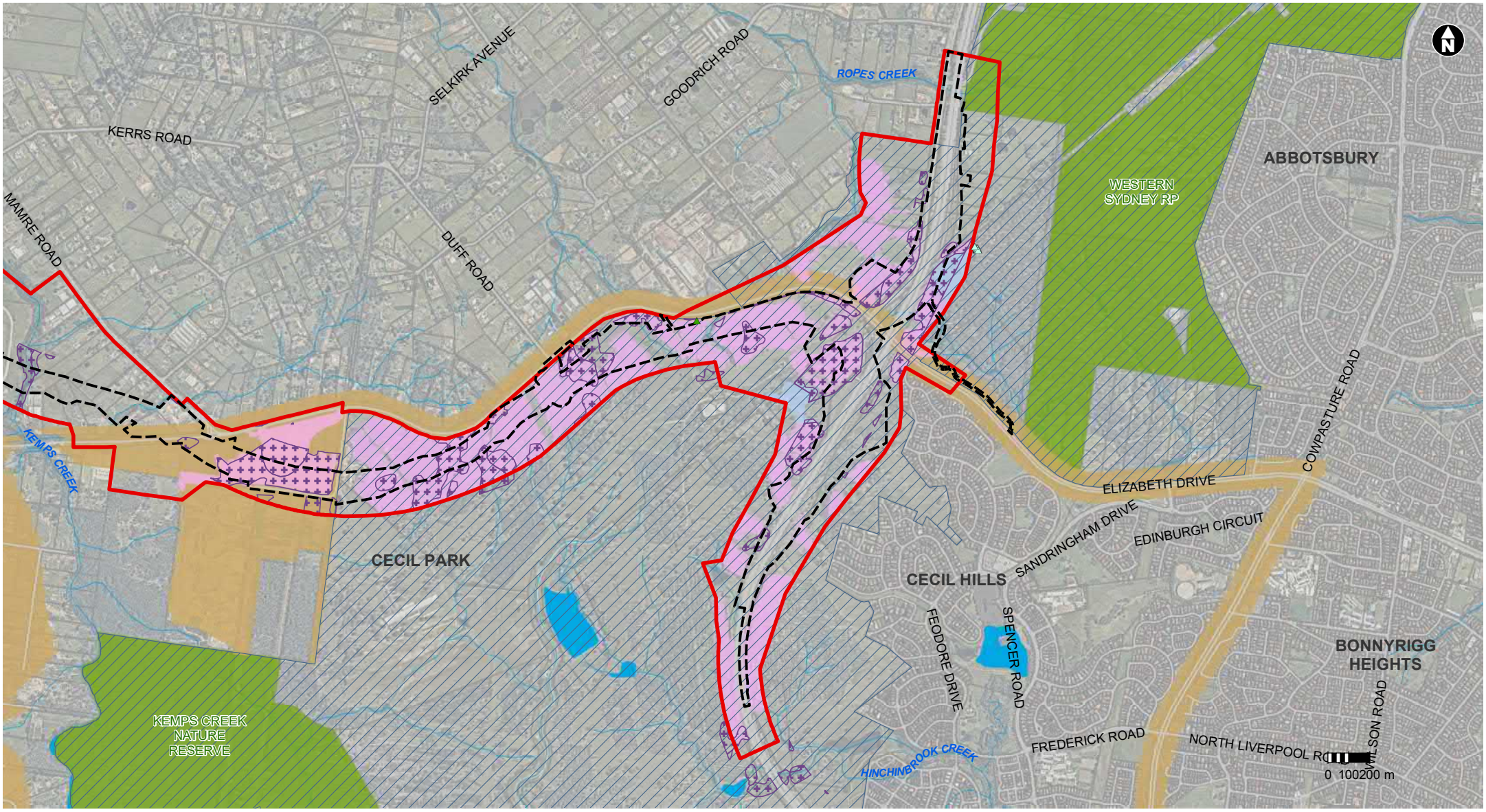

Study area corridor
The project construction footprint
Western Sydney Parklands
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Threatened Ecological Communities (EPBC Act)

Cumberland Plain Shale Woodlands and Shale/Gravel Transition Forest
Western Sydney Dry Rainforest and Moist Woodland on Shale

EPBC Habitat

Grey-headed Flying-fox

Threatened Flora Species

Pimelea spicata
Pultenaea parviflora

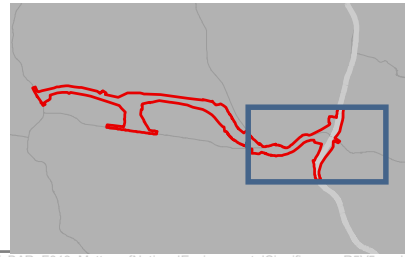

Figure 5-1 Matters of National Environmental Significance

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6 Summary of biodiversity values

6.1 Biodiversity values assessed under the FBA

Biodiversity values that are known to occur in the study area and require assessment under Section 9.3 of the FBA are summarised in **Table 6-1**. This includes threatened species, populations, and communities listed under the TSC Act and the EPBC Act (see **Table 6-1** below). Biodiversity values that are unconfirmed but presumed to be present in the study area are also included in **Table 6-1**.

Table 6-1 Summary of biodiversity values assessed under the FBA

Biodiversity value	Ecosystem or species credit species	Identification method (assumed, recorded, expert report)	Area/ individuals within study area	Area/ individuals within construction footprint excluding certified areas (ha)
Broad-leaved Ironbark - Grey Box - Melaleuca decora grassy open forest on clay/gravel soils of the Cumberland Plain, Sydney Basin Bioregion (PCT 724)	Ecosystem	Recorded	12.82	6.91
Broad-leaved Ironbark - Melaleuca decora shrubby open forest on clay soils of the Cumberland Plain, Sydney Basin Bioregion (PCT 725)	Ecosystem	Recorded	0.50	0
Forest Red Gum - Grey Box shrubby woodland on shale of the southern Cumberland Plain, Sydney Basin Bioregion (PCT 830)	Ecosystem	Recorded	4.97	0.44
Forest Red Gum - Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney Basin Bioregion (PCT 835)	Ecosystem	Recorded	20.70	3.23
Grey Box - Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin Bioregion (PCT 849)	Ecosystem	Recorded	18.11	6.09
Grey Box - Forest Red Gum grassy woodland on shale of the southern Cumberland Plain, Sydney Basin Bioregion (includes revegetation within Western Sydney Parklands and derived grasslands in Low condition) (PCT 850)	Ecosystem	Recorded	154.44	54.07
Hard-leaved Scribbly Gum - Parramatta Red Gum heathy woodland of the Cumberland Plain, Sydney Basin Bioregion (PCT 883)	Ecosystem	Recorded	0.93	0.38
Swamp Oak open forest on riverflats of the Cumberland Plain and Hunter valley (PCT 1800)	Ecosystem	Recorded	16.00	2.53
Dillwynia tenuifolia	Species	Recorded	464 plants	244 plants
Grevillea juniperina subsp. juniperina	Species	Recorded	32 plants	0
Marsdenia viridiflora subsp. viridiflora in the Bankstown, Blacktown, Camden, Campbelltown, Fairfield, Holroyd, Liverpool and Penrith Local Government Areas	Species	Recorded	Three plants	0
Pimelea spicata	Species	Recorded	0 (recorded 15 m to east of study area)	0

Biodiversity value	Ecosystem or species credit species	Identification method (assumed, recorded, expert report)	Area/ individuals within study area	Area/ individuals within construction footprint excluding certified areas (ha)
Pultenaea parviflora	Species	Recorded	278 plants	90 plants
Cumberland Plain Land Snail	Species	Assumed	6.00 ha	1.86 ha
Cave-dependent microbats: Eastern Bentwing-bat (breeding habitat) Little Bentwing-bat (breeding habitat)	Species	No breeding habitat present	0 ha	0 ha
Hollow-dependent microbats: Southern Myotis (breeding habitat)	Species	Potential breeding habitat recorded	1.54 ha	0.92 ha
Grey-headed Flying-fox (breeding)	Species	No camps recorded	0 ha	0 ha
White-bellied Sea-Eagle	Ecosystem	Recorded (breeding) Assumed (foraging)	One nest (breeding habitat) 11.98 ha (foraging habitat)	One nest (breeding habitat) 3.69 ha (foraging habitat)
Microbats (terrestrial foragers): Yellow-bellied Sheathtail-bat Eastern Freetail-bat Greater Broad-nosed Bat Eastern Bentwing-bat (foraging habitat) Little Bentwing-bat (foraging habitat) Eastern False Pipistrelle	Ecosystem	 Recorded Recorded Recorded Recorded Recorded Assumed	197.14 ha	55.58 ha
Microbats (aquatic foragers): Southern Myotis (foraging habitat)	Ecosystem	Assumed	11.98 ha (foraging habitat)	3.69 ha (foraging habitat)
Grey-headed Flying-fox (foraging habitat)	Ecosystem	Recorded	195.71 ha (foraging habitat)	55.20 ha (foraging habitat)

6.2 Biodiversity values outside the FBA

Biodiversity values that are known to occur in the study area, that have not been assessed under the FBA are summarised in **Table 6-2**. This includes migratory species listed under the EPBC Act, species, populations and communities listed under the FM Act, and GDEs (see **Table 6-2** below). Biodiversity values that are unconfirmed, but that are presumed to be present in the study area are also included in **Table 6-2**.

Table 6-2 Summary of biodiversity values outside the FBA

Biodiversity value	Overview of presence within the construction and operational footprint and identification method (assumed, recorded, expert report)	Area/individuals within project site
Migratory species	Low likelihood of occurrence, no important habitat.	N/A
GDEs	South Creek is considered to have a high potential to support aquatic GDEs.	Groundwater at creek crossings would not be abstracted and therefore no impacts on potential GDEs in these areas is expected.
	There is a moderate to high likelihood of GDEs occurring at the crossing of Cosgroves, Kemps, Badgerys and South Creeks.	

7 Avoid and minimise impacts

7.1 Overview

The project was developed through considering the relative merits of two alternative means of providing main road access between the existing metropolitan motorway network and the Western Sydney Airport:

- Alternative 1 – the base case, or 'do minimum' alternative of upgrading Elizabeth Drive
- Alternative 2 – construction of the M12 Motorway, an alternative route to Elizabeth Drive, between The Northern Road and the M7 Motorway.

The 'do nothing' option of maintaining the existing Elizabeth Drive without any upgrades was not considered to be a viable alternative for the project as it would not provide a dedicated access to the Western Sydney Airport site, whilst Elizabeth Drive, in its current state, as well as the surrounding road network, are already constrained. The 'do nothing' scenario would not be resilient enough to accommodate future traffic needs or contribute to growth at the Western Sydney Airport and the DPIE (Planning and Assessment) planned land use changes around the airport. As such, a 'do nothing' option was not considered to be a viable alternative, or representative of a base case for project decision making at this location so was not considered further.

The two selected alternatives have been considered and assessed based on the extent to which they can meet the project objectives and project assessment criteria and how well they perform against other transport, environmental, engineering, social and economic factors.

Chapter 4 of the EIS describes the project development and route alternatives in detail that were considered and explains how and why the project was selected as the preferred option. Further, Chapter 4 of the EIS outlines how particular elements of the project have been refined.

The FBA requires consideration of the steps taken to avoid and minimise the direct and indirect impacts of a development proposal on biodiversity values. Section 8.3.2 of the FBA sets out guidelines for the avoidance and minimisation of impacts to biodiversity during all phases of the project life cycle, including:

- Site selection phase
- Planning phase
- Construction phase
- Operational phase.

7.2 Site selection phase

Avoidance and minimisation of impacts have been considered at several project stages, including the route options analysis stage and through selection of the preferred option.

7.2.1 Route options development

The project went through a Strategic Route Options Analysis (SROA) process to identify the preferred route. The details and timeframe for this analysis is summarised in Section 4.2 of the EIS.

The process for the selection of the preferred route option included the following key stages:

- Stage 1: Identification of study area constraints – this stage included a review of existing information, identification of the study area and identification of environmental and technical constraints
- Stage 2: Identification and assessment of long list route options – this stage included the identification of a long list of 15 route options taking into consideration environmental and technical constraints, as well as assessment of these route options (Figure 4-1 in EIS)
- Stage 3: Identification and assessment of shortlisted route options – this stage included a review and refinement of the long list of route options to identify a short list of eight route options and undertake further desktop and field investigations of the shortlisted route options to further refine them against project objectives and assessment criteria (Figure 4-2 in EIS)

- Stage 4: Identification of preferred route option – the final stage in the options development phase included a review of shortlisted route options to identify the preferred route option and undertake further investigations of this preferred option.

7.2.2 Preferred option

A detailed description of the preferred option is presented in Section 5 of the EIS and summarised in **Section 1.2** of this report. The preferred option was chosen to balance WSIP program objectives which focus on connectivity to the Western Sydney Airport, demand for roads due to local residential growth and customer focus with environmental considerations.

The guidelines for the avoidance and minimisation of biodiversity impacts during the site selection phase as outlined in Sections 8.3.2.2 to 8.3.2.6 of the FBA, and the biodiversity assessment process undertaken for the project are summarised in **Table 7-1.**

7.3 Planning phase

The guidelines for the avoidance and minimisation of biodiversity impacts during the planning phase as outlined in Sections 8.3.2.7 to 8.3.2.8 of the FBA, and the biodiversity assessment process undertaken for the project are summarised in **Table 7-2**.

7.3.1 Impact minimisation

Where it is not possible to avoid impacts, ecological input during the remainder of the design process would focus on minimising impacts to biodiversity as far as possible, especially minimising the clearing of Cumberland Plain Woodland. The current design also provides bridges for all creek crossings which would assist in maintaining wildlife connectivity. Road design would incorporate suitably placed fauna fencing to reduce mortality risks from motor vehicles, which would further reduce impacts to wildlife. Further impact minimisation measures are detailed in **Chapter 10**.

Table 7-1 FBA guidelines for avoidance and minimisation of biodiversity impacts during the site selection phase

FBA section	FBA guidelines	Consistency of the project with FBA guidelines
8.3.2.2	Selecting a suitable development site for a Major Project or a route for linear projects, should be informed by knowledge of biodiversity values. An initial desktop assessment of biodiversity values would assist in identifying areas of native vegetation cover, EECs or CEECs, and potential habitat for threatened species.	Biodiversity considerations have continued to inform refinement of the design throughout the site selection phase from the development of a long list of route options through to the selection of the preferred option. Selection of a study area that is broader than the construction footprint allowed input from ecologists on an optimal design that best minimises potential impacts on Cumberland Plain Woodland. Where impacts are unavoidable, the selection of areas of poorer quality vegetation for removal would further minimise impacts on this CEEC.
8.3.2.3	Stage 1 of the FBA would provide the preliminary information necessary to inform project planning. Early consideration of biodiversity values is recommended in site selection, or route selection for linear projects, and the planning phase.	As above.
8.3.2.4	The site/route selection process should include consideration and analysis of the biodiversity constraints of the proposed development site and consider the suitability of the Major Project based on the types of biodiversity values present on the development site.	As above, assessment of biodiversity impacts was integral to the selection of the preferred option and the consideration of impacts influenced the selection of the preferred route.

FBA section	FBA guidelines	Consistency of the project with FBA guidelines
8.3.2.5	When considering and analysing the biodiversity constraints for the purpose of selecting a development site, the following matters should be addressed: (a) whether there are alternative sites within the property on which the proposed development is located where siting the proposed Major Project would avoid and minimise impacts on biodiversity values (b) how the development site can be selected to avoid and minimise impacts on biodiversity values as far as practicable (c) whether an alternative development site to the proposed development site, which would avoid adversely impacting on biodiversity values, might be feasible.	Biodiversity was considered as part of a detailed analysis of route options (Section 4.2 of the EIS). The route is restricted to a fairly narrow corridor due to the need to link infrastructure such as the Western Sydney Airport with nearby major roads such as the M7.
8.3.2.6	For linear projects, the route selection process must include consideration and an analysis of the biodiversity constraints of the various route options. In selecting a preferred option, loss of biodiversity values must be weighed up and justified against social and economic costs and benefits.	Refinements to the preferred option have been considered reducing social and economic impacts, while minimising impacts to biodiversity. Changes to the route within the Western Sydney Parklands in response to concerns from Western Sydney Parklands Trust.

Table 7-2 Planning phase FBA guidelines for avoidance and minimisation of biodiversity impacts

FBA section	FBA guidelines	Consistency of the project with FBA guidelines
8.3.2.7	Once a suitable development site has been selected, further analysis of the biodiversity constraints of the proposed development site can then be used to inform concept planning, project siting and design. This includes the proposed location of temporary construction infrastructure such as roads, camps, stockpile sites and parking bays.	Preliminary desktop research, detailed surveys and this BAR describe detailed investigations that are part of considerations for the development of the design of the project. Consideration in the planning phase has also been given to design elements such as fauna fencing and fauna crossings to prevent road kill and preserve connectivity. Ancillary infrastructure would be situated in areas of low biodiversity value to minimise impacts on native vegetation. Further mitigation measures are provided in **Chapter 10** of this report.
8.3.2.8	The Major Project should be located in areas where the native vegetation or threatened species habitat is in the poorest condition (ie areas that have a lower site value) or which avoid an EEC or CEEC. The following matters should be considered for this purpose: 1) siting of the project – the Major Project should be located in areas where the native vegetation or threatened species habitat is in the poorest condition (ie areas that have a lower site value score) or which avoid an EEC or CEEC.	Condition assessment has been carried out at 39 vegetation survey points across the study area. Where possible, native vegetation removal, particularly of good quality Cumberland Plain Woodland would be avoided. Ancillary infrastructure would be situated in areas of low biodiversity value to minimise impacts on native vegetation. Further mitigation measures are provided in **Chapter 10** of this report.

FBA section	FBA guidelines	Consistency of the project with FBA guidelines
	2) minimise the amount of clearing or habitat loss – the Major Project (and associated construction infrastructure) should be located in areas that do not have native vegetation, or in areas that require the least amount of vegetation to be cleared (ie the development footprint is minimised), and/or in areas where other impacts to biodiversity would be the lowest.	As above.
	3) loss of connectivity – some developments can impact on the connectivity and movement of species through areas of adjacent habitat. Minimisation measures may include providing structures that allow movement of species across barriers or hostile gaps.	The area is currently highly fragmented through urbanisation and existing roads. Limited connectivity through the study area is currently along creek systems, particularly Kemps Creek, Badgerys Creek and South Creek. Bridges, detailed planting for connectivity and fauna fencing for the project would be designed to maintain or enhance that connectivity where possible. The preferred footprint has been refined through the options development phase to realign it as far to the north through Western Sydney Parklands which has minimised the fragmentation and isolation of bushland patches in this area.
	4) other site constraints – any other constraints that the assessor has considered in determining the siting and layout of the Major Project, eg bushfire protection requirements including clearing for asset protection zones, flood planning levels, servicing constraints.	Yes. Minimising flood risk, maximising access to new airport, access to services for maintenance and traffic management for current and potential housing estates within the area.

7.4 Construction phase

The FBA also provides guidance on the minimisation of impacts during the construction phase of a major project. **Table 7-3** summarises the steps that would be taken to minimise impacts to biodiversity during construction. Further information is provided in **Chapter 10** of this document.

Table 7-3 Summary of how impacts would be minimised during construction and how these actions address FBA guidelines

FBA section	FBA guidelines	Consistency of the project with FBA guidelines
8.3.2.9	The construction phase of the Major Project can have direct impacts on biodiversity values that are additional to the impacts which occur during the site selection and planning phase. These impacts must be avoided and minimised during the construction phase of the project where reasonable.	A construction environmental management plan (CEMP) would be developed prior to any work commencing. This document would include standard methods to reduce environmental impacts and would include a flora and fauna sub-plan that details methods to reduce impacts during construction on biodiversity, especially threatened species and communities.
8.3.2.10	a) method of clearing – using a method of clearing during the construction phase that avoids damage to retained native vegetation and reduces soil disturbance. For example, removal of native vegetation by chain-saw, rather than heavy machinery, is preferable in situations where partial clearing is proposed.	Clearing would be in accordance Biodiversity Guidelines: Protecting and managing biodiversity RTA projects (RTA, 2011). This includes a two stage approach to clearing whereby non-habitat trees are removed first, allowing animals to escape prior to the removal of habitat trees. Refer to **Chapter 10** for further information.

FBA section	FBA guidelines	Consistency of the project with FBA guidelines
	b) clearing operations – minimising direct harm to native fauna during actual construction operations through onsite measures such as undertaking pre-clearing surveys, daily fauna surveys and the presence of a trained ecologist during clearing events.	Biodiversity Guidelines: Protecting and managing biodiversity RTA projects (RTA, 2011), pre-clearing surveys would be completed and an ecologist would be on-site during clearing.
	c) timing of construction – identifying reasonable measures that minimise the impacts on biodiversity. For example, timing construction activities for when migratory species are absent from the site, or when particular species known to or likely to use the habitat on the site are not breeding or nesting, can minimise the impacts of construction activities on biodiversity.	As far as practicable, breeding season for hollow-nesting species would be avoided to reduce potential impacts on breeding success.
	d) other measures that minimise inadvertent impacts of the Major Project on the biodiversity values – measures such as installing temporary fencing to protect significant environmental features such as riparian zones, promoting the hygiene of construction vehicles to minimise spread of weeds or pathogens, appropriately training and inducting project staff and contractors so that they can implement all measures that minimise inadvertent adverse impacts of the Major Project on biodiversity values.	"No go" zones would be established to prevent accidental impacts to retained vegetation, especially around TECs and areas of retained threatened flora. Protocols to minimise spread of disease through vehicle or human transport of diseases (eg Phytophthora and Chytrid) would be included in the CEMP. Further information can be found in RTA (2011).

7.5 Operational phase

The FBA provides guidelines for the minimisation of biodiversity impacts during the operational phase of a Major Project. For the project, an Operational Management Plan would be developed to provide guidance on reducing impacts to biodiversity during the operation of the project. FBA guidelines for Operational Phase measures are summarised in **Table 7-4** below.

Table 7-4 FBA guidelines for Operational Phase measures to reduce impacts to biodiversity and how these would be met for the project

FBA section	FBA guidelines	Consistency of the project with FBA guidelines
8.3.2.11	The proponent should consider implementing reasonable measures to avoid and minimise any impacts that may occur during the operational phase of the Major Project that are additional to the impacts which occurred during the site selection, planning and construction phases.	An Operational Environmental Management Plan (OEMP) would be developed and approved prior to the beginning of operation on the project. This document would include standard methods to reduce environmental impacts and would include a flora and fauna sub-plan that details methods to reduce impacts on biodiversity during operation of the road, especially threatened species and communities.
8.3.2.12	a) seasonal impacts – whether there are likely to be any impacts that occur during specific seasons. Minimisation measures may include amending operational times to minimise impacts on biodiversity during periods when seasonal events such as breeding, or species migration occur.	There may be variation in dispersal patterns of local fauna, however maintaining fencing along the footprint would minimise impacts to species year-round.
	b) artificial habitats – using 'artificial habitats' for fauna where they may be effective in minimising impacts on such fauna. These include nest boxes, glider-crossings or habitat bridges.	A pre-clearing survey would identify the number and type of hollows to be removed and if necessary, artificial nest boxes would be installed prior to clearing (as part of CEMP, before construction phase). Fauna crossing of the road would be primarily be under bridges, Further information is in **Chapter 10**.

8 Impact assessment

8.1 Areas not requiring further assessment

The following areas do not require further assessment, either because they fall below the threshold outlined in the FBA or because they have been assessed under an alternative statutory process.

8.1.1 FBA assessment thresholds

In accordance with the FBA, areas that do not require assessment include land without native vegetation (as per the definition under the *Native Vegetation Act 2003*), unless the area of land requires assessment under the SEARs.

Other areas not requiring offsets as identified in the FBA include:

- Impacts on PCTs that have a site value score of less than 17
- Areas not identified as critically endangered ecological communities (CEECs) or endangered ecological communities (EECs)
- Impacts on PCTs that are not associated with threatened species habitat and are not identified as CEECs/EECs
- Impacts on non-threatened species and populations that do not form part of a CEEC or EEC
- Impacts on threatened species habitat associated with a PCT within a vegetation zone with a site value score of less than 17.

One vegetation zone within the construction footprint, Grey Box – Forest Red Gum grassy woodland on shale of the southern Cumberland Plain, Sydney Basin Bioregion – Low condition, was identified as having a site value score of less than 17 (13.77). As such, impacts to this vegetation zone do not require assessment.

8.1.2 Biodiversity certified land

Certified areas within the Growth Centres SEPP, which have already been subject to assessment as part of the certification of this area, are mapped within **Figure 2-1**. This portion consists of a linear corridor adjoining Elizabeth Drive, as well as the land south of Elizabeth Drive and west of Range Road. Of the 17.38 hectares of certified land in the construction footprint, 4.1 hectares are located within the Western Sydney Parklands, within the linear corridor adjoining Elizabeth Drive. While the certified areas are included in the biodiversity study area, they have been excluded from impact assessment calculations under the FBA (further detail on certified areas is provided in **Table 8-1**).

According to the definitions in schedule 1 of the biodiversity certification order:

> *"existing native vegetation" means areas of indigenous trees (including any sapling) that:*
>
> *(a) had 10% or greater over-storey canopy cover present,*
>
> *(b) were equal to or greater than 0.5 ha in area, and*
>
> *(c) were identified as "vegetation" on maps 4 and 5 of the draft Growth Centres Conservation Plan*

Most of the 8.19 hectares of native vegetation identified in the certified areas of the South West Growth Centre meets criteria (a) and (b) for existing native vegetation (ENV), however only 1.43 hectares within the construction footprint were identified as 'vegetation' on maps 4 and 5 of the draft Growth Centres Conservation Plan (ELA, 2007) (**Figure 1-4**). Impacts to areas of ENV within certified areas are offset using funds from special infrastructure contributions that apply within the Growth Centres, as determined during precinct planning. Offsets are therefore not required for the biodiversity impacts of the project within the certified areas.

Table 8-1 Plant Community Types mapped within certified land

TEC Name	TSC Act Status	EPBC Act status*	PCT No(s)	Area within study area (ha)	Area within construction footprint (ha)	Area within construction footprint and within certified areas (ha)
Shale Gravel Transition Forest in the Sydney Basin Bioregion	E	CE	724	12.82	6.91	0
Cooks River/Castlereagh Ironbark Forest in the Sydney Basin Bioregion	E	CE	725	0.50	0	0
Moist Shale Woodland in the Sydney Basin Bioregion	E	CE	830	4.97	0.44	0
River-Flat Eucalypt Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions	E	Not listed	835	20.70	3.23	0
Cumberland Plain Woodland in the Sydney Basin Bioregion	CE	CE	849 850	172.55 (includes 66.02 ha of revegetation and 31.33 ha of derived native grassland in Low condition)	68.35 (includes 22.74 ha of revegetation and 18.07 ha of derived native grassland in Low condition)	8.19 (includes 0.09 ha of revegetation)
Swamp oak floodplain forest of the NSW North Coast, Sydney Basin and South East Corner bioregions	E	E	1800	16.00	2.53	0
Total				**227.54**	**81.46**	**8.19**

CE = Critically Endangered, E = Endangered, V = Vulnerable

*Not all areas meet the criteria for the listed EPBC TEC

8.2 Areas requiring assessment

The following sections identify the impacts that require assessment under the FBA.

8.2.1 Removal of native vegetation

Construction of the project requires the removal of native vegetation that occurs in the construction footprint.

Direct impacts

The construction footprint, excluding certified areas, contains about 73.65 hectares of PCTs. Much of this vegetation exists in small fragmented patches which have been disturbed by agricultural and industrial developments and exist in varying conditions. There are also some larger areas of remnant, regrowth and revegetated bushland in and adjoining the construction footprint, in the Western Sydney Parklands and around Clifton Avenue. The areas of each vegetation zone that would be directly impacted are listed in **Table 8-2**.

Table 8-2 Direct impacts to native vegetation

PCT	Condition	Per cent cleared	Area within construction footprint excluding certified areas (ha)
Broad-leaved Ironbark - Grey Box - Melaleuca decora grassy open forest on clay/gravel soils of the Cumberland Plain, Sydney Basin Bioregion (PCT 724)	Moderate/ Good_High	75	3.50
	Moderate/ Good_Medium	75	2.96
	Moderate/ Good_Poor	75	0.45
Forest Red Gum - Grey Box shrubby woodland on shale of the southern Cumberland Plain, Sydney Basin Bioregion (PCT 830)	Moderate/ Good_Poor	75	0.44
Forest Red Gum - Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney Basin Bioregion (PCT 835)	Moderate/ Good_Poor	93	3.23
Grey Box - Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin Bioregion (PCT 849)	Moderate/ Good_Medium	93	3.54
	Moderate/ Good_Poor	93	2.07
	Moderate/ Good_Other (Derived Shrubland)	93	0.48
Grey Box - Forest Red Gum grassy woodland on shale of the southern Cumberland Plain, Sydney Basin Bioregion (PCT 850)	Moderate/ Good_High	88	3.21
	Moderate/ Good_Medium	88	10.14
	Moderate/ Good_Other (Revegetation)	88	22.65
	Low	88	18.07
Hard-leaved Scribbly Gum - Parramatta Red Gum heathy woodland of the Cumberland Plain, Sydney Basin Bioregion (PCT 883)	Poor	50	0.38
Swamp Oak open forest on riverflats of the Cumberland Plain and Hunter valley (PCT 1800)	Moderate/ Good_Poor	60	2.53
Total			**73.65**

All areas of native vegetation to be removed fall within the criteria of TECs listed under the TSC Act and/or the EPBC Act. The areas of each TEC that would be directly impacted are listed in **Table 8-3**.

Table 8-3 Direct impacts to Threatened Ecological Communities

PCT No.	PCT Name	Equivalent TECs	Total area directly impacted (ha)	Area impacted meeting EPBC TEC criteria (ha)
724	Broad-leaved Ironbark - Grey Box - Melaleuca decora grassy open forest on clay/gravel soils of the Cumberland Plain, Sydney Basin Bioregion	Shale Gravel Transition Forest in the Sydney Basin Bioregion (Endangered, TSC Act) Cumberland Plain Shale Woodlands and Shale-Gravel Transition Forest (Critically Endangered, EPBC Act)	6.91	4.86
830	Forest Red Gum - Grey Box shrubby woodland on shale of the southern Cumberland Plain, Sydney Basin Bioregion	Moist Shale Woodland in the Sydney Basin Bioregion (Endangered, TSC Act; Critically Endangered, EPBC Act)	0.44	0.44
835	Forest Red Gum - Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney Basin Bioregion	River-Flat Eucalypt Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions (Endangered, TSC Act)	3.23	N/A – not listed
849	Grey Box - Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin Bioregion	Cumberland Plain Woodland in the Sydney Basin Bioregion (Critically Endangered, TSC Act) Cumberland Plain Shale Woodlands and Shale-Gravel Transition Forest (Critically Endangered, EPBC Act)	6.09	1.61
850	Grey Box - Forest Red Gum grassy woodland on shale of the southern Cumberland Plain, Sydney Basin Bioregion		54.07	32.01
1800	Swamp Oak open forest on riverflats of the Cumberland Plain and Hunter valley	Swamp oak floodplain forest of the NSW North Coast, Sydney Basin and South East Corner bioregions (Endangered, TSC Act and EPBC Act)	2.53	0
Total			**73.27**	**38.92**

Indirect impacts

The project will also result in indirect impacts to some areas of native vegetation adjoining the construction footprint, mainly due to fragmentation of vegetation and creation of new edges, which may result in edge effects. Edge effects are discussed further in **Section 8.5.5** of this report.

Across most of the study area and construction footprint, patches of native vegetation are small, fragmented and contain no core habitat. Much of this vegetation is already situated adjacent to an existing cleared edge, often a road, and is subject to ongoing disturbance. As such, many of the areas of vegetation within and directly adjacent to the construction footprint are already subject to considerable edge effects. Most areas of riparian woodland adjoining creeks that intersect the construction footprint have a highly disturbed understorey, with reduced native ground cover, high exotic ground cover and soil and landform disturbance from erosion and grazing.

In some areas of Western Sydney Parklands and along Clifton Avenue, the construction footprint crosses through some larger patches of native vegetation in Moderate/Good condition, including revegetated areas. Within these larger areas it is likely that the project would increase the potential for edge effects to occur.

Edge effects resulting from the formation of new edges could extend up to 30 metres into areas of adjoining native vegetation. This number is based on extensive site inspections in the study area, and observations of the existing level of disturbance and fragmentation within the native vegetation adjoining the construction footprint, given that it is currently located in proximity to major roads and the M7 Motorway.

A 30 metre buffer was applied from the edge of the construction footprint and an analysis of native vegetation mapped within the buffer zone was conducted. The analysis focused on the potential for edge effects such as changes to vegetation structure, increase in exotic species cover and alteration of microhabitats to occur within the buffer zone as a result of the project. Five categories for potential edge effects were determined, as listed in **Table 8-4**, and the categories were mapped (**Figure 8-1**, **Figure 8-2**).

Table 8-4 Potential for edge effects in vegetation within 30 metres of the construction footprint in Western Sydney Parklands and adjoining Clifton Avenue

Category	Description	Area of vegetation within 30 metre buffer excluding certified areas (ha)
Non-viable fragment	Small fragments of vegetation (<0.2 ha) left between clearing or adjacent to other permanent disturbance. These vegetation fragments are considered no longer likely to be viable in the long term. This vegetation is located between the construction footprint and Elizabeth Drive.	0.31
New edge	Vegetation patch will be fragmented by the construction footprint to form one or more new edges within previously unfragmented vegetation. Note some of these areas are still currently subject to disturbance.	12.42
Existing edge	Vegetation edge adjoins or only slightly overlaps the construction footprint; therefore, the existing edge effects are unlikely to increase. Most of these areas are adjacent to the M7 Motorway in the south-east of the construction footprint.	4.47
Existing edge set back	Vegetation edge is set back from the construction footprint, often separated by a track or other clearing, therefore the existing edge effects are unlikely to increase.	0.62
Fragmented and disturbed	Vegetation within the patch is currently fragmented and disturbed with a scattered overstorey and open understorey with high exotic cover, therefore new edges are unlikely to result in substantial alteration to these areas of vegetation. Most of these areas occur in the western part of the Western Sydney Parklands and are fragmented by bicycle tracks.	1.89
Total		**19.49**

The analysis of potential for edge effects found:

- A total of 0.31 hectares of native vegetation (including 0.30 hectares of revegetation) within Western Sydney Parklands would be subject to increased edge effects to the extent they would become unviable due to the small size of the remaining patches
- A total of 12.42 hectares of native vegetation (including 6.73 hectares of revegetation) within Western Sydney Parklands and east of Clifton Avenue would be subject to increased edge effects as a result of the project due to the creation of one or more new edges within previously unfragmented vegetation.

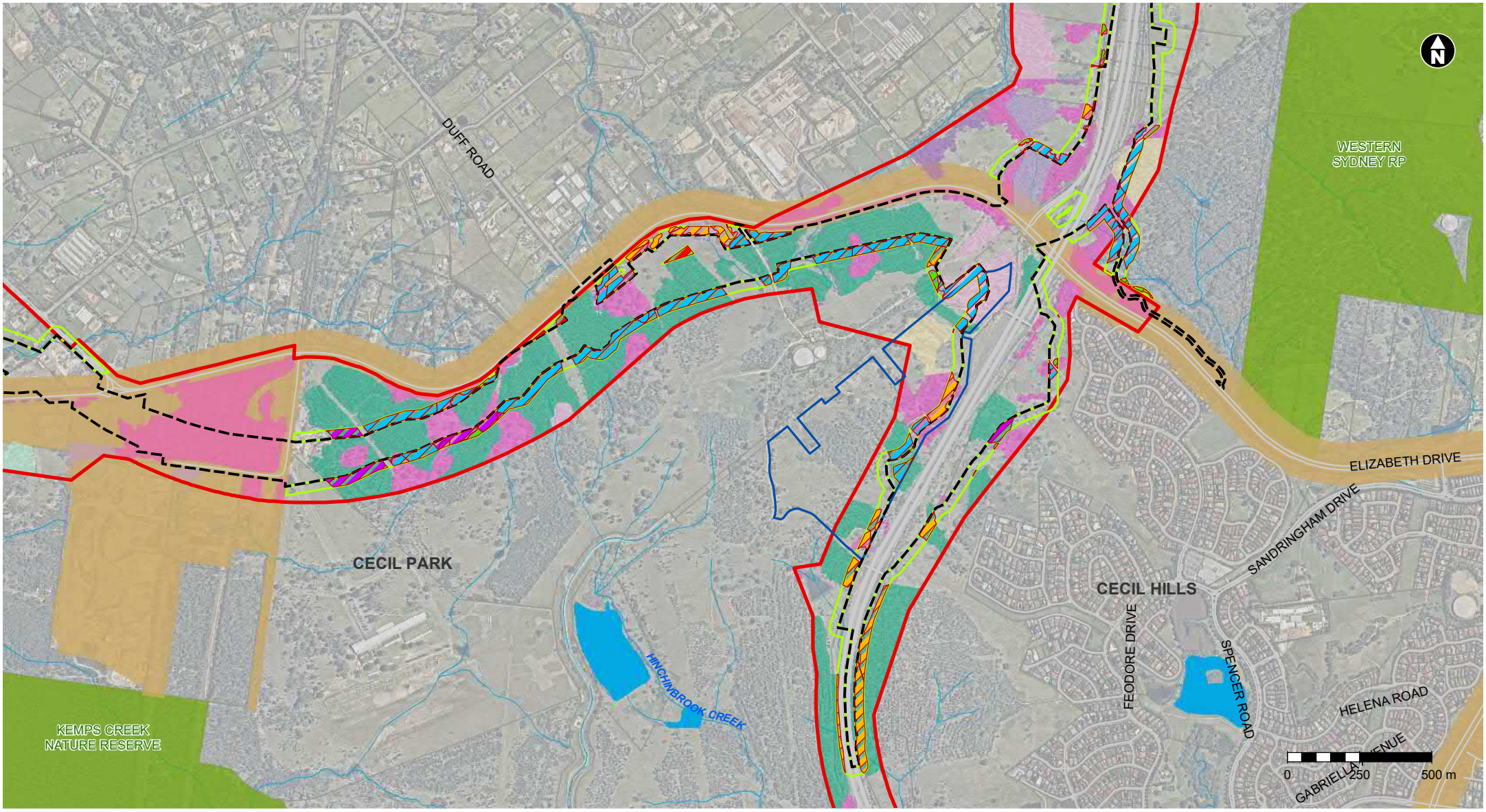
All areas of indirect impact meet the criteria for TSC Act listed TECs, and 12.63 hectares of the total 12.73 hectares impacted meet the criteria for the EPBC Act listed TEC The indirect impacts of the project on native vegetation are detailed in **Table 8-5**. Offsets for these impacts are considered in **Chapter 11.**

Table 8-5 Native vegetation subject to indirect impacts (potential edge effects)

Location	PCT	Condition	Area of indirect impacts (ha)
Western Sydney Parklands (excluding certified areas)	**Non-viable fragments**		
	Grey Box - Forest Red Gum grassy woodland on shale of the southern Cumberland Plain, Sydney Basin Bioregion (PCT 850)	Moderate/ Good_Medium	0.01
		Moderate/ Good_Other (Revegetation)	0.30
	New edges		
	Forest Red Gum - Grey Box shrubby woodland on shale of the southern Cumberland Plain, Sydney Basin Bioregion (PCT 830)	Moderate/ Good_Poor	0.54
	Grey Box - Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin Bioregion (PCT 849)	Moderate/ Good_Medium	0.24
	Grey Box - Forest Red Gum grassy woodland on shale of the southern Cumberland Plain, Sydney Basin Bioregion (PCT 850)	Moderate/ Good_High	1.06
		Moderate/ Good_Medium	3.33
		Moderate/ Good_Other (Revegetation)	6.73
	Total Western Sydney Parklands		**12.21**
East of Clifton Avenue	Broad-leaved Ironbark - Grey Box - Melaleuca decora grassy open forest on clay/gravel soils of the Cumberland Plain, Sydney Basin Bioregion (PCT 724)	Moderate/ Good_High	0.52
	Total East of Clifton Avenue		**0.52**
Grand total			**12.73**

Impacts to native vegetation within M7 Biobank site

The construction footprint overlaps a Biobank site in Western Sydney Parklands, located to the south-west of the M7/Elizabeth Drive intersection. About 2.89 hectares of the Biobank site is within the construction footprint, comprising a strip along the eastern boundary ranging from about 10 metres to 80 metres wide. Of the 73.65 hectares of native vegetation mapped within the construction footprint, about 1.85 hectares are located within the Biobank site. The areas of each vegetation zone within the Biobank site that would be directly and indirectly impacted are listed in **Table 8-6**. It should be noted that the vegetation impacts within the Biobank site are included in the total native vegetation impact calculations, as listed in **Table 8-2** and **Table 8-4**, and are not additional.



Study area corridor
The project construction footprint
Western Sydney Parklands
NPWS Reserves
Biodiversity certified land
Biobank site

30 m buffer around construction footprint, excluding certified areas
Cadastre
Waterways

Vegetation Zones
830 - Moderate/Good - Poor
835 - Moderate/Good - Poor
849 - Moderate/Good - Medium
849 - Moderate/Good - Poor
850 - Moderate/Good - High
850 - Moderate/Good - Medium
850 - Moderate/Good -Other (Revegetation)

Potential for Edge Effects
Non-viable fragment
New edge
Existing edge
Existing edge set back
Fragmented and disturbed

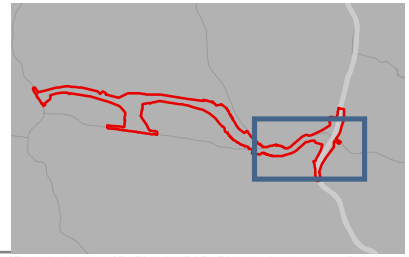


Figure 8-1 Indirect impacts to native vegetation in Western Sydney Parklands

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Table 8-6 Direct and indirect impacts to native vegetation in the Biobank site

PCT	Condition	TSC Act Status	EPBC Act Status	Area within construction footprint excluding certified areas (ha)	Area within 30 metres of the construction footprint and subject to indirect impacts (ha)
Grey Box - Forest Red Gum grassy woodland on shale of the southern Cumberland Plain, Sydney Basin Bioregion	Moderate/ Good_High	CE	CE	1.17	0.64
	Moderate/ Good_Medium	CE	CE	0.35	0.19
	Moderate/ Good_Other (Revegetation)	CE	CE	0.33	0.69
Total				**1.85**	**1.52**

CE = Critically Endangered

8.2.2 Removal of threatened fauna habitat

Fauna habitat within the study area includes about 197.14 hectares of Woodland and Riparian Forest, about 684.54 hectares of Grassland, and about 11.98 hectares of Wetlands and Watercourses. About 55.58 hectares of Woodland and Riparian Forest habitat, about 275.05 hectares of Grassland habitat, and about 3.69 hectares of Wetlands and Watercourses would be removed from the construction footprint, excluding certified areas, as a result of the project.

This Section discusses impacts to habitat of the threatened species, populations, and communities listed in **Table 6-1**. Impacts to habitat of presumed present species (see also **Table 6-1**) are also discussed.

Species credit species

The study area supports about six hectares of riparian forest habitat along Badgerys Creek assumed to provide suitable habitat for the Cumberland Plain Land Snail. This species was not detected within the study area during targeted surveys but was recorded immediately adjacent to the study area during subsequent surveys, unrelated to the project. Given the proximity of this record, the similarity of habitat quality and habitat connectivity the Cumberland Plain Land Snail is therefore assumed present within the adjacent riparian forest habitat along Badgerys Creek within the study area.

The study area provides suitable foraging habitat for the Southern Myotis which is assumed to be present within the study area (see further details below in Ecosystem credit species sub-section). This is a species credit species where potential breeding habitat occurs. The study area supports about 1.54 hectares of potential breeding habitat for the Southern Myotis, represented as a 10 metre radius surrounding 52 hollow-bearing trees within 200 metres of riparian zones (**Table 8-7**).

Potential impacts to species credit threatened fauna species are summarised in **Table 8-7** below.

Table 8-7 Summary of impacts to species credit threatened fauna

Threatened fauna species	Status		Area of habitat within the study area (ha)	Potential area of habitat to be impacted excluding certified areas (ha)
	TSC Act	EPBC Act		
Cumberland Plain Land Snail	E	Not listed	6.00	1.86
Southern Myotis	V	Not listed	1.54	0.92

E = Endangered, V = Vulnerable

Ecosystem credit species

The study area provides about 197.14 hectares of habitat for seven ecosystem credit threatened bat species including:

- Grey-headed Flying-fox (foraging habitat only)
- Eastern Bentwing-bat (foraging habitat only)
- Little Bentwing-bat (foraging habitat only)
- Eastern Freetail-bat
- Eastern False Pipistrelle
- Greater Broad-nosed Bat
- Yellow-bellied Sheathtail-bat.

It is anticipated that the construction footprint would require removal of about 55.58 hectares of Woodland and Riparian Forest habitat used as foraging habitat for these threatened microbat species.

Field surveys recorded a total of 94 hollow-bearing live trees and stags. The construction footprint is anticipated to require removal of 54 hollow-bearing trees. Hollow-bearing trees in Woodland and Riparian Forest habitats are assumed to provide roosting habitat for Eastern Freetail-bat, Eastern False Pipistrelle, Greater Broad-nosed Bat and Yellow-bellied Sheathtail-bat. These four threatened hollow-dependent microbats are all ecosystem credit species. Removal of roosting and breeding resources for these species is therefore assumed as a component of ecosystem credits.

No other threatened hollow-dependent fauna was recorded or assumed present within the study area. Given the results of surveys and condition of habitat present it is not anticipated that removal of 54 hollow-bearing trees from the construction footprint would result in impacts to any other threatened hollow-dependent fauna.

The study area supports about 11.98 hectares of wetlands and watercourses that provide suitable foraging habitat for Southern Myotis (ecosystem credit species for foraging habitat) and the White-bellied Sea-Eagle. The project would involve the removal of 3.69 hectares of foraging habitat (within the construction footprint and excluding the certified area) for these two species.

The study area also supports one active White-bellied Sea-Eagle nest (see **Figure 4-2**). This habitat feature is anticipated to require removal from within the construction footprint. Appropriate licenses for relocation and best practice protocols would be required (see **Table 10-1**).

The Grey-headed Flying-fox is the only EPBC listed species recorded or assumed present within the study area. This species is a dual-credit species under the FBA. For the Grey-headed Flying-fox, species credits are only required for impacts to breeding habitat. As the study area does not provide breeding habitat for this species no species credits are required. The Grey-headed Flying-fox is considered an ecosystem credit species where only foraging habitat would be impacted. Therefore, removal of foraging habitat for this species is a component of ecosystem credits.

8.2.3 Removal of threatened flora

The project would result in direct impacts to two threatened plant species: *Pultenaea parviflora* (listed as Endangered under the TSC Act and Vulnerable under the EPBC Act) and *Dillwynia tenuifolia* (listed as Vulnerable under the TSC Act).

Of the 260 individuals of *Pultenaea parviflora* recorded around Clifton Avenue, 90 are situated within the construction footprint and would be removed as a result of the project. While a comprehensive stem count of the species has not been finalised due to property access limitations, it is likely that more individuals of the species occur along Clifton Avenue, and there is potentially a larger population in this area. The majority of relatively intact habitat for the population of *Pultenaea parviflora* around Clifton Avenue would be removed, leaving mostly disturbed roadside fragments.

There are about 140 plants of *Pultenaea parviflora* located within one to 15 metres of the western edge of the construction footprint where it overlaps Clifton Avenue, 139 of which are situated in a thin strip of roadside vegetation between Clifton Avenue and cleared industrial land to the west. These individuals would be further isolated from other populations of the species as a result of the project, however they are already subject to impacts of fragmentation and edge effects, and further indirect impacts as a result of the project are unlikely, provided suitable site controls are implemented.

An additional 18 plants of *Pultenaea parviflora* are located on the boundary of the construction footprint and biodiversity certified land, in the Western Sydney Parklands, at the northern edge of a patch of native vegetation adjoining a cleared easement. At minimum, removal of native vegetation from the construction footprint would reduce the area of habitat that the 18 plants of *Pultenaea parviflora* are located within to the narrow corner of a triangular patch of retained native vegetation, cleared on both sides. It is likely that clearance of native vegetation within the construction footprint would result in the loss of these individuals due to fragmentation and degradation of the roadside habitat from edge effects.

There are 244 plants of *Dillwynia tenuifolia* located within the construction footprint, recorded from patches of Broad-leaved Ironbark – Grey Box – Melaleuca decora grassy open forest on clay/gravel soils of the Cumberland Plain, Sydney Basin Bioregion to the north-east and west of Clifton Avenue.

There are about 44 plants of *Dillwynia tenuifolia* located within one to 15 metres of the western edge of the construction footprint where it overlaps Clifton Avenue, all of which are situated in a thin strip of roadside vegetation between Clifton Avenue and cleared industrial land to the west. These individuals would be further isolated from other populations of the species as a result of the project, however they are already subject to impacts of fragmentation and edge effects, and further indirect impacts as a result of the project are unlikely, provided suitable site controls are implemented.

Forty-nine additional plants of *Dillwynia tenuifolia* may be indirectly impacted by edge effects, including weeds and sedimentation, due to their location within 30 metres of the eastern edge of the construction footprint. The indirect impacts to native vegetation that forms habitat for these plants have been considered in **Section 8.2.1.**

Two other threatened flora species were recorded in the study area: *Grevillea juniperina* subsp. *juniperina* (listed as Vulnerable under the TSC Act) and *Marsdenia viridiflora* subsp. *viridiflora,* part of the population in the Bankstown, Blacktown, Camden, Campbelltown, Fairfield, Holroyd, Liverpool and Penrith Local Government Areas (listed as an Endangered Population under the TSC Act).

Another threatened flora species, *Pimelea spicata* (listed as Endangered under the TSC Act and EPBC Act) was recorded just outside the study area. These three species were recorded about 70 to 90 metres from the edge of the construction footprint, and it is unlikely that there would be indirect impacts to these species as a result of the project.

The numbers of individuals of each threatened flora species recorded in the study area and an estimate of how many would be directly and indirectly impacted as a result of the project are listed in **Table 8-8**, overleaf. The direct impacts to *Dillwynia tenuifolia* and *Pultenaea parviflora* are shown in **Figure 8-2**.

Table 8-8 Summary of threatened flora species impacts

Threatened species	Can the species withstand further loss?	Applicable negligible loss	Status		Individuals in the study area	Individuals to be directly impacted excluding certified areas	Individuals to be potentially indirectly impacted
			TSC Act	EPBC Act			
Dillwynia tenuifolia	No	50	V	-	464	244	49
Grevillea juniperina subsp. juniperina	No	5	V	-	32	0	0

Threatened species	Can the species withstand further loss?	Applicable negligible loss	Status		Individuals in the study area	Individuals to be directly impacted excluding certified areas	Individuals to be potentially indirectly impacted
			TSC Act	EPBC Act			
Marsdenia viridiflora subsp. viridiflora in the Bankstown, Blacktown, Camden, Campbelltown, Fairfield, Holroyd, Liverpool and Penrith Local Government Areas	No	0	EP	-	3	0	0
Pimelea spicata	No	2	E	E	0 (recorded 15 m to east of study area)	0	0
Pultenaea parviflora	No	10	E	V	278	90	0

EP = Endangered Population, E = Endangered, V = Vulnerable

8.3 Matters for further consideration

Under the FBA, certain impacts on biodiversity values require further consideration by the relevant consent authority. These are impacts that are considered to be complicated or severe, and a decision would be made by the relevant consent authority on whether it is appropriate for these impacts to occur, and whether additional offsets, supplementary measures or other actions may be required.

The project would result in two types of impact that require further consideration:

- Impacts that would substantially reduce the width of vegetation in the riparian buffer zone bordering rivers and streams 4th order or greater
- Any impact on a critically endangered ecological community (unless specifically excluded in the SEARs) because it is likely to:
  - cause the extinction of the CEEC from the IBRA subregion, or;
  - significantly reduce the viability of the CEEC.

Matters for further consideration are shown below in Figure **8-3**.

8.3.1 Riparian corridors

The project would result in impacts to the riparian buffers of the following four creeks that are fourth order streams according to the Strahler (1952) classification system:

- Cosgroves Creek
- Badgerys Creek
- South Creek
- Kemps Creek.

Riparian buffers of the creeks were determined according to Annexure 2 of the FBA. Fourth order streams were assigned a 40 metre buffer on either side of the centreline of the creek.
Complete removal of the riparian vegetation would occur at each of the four creeks for the construction of bridges resulting in gaps of up to 110 metres in length along the riparian corridors.

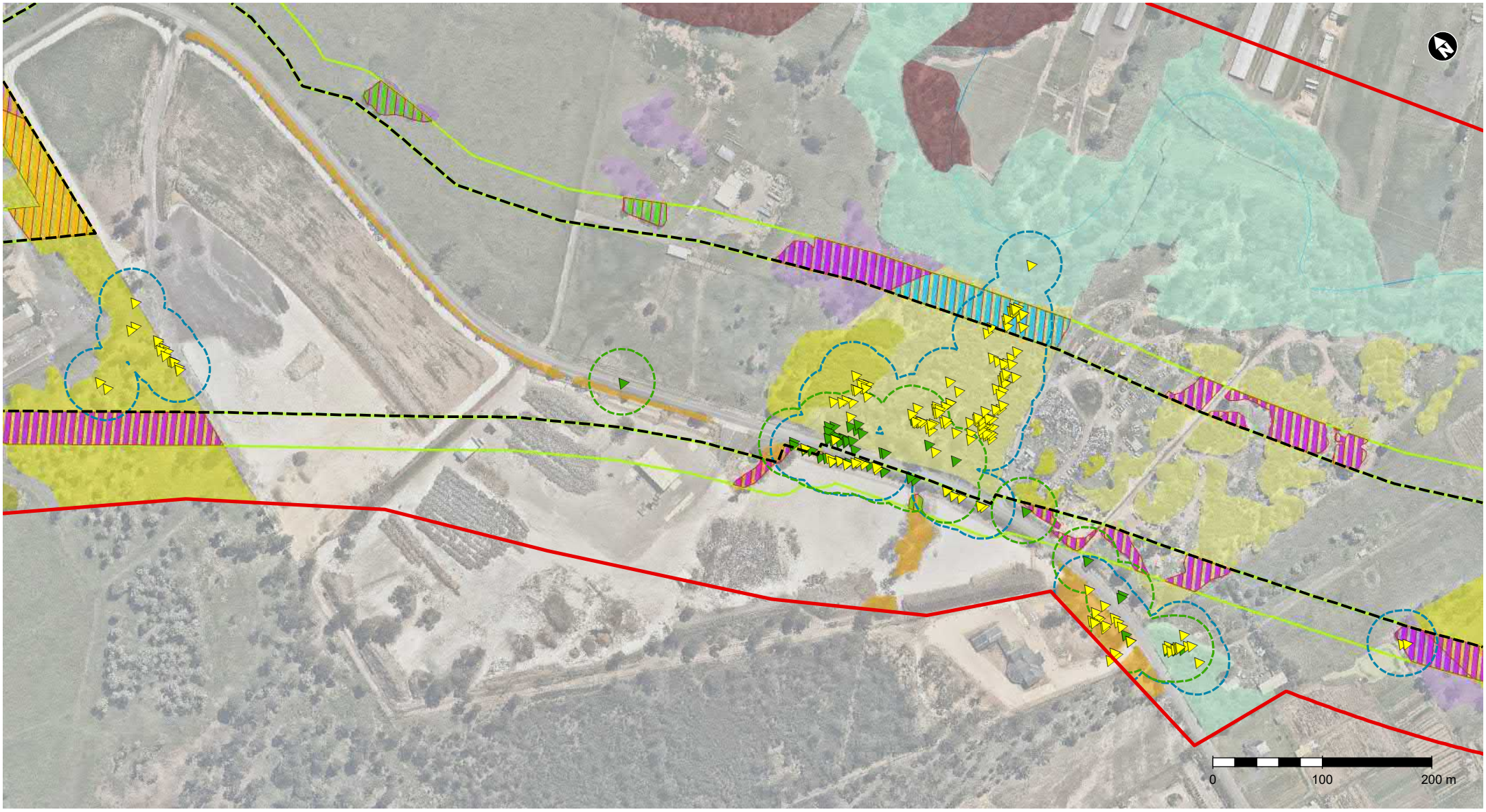

Figure 8-2 Direct and indirect impacts to threatened flora species

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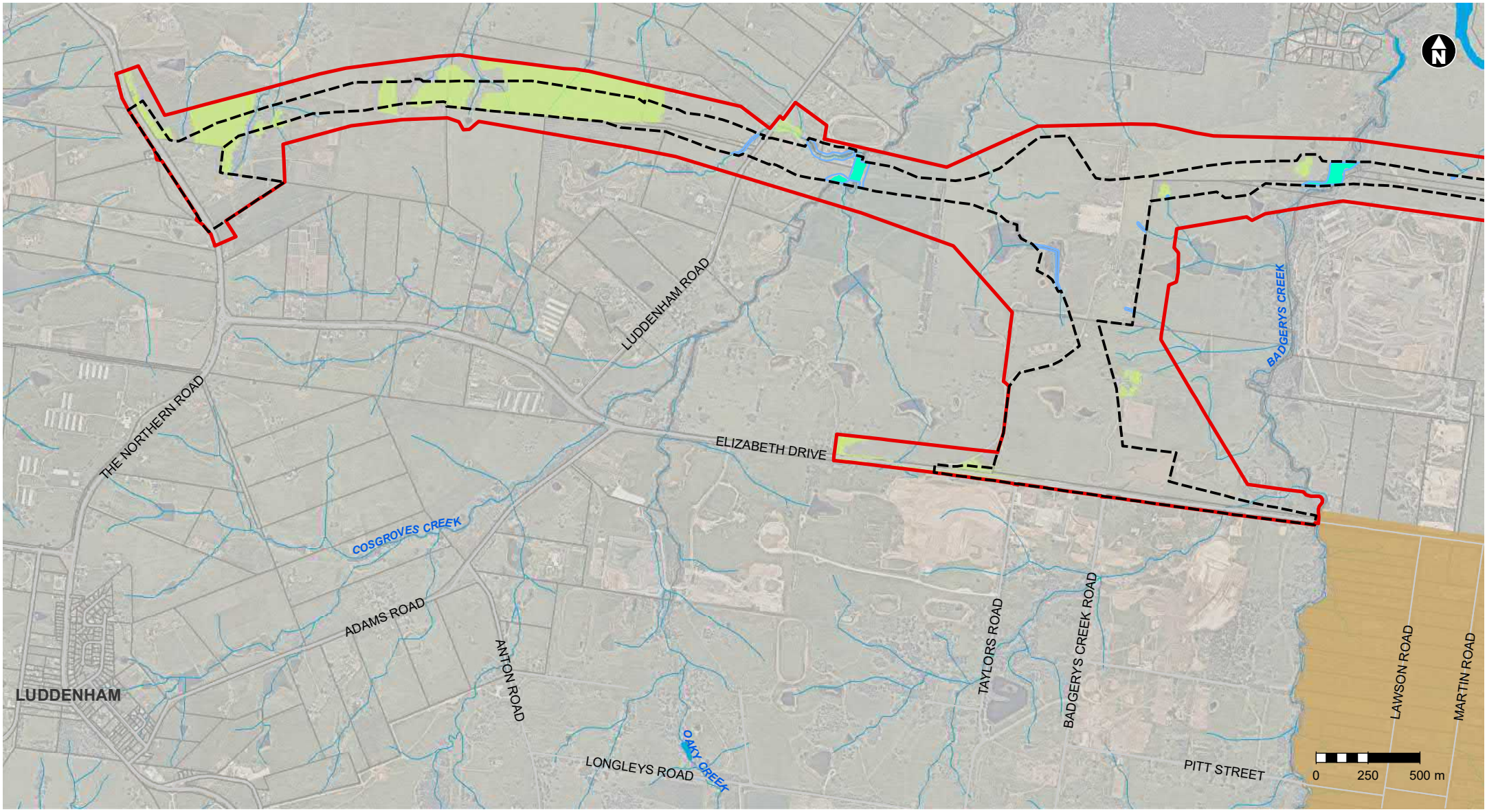

Study area corridor
The project construction footprint
Cadastre
Western Sydney Parklands
Biodiversity certified land
NPWS Reserves
Riparian buffer area
Riparian vegetation
Threatened Ecological Communities (TEC)
Cumberland Plain Woodland in the Sydney Basin Bioregion

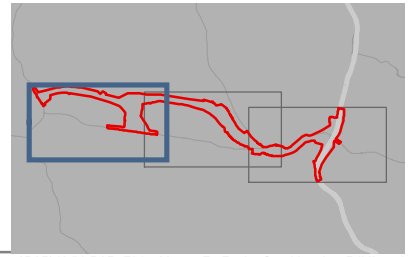

Figure 8-3 Matters for further consideration

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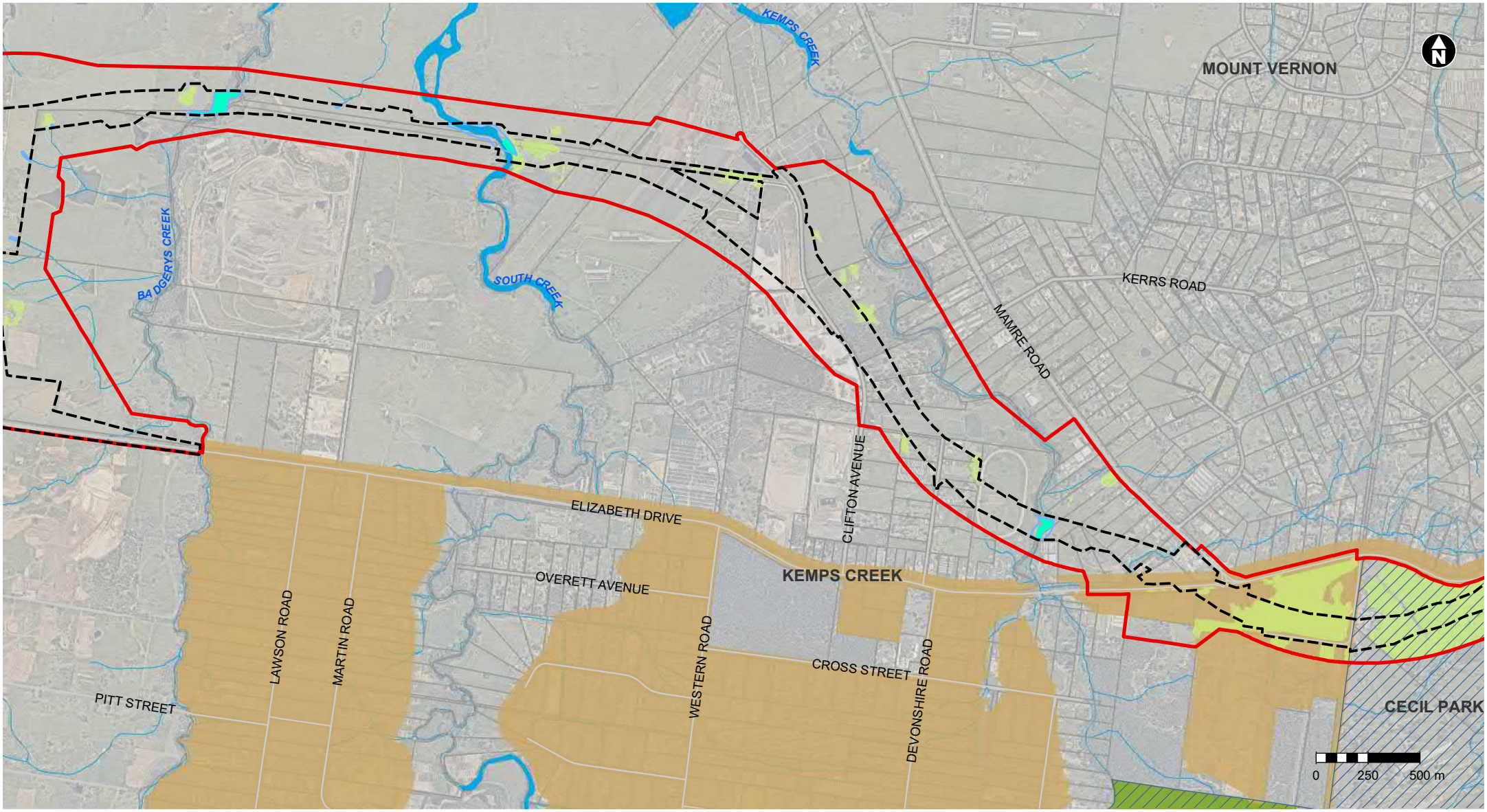

Figure 8-3 Matters for further consideration

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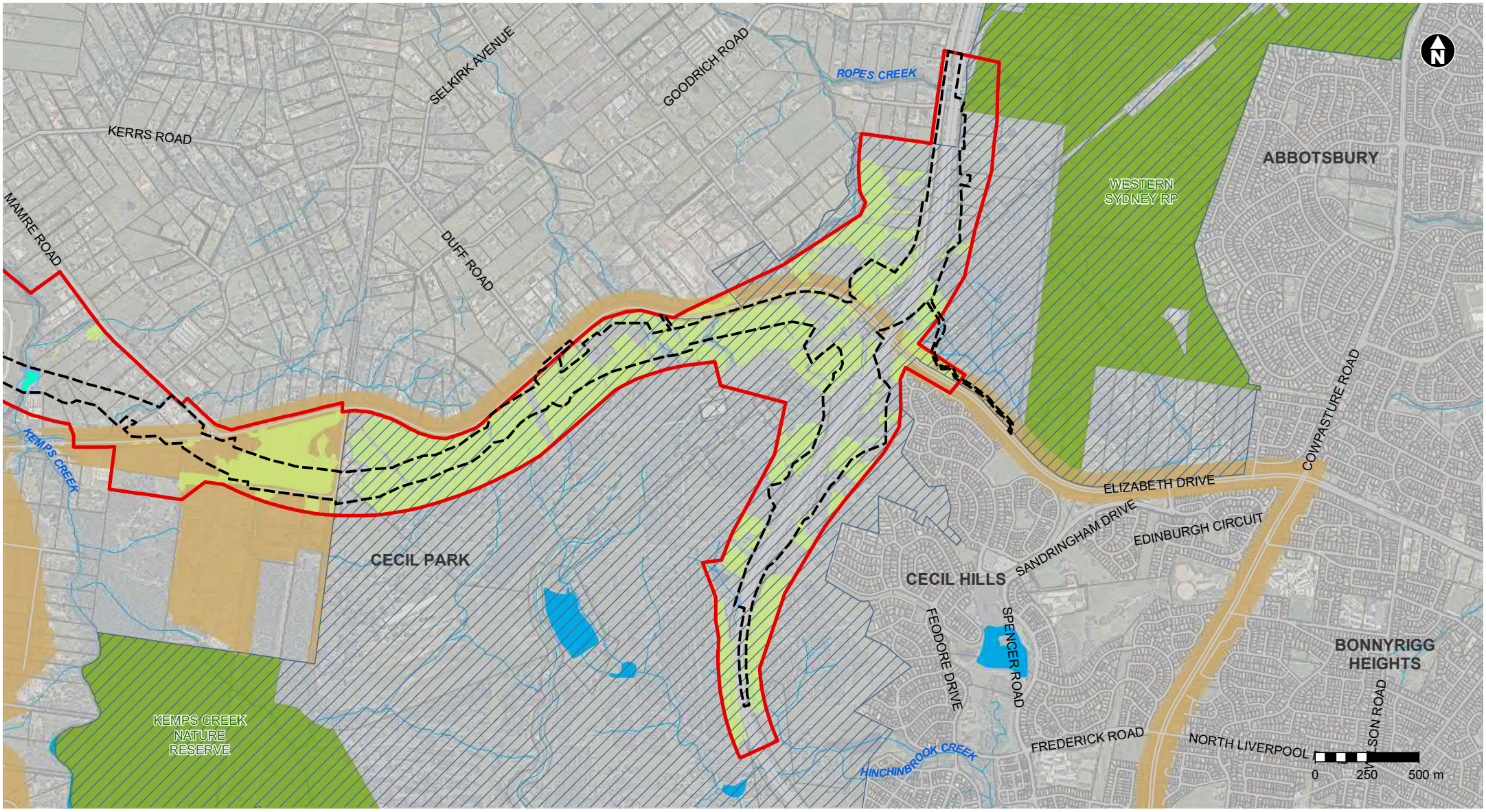

Study area corridor
The project construction footprint
Cadastre
Western Sydney Parklands
Biodiversity certified land
NPWS Reserves
Riparian buffer area
Riparian vegetation
Threatened Ecological Communities (TEC)
Cumberland Plain Woodland in the Sydney Basin Bioregion

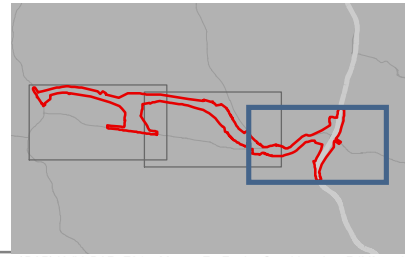

Figure 8-3 Matters for further consideration

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About 3.32 hectares of riparian vegetation would be removed in total from riparian zones of the four creeks. Revegetation following construction would result in narrower gaps in riparian vegetation to mitigate impacts. The impacts to riparian vegetation at each creek, including the resulting gap due to clearing for construction is summarised in **Table 8-9** below. There is an existing gap in riparian vegetation of South Creek from the northern extent of the construction footprint for a length over two kilometres along both sides of the watercourse. The project would expand this gap by about 70 metres.

Removal of riparian vegetation would be minimised, and vegetation connectivity retained across the riparian zone where possible. Upon completion of construction, riparian vegetation in the vicinity of creek works would be improved and enhanced. Revegetation under bridges would be undertaken where possible to re-establish connectivity. Where revegetation under bridges is not possible or is not successful, gaps in riparian vegetation would permanently alter connectivity over short distances of the riparian corridors, affecting some terrestrial species that require continuity of vegetation for movement. Current regional and local connectivity is shown in **Figure 8-4**.

Impacts on species movement along riparian corridors

Fish passage would be maintained throughout the construction period. Creek adjustments, changes to hydrology and shading from construction of bridges at the four creek crossings with potential fish habitat could impact fish movement/behaviour. Impacts are likely to be minor/negligible due to the small scale of change.

Terrestrial species movement corridors are discussed in detail in **Section 8.5.4**.

Table 8-9 Fourth order waterways to be impacted by a reduction in the width of vegetation in the riparian zone

Waterway	PCTs impacted	Vegetation condition	Total area of impact (ha)	Length of gap in riparian vegetation
Badgerys Creek	Forest Red Gum - Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney Basin Bioregion	Moderate/Good – Poor	1.3	110 m
	Swamp Oak open forest on riverflats of the Cumberland Plain and Hunter valley	Moderate/Good – Poor	0.05	
Kemps Creek	Swamp Oak open forest on riverflats of the Cumberland Plain and Hunter valley	Moderate/Good – Poor	0.58	110 m
	Forest Red Gum - Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney Basin Bioregion	Moderate/Good – Poor	0.04	
South Creek	Swamp Oak open forest on riverflats of the Cumberland Plain and Hunter valley	Moderate/Good – Poor	0.05	70 m expansion of existing 2 km gap
	Forest Red Gum - Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney Basin Bioregion	Moderate/Good – Poor	0.16	
	Grey Box - Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin Bioregion	Moderate/Good – Moderate	0.33	
Cosgroves Creek	Swamp Oak open forest on riverflats of the Cumberland Plain and Hunter valley	Moderate/Good – Poor	0.81	105 m
Total			**3.32**	

8.3.2 Native vegetation

The project would have impacts on one critically endangered ecological community (CEEC) under the TSC Act: Cumberland Plain Woodland in the Sydney Basin Bioregion. An assessment of the impact to this community is provided below, based on FBA requirements.

(a) the area and condition of the CEEC or EEC to be impacted directly and indirectly by the project

About 60.16 hectares of Cumberland Plain Woodland in the Sydney Basin Bioregion lies within the construction footprint (excluding areas certified under the strategic assessment) and would be directly impacted by the project. Of this area, about 42.09 hectares of the community is in Moderate/Good condition and about 18.07 hectares is in Low condition, comprising derived native grassland in the west of the construction footprint.

Of the 42.09 hectares of the community that is in Moderate/Good condition in the construction footprint, about 36.86 hectares is located within the Western Sydney Parklands in the east of the construction footprint. This vegetation includes about 22.65 hectares of revegetated areas which meet the criteria for the CEEC.

The site value score calculated for areas of Cumberland Plain Woodland in the Sydney Basin Bioregion within the construction footprint is generally quite low when compared to benchmark values. Site value ranges from 13.77 in areas of derived native grassland in Low condition, to 57.97 in areas in Moderate/Good_Other condition.

Most patches of Cumberland Plain Woodland in and adjoining the construction footprint are small, fragmented and contain no core habitat. Much of this vegetation is already situated adjacent to an existing cleared edge, often a road, and is subject to ongoing disturbance. As such, many of the areas of vegetation within and directly adjacent to the construction footprint are already subject to considerable edge effects, and additional indirect impacts are considered unlikely to substantially impact on these patches.

An analysis of the potential for edge effects on vegetation within the study area was undertaken by placing a buffer of 30 metres around the construction footprint. This buffer was used to identify a total of 11.36 hectares of Cumberland Plain Woodland (including 6.73 hectares of revegetation) that may be further impacted by edge effects from the project. This area was mainly within Western Sydney Parklands and east of Clifton Avenue.

The condition and site value of areas of Cumberland Plain Woodland in the Sydney Basin Bioregion and associated areas to be directly and indirectly impacted are outlined in **Table 8-10**.

Table 8-10 Direct impacts on Cumberland Plain Woodland in the Sydney Basin Bioregion

PCT corresponding with Cumberland Plain Woodland in the Sydney Basin bioregion	Condition (vegetation zone)	Site value score	Area to be directly impacted excluding certified areas (ha)	Area to be indirectly impacted excluding certified areas (ha)
Grey Box - Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin Bioregion (PCT 849)	Moderate/Good_Medium	45.65	3.54	0.24
	Moderate/Good_Poor	22.46	2.07	-
	Moderate/Good_Other (Derived Shrubland)	26.09	0.48	-
Grey Box - Forest Red Gum grassy woodland on shale of the southern Cumberland Plain, Sydney Basin Bioregion (PCT 850)	Moderate/Good_High	50.97	3.21	1.07
	Moderate/Good_Medium	42.03	10.14	3.33
	Moderate/Good_Other (Revegetation)	57.97	22.65	7.03
	Low (Derived Native Grassland)	27.26	18.07	-

PCT corresponding with Cumberland Plain Woodland in the Sydney Basin bioregion	Condition (vegetation zone)	Site value score	Area to be directly impacted excluding certified areas (ha)	Area to be indirectly impacted excluding certified areas (ha)
Total area of Cumberland Plain Woodland in the Sydney Basin Bioregion to be impacted (excluding certified areas)			**60.16**	**11.67**
Total area of Cumberland Plain Woodland in the Sydney Basin Bioregion in Moderate/Good condition to be impacted (excluding certified areas)			**42.09**	**11.67**

(b) the extent and overall condition of the CEEC or EEC within an area of 1000 ha and then 10,000 ha surrounding the proposed development footprint

The extent and overall condition of Cumberland Plain Woodland within a 1000 hectare and 10,000 hectare buffer was calculated using GIS and regional vegetation mapping (OEH, 2013, OEH, 2016). These extents do not include the area within the construction footprint and as such represent the Cumberland Plain Woodland that would be unaffected by the project. The 1000 hectare buffer was created using a 230 metre radius from the construction footprint while the 10,000 hectare buffer used a 2250 metre radius from the construction footprint.

Vegetation which had a canopy cover of greater than 10 per cent was considered to be in moderate/good condition while vegetation with a canopy cover of less than 10 per cent was considered to be in moderate/poor condition. These areas are outlined in **Table 8-11**.

It should be noted that the areas listed in **Table 8-11** mostly do not include areas of native revegetation within the Western Sydney Parklands, as these are generally not mapped as PCTs in the vegetation mapping (OEH, 2013, OEH, 2016), as they are regrowth vegetation.

Derived native grassland is also generally not included in the regional mapping. Areas of revegetation account for 22.65 hectares of the total 42.09 hectares of Moderate/Good condition Cumberland Plain Woodland identified in the construction footprint. In order to provide a “like for like” comparison with vegetation within the surrounding area and that within the construction footprint, revegetation areas must be removed from the calculation. The values shown in the last column of **Table 8-11** have been calculated based on the percentage of the total area of Cumberland Plain Woodland within the construction footprint plus the buffer zones, excluding revegetation areas.

Table 8-11 Condition and associated area of Cumberland Plain Woodland in 1000 ha and 10,000 ha buffers surrounding the construction footprint

Buffer area surrounding construction footprint	Area of Cumberland Plain Woodland (ha) within buffer area (excluding construction footprint)			Area of Moderate/Good CPW within construction footprint (excluding revegetation and derived grassland)	Percentage of Cumberland Plain Woodland removed
	Moderate/Poor	Moderate/Good	Total		
1000 ha	125.41	49.25	174.65	19.44	10%
10,000 ha	1042.35	629.09	1671.43	19.44	1%

(c) an estimate of the extant area and overall condition of the CEEC or EEC remaining in the IBRA subregion after the impact of the project has been taken into consideration

The area and overall condition of extant Cumberland Plain Woodland within the Cumberland subregion was calculated using a GIS and regional vegetation mapping (OEH, 2013, OEH, 2016). A total of 32,730 hectares of PCTs 849 and 850 were mapped in the Cumberland subregion. Of this, 14,503 hectares is mapped as higher canopy cover and/or less disturbed condition classes, while 18,227 hectares is mapped as lower canopy cover and/or more disturbed condition. When the removal of about 42.09 hectares of Cumberland Plain Woodland for the project is taken into consideration, about 32,688 hectares of extant Cumberland Plain Woodland would exist within the Cumberland subregion based on vegetation mapping (OEH, 2013, OEH, 2016).

The regional vegetation mapping (OEH, 2013, OEH, 2016) has identified 32,730 hectares of PCTs that correspond to Cumberland Plain Woodland in the Sydney Basin bioregion in the Cumberland subregion. However, the final determination for this TEC states that the total extent of woody vegetation referred to as Cumberland Plain Woodland was estimated at 11,054 (±1,564) hectares in 2003, based on interpretation of aerial photography dating from 1998, and that by 2007 the extent of the TEC had declined by 442 (±46) hectares. This discrepancy is likely due to improvements in the resolution of vegetation mapping between 1998 and 2013 leading to smaller and more fragmented patches of the community being captured in the 2013 and 2016 mapping. The higher resolution mapping areas have therefore been used in the calculations above.

The extant area of Cumberland Plain Woodland within the Sydney Basin is known to decreasing (due to ongoing clearing for development). The proposed loss of 42.09 hectares of this community as a result of the project constitutes 0.13% of the total remaining area of Cumberland Plain Woodland identified in the regional vegetation mapping and 0.4% of the total remaining area of Cumberland Plain Woodland identified in the Final Determination for this community).

(d) the project's impact on:

(i) abiotic factors critical to the long-term survival of the CEEC or EEC. For example, would the impact lead to a reduction of groundwater levels or substantial alteration of surface water patterns?

The maximum potential groundwater drawdown associated with cut dewatering is predicted to be about 1.6 metres and is unlikely to cause impacts at surrounding registered bores or sensitive environmental receptors (JAJV, 2018).

The construction of the project would involve a range of activities that may affect surface water patterns in the locality, including earthworks, construction of drainage infrastructure, construction of bridges over waterways and minor creek adjustment.

Adjustment of small sections of creeks where bridge crossings are proposed could result in a decline in ecosystem function downstream due to habitat removal and alteration/fill materials into existing waterways (Jacobs, 2018). Minor creek adjustment of Badgerys Creek, South Creek and Kemps Creek is proposed. Adjustments are designed to reduce erosion around bridge piers, provide adequate flood pathways and reduce disturbance of creeks during construction. Vegetation adjoining these creeks downstream of the construction footprint is degraded and often absent, but some fragmented patches of Cumberland Plain Woodland in the Sydney Basin bioregion may be impacted. Cumberland Plain Woodland in the Sydney Basin bioregion is typically located outside of the riparian corridors, on slopes and flats and therefore has only a low level of interaction with existing surface water flow regimes.

Unmanaged construction activities associated with the project could result in alteration of surface water patterns as soil erosion, siltation and off-site movement of eroded sediments by stormwater into adjacent areas of TEC. appropriate management measures would be installed prior to and maintained throughout the construction period to prevent these impacts. These would be detailed in a construction environmental management plan for the project (see Section 9 of the EIS for further details).

(ii) characteristic and functionally important species through impacts such as, but not limited to, inappropriate fire/flooding regimes, removal of understorey species or harvesting of plants

Most of the Cumberland Plain Woodland in the Sydney Basin Bioregion within and adjoining the construction footprint is located in the Western Sydney Parklands and is managed for conservation and/or recreational purposes. It is unlikely that the project would result in removal of understorey species or harvesting of plants from retained areas of Cumberland Plain Woodland in the Western Sydney Parklands.

(iii) the quality and integrity of an occurrence of the CEEC or EEC through threats and indirect impacts including, but not limited to, assisting invasive flora and fauna species to become established or causing regular mobilisation of fertilisers, herbicides or other chemicals or pollutants which may harm or inhibit growth of species in the CEEC or EEC.

Invasive exotic plant species, including priority weeds and Weeds of National Significance (WoNS) are widespread in the study area. The dispersal of weeds from infested areas to relatively intact retained patches of Cumberland Plain Woodland in the Sydney Basin Bioregion adjoining the construction footprint is possible through the movement of plant and weed-laden sediment. These potential impacts would likely be mitigated through implementing management measures during construction to minimise the risk of introduction and spread of weeds.

Pest fauna species are already well established in the study area. Consequently, while pest species are likely to capitalise on the disturbance associated with construction and development activities, the project is unlikely to significantly increase the overall impact of pest species within the study area. Areas of vegetation at the north-eastern extent of the study area were recorded as having high abundance of the native Bell Miner (*Manorina melanophrys*) and increased dieback during surveys. Given that the project would result in further vegetation clearing and localised fragmentation, it could increase the prevalence and severity of Bell Miner Associated Dieback (BMAD) in the locality. However, impacts are likely to be insignificant when compared to the broad-scale clearing that has occurred in the past as a result of agriculture and urban development.

(e) direct or indirect fragmentation and isolation of an important area of the CEEC or EEC

Much of the Cumberland Plain Woodland in the Sydney Basin Bioregion in the construction footprint is currently fragmented by historical clearing, rural/residential and industrial land uses, as well as roads and bike tracks. The larger patches of Cumberland Plain Woodland in the Sydney Basin Bioregion in the study area are situated in the Western Sydney Parklands. However, the vegetation here is regrowth or revegetation from historical agricultural lands, and as such the patches are still fragmented. The project would involve the clearing of some of these areas and as a result, further fragment this CEEC and reducing its connectivity within the locality.

New edge effects would also be created as a result of the project, as described in **Section 8.5.5**. The clearing of vegetation would create a new edge which would likely be subject to increased run-off, dumping of rubbish and the establishment and spread of weeds. Most of the Cumberland Plain Woodland in the study area and construction footprint comprises small, fragmented patches that are already situated adjacent to an existing cleared edge, often a road. As such, many of the areas of vegetation within and directly adjacent to the construction footprint are already subject to considerable edge effects. In some areas of Western Sydney Parklands, the construction footprint crosses through some larger patches of Cumberland Plain Woodland in Moderate/Good condition, including revegetated areas. Within these larger areas it is likely that the project would increase the potential for edge effects to occur.

Management measures would be implemented to minimise the risk of the introduction and spread of weeds (**Chapter 10**).

(f) the measures proposed to contribute to the recovery of the CEEC or EEC in the IBRA subregion

The estimated 42.09 hectares of Cumberland Plain Woodland in the Sydney Basin Bioregion in Moderate/Good condition to be removed would be offset in accordance with the FBA, allowing in-perpetuity conservation of an alternative area of Cumberland Plain Woodland.

8.3.3 Species and populations

The project would not impact on any land declared by the NSW Minister for Planning and Public Spaces as Critical Habitat in accordance with Section 47 of the TSC Act. No threatened species or populations have been nominated for further consideration in the SEARs.

The project would not impact on any threatened species or population not previously recorded from the Cumberland IBRA subregion. There would also be no impact to a critically endangered species as a result of the project.

8.3.4 Critical habitat

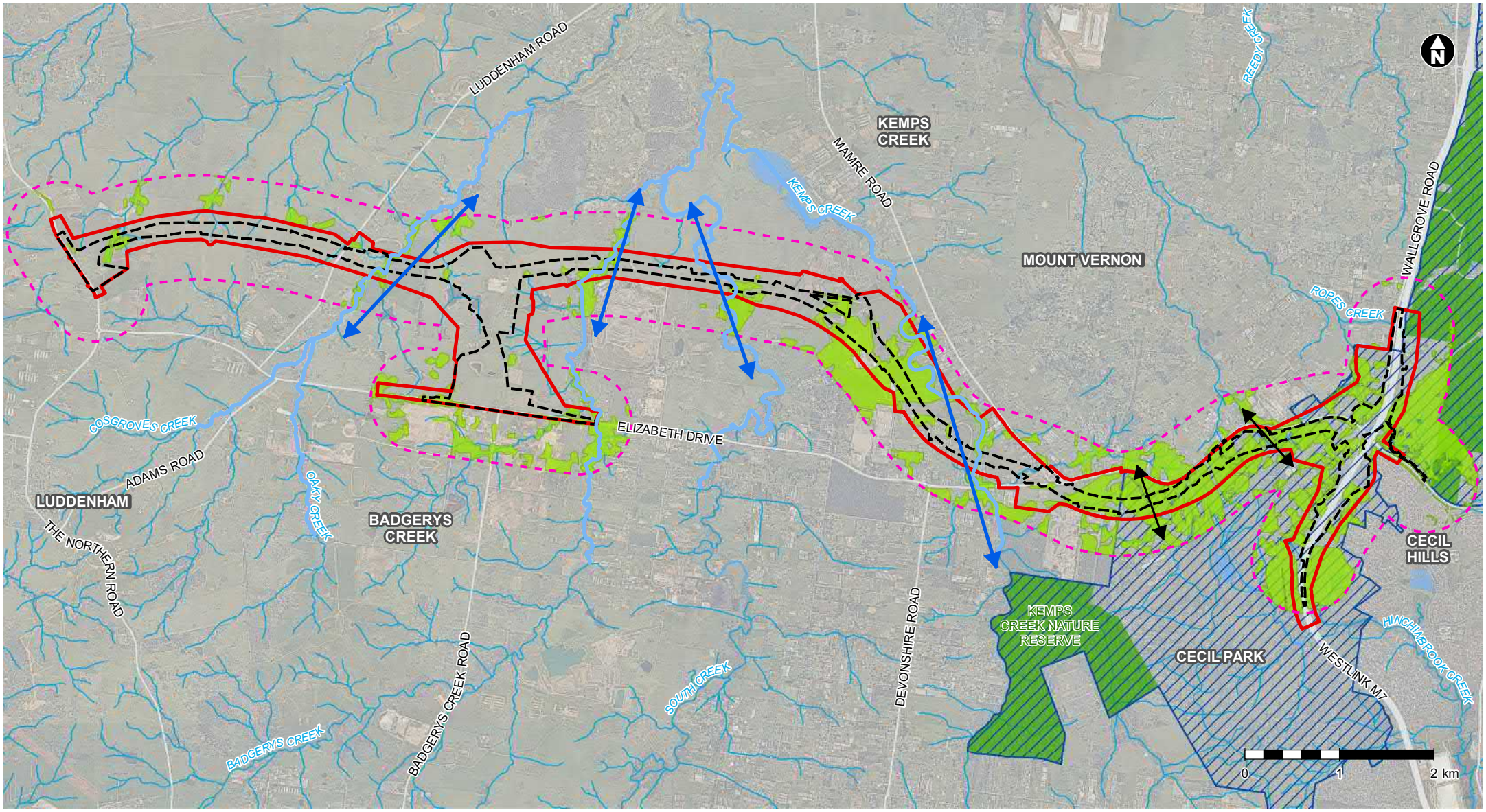
There are no areas of land within the study area that the Minister for Planning and Public Spaces has declared 'critical habitat' in accordance with Section 47 of the TSC Act, and that are listed on the Critical Habitat Register in NSW.

8.3.5 Protected and Sensitive Lands

As well as adhering to the requirements of biodiversity assessment set out in the FBA, this report was also required by DPIE (Planning and Assessment) in Section 16 – Protected Lands. Protected and Sensitive Lands which are included in this assessment are shown in **Table 8-12**. A summary of potential impacts is provided, as well as information in the document for where more detailed information is located.

Table 8-12 Summary of impacts on Protected and Sensitive Lands

Entity identified in Section 16 of the SEARS	Summary of potential impacts	Section in the BAR with further information
Key Fish Habitat as mapped and defined under the FM Act	The following creeks within the study area are identified as key fish habitat: • Cosgroves Creek • Badgerys Creek • South Creek • Kemps Creek • Hinchinbrook Creek (including downstream of SEPP Coastal Wetland) • Unnamed tributary of Hinchinbrook Creek • Doujon Lake. Temporary impacts may occur, but no significant impact to long term fish passage.	**Section 4.3** **Section 8.5** **Section 8.6**
Waterfront Land	While temporary impacts are expected to creeks and riparian areas, no permanent significant impacts are anticipated.	**Section 4.3** **Section 8.5** **Section 8.6**
Critical Habitat	Addressed in **Section 8.3.4**.	**Section 8.3.4**
Biobank sites, private conservation lands and other lands identified as offsets	The M7 biobanking site is the only offset site within the study area. It is comprised of approximately 32 ha of land set aside for offsets as result of the M7 project. The construction footprint requires the removal of approximately 2.89 ha of Critically Endangered Cumberland Plain Grey Box Red Gum Critically Endangered Community. This vegetation has been included in an assessment of impacts to this community and will require offsetting as per Biodiversity Offset Strategy (**Annexure D**).	**Section 2.1** **Section 8.2.1** **Chapter 11**



Study area corridor
The project construction footprint
550m landscape assessment buffer
Local government area
Riparian buffer area

Native vegetation
Western Sydney Parklands
Biodiversity certified land
NPWS Reserves
Waterways

Regionally significant biodiversity link
Local area biodiversity link

*Entire map extent is covered by the IBRA 7 Region - Sydney Basin,and IBRA 7 Subregion - Cumberland. No SEPP 14 Coastal Wetlands or Ramsar Wetlands are present in the entire map extent.

Figure 8-4 Local and regional fauna connectivity

Date: 28/06/2019 Path: \\10.10.25.32\data\GIS\MXDs\Figures\Technical_reports\BAR\JAJV_BAR_F019_ConnectivityMap_R3V1.mxd
Created by : JR | QA by : TBC

8.4 Matters of National Environmental Significance

There are nine different categories of MNES as listed under the EPBC Act. Only MNES with the potential to occur and be impacted, as discussed in **Chapter 5** are examined in this section. They are:

- Listed threatened species and ecological communities
- Migratory species
- Commonwealth Land.

This section discusses potential impacts of the project on each of these entities.

8.4.1 Listed threatened flora species

Field surveys identified the occurrence of two EPBC listed threatened flora species within or in the immediate vicinity of the study area. They are:

- Sydney Bush Pea (*Pultenaea parviflora*)
- Spiked Rice flower (*Pimelea spicata*).

Assessments of significance under *Matters of National Environmental Significance: Significant impact guidelines 1.1* (DoE, 2013) were carried out for both species, with very different outcomes (**Annexure G**).

Pimelea spicata occurs about 15 metres outside of the study area, and about 70 metres from the proposed construction footprint. No individuals would be disturbed as part of the project. Potential habitat for this species does occur within the construction footprint, with about 44 hectares of suitable habitat currently planned to be removed, however this is not considered to be a significant reduction in potential habitat, given that the known population would be undisturbed. Therefore, the project is unlikely to have a significant impact on *Pimelea spicata.*

A population of *Pultenaea parviflora* was recorded within the study area (278 individuals), in the vicinity of Clifton Avenue (**Figure 4-2**). This population is likely to be a source population and potentially important for maintaining genetic diversity for the species, it is also near the limit of the species' range and for these reasons is considered to be an important population for this species (**Annexure G**). The proposed construction footprint requires the removal of 90 individuals which has the potential to significantly impact on this species. This species, along with other MNES, was the subject of a referral to the DoEE in August 2018. On October 19 2018 the Commonwealth Minister for the Environment determined that the project was a controlled action due to potential impacts to threatened species and communities (EPBC 2018/8286).

8.4.2 Listed threatened fauna species

Detailed desktop and field study were undertaken for the 29 EPBC listed fauna species identified in database searches (**Annexure B** and **Annexure E**).

These investigations concluded that only one EPBC listed fauna species, the Grey-headed Flying-fox, had a moderate or higher likelihood of occurrence within the study area (**Section 4.2.5**, **Section 5.4.2.2**).

To determine the significance of impacts on EPBC listed fauna species, impacts on an 'important' population, as defined in *Matters of National Environmental Significance: Significant impact guidelines 1.1* (DoE, 2013) for vulnerable species is used. An 'important' population is one necessary for the long term survival and recovery of the species.

The Grey-headed Flying-fox does not have separate or disjunct populations due to the constant genetic exchange and movement between camps throughout the species' entire geographic range and as such the National population is considered to be the important population. The Grey-headed Flying-foxes recorded foraging in the study area are considered to be part of this population.

The study area provides foraging habitat for this species, with the closest camp about seven kilometres away. The project would remove about 55.20 hectares of foraging habitat. This would impact on the sub-population of Grey-headed Flying-foxes that use nearby camps and forage in the area, however, it is unlikely to significantly impact this sub-population since there are still significant foraging resources available within areas such as the Western Sydney Parklands and other areas within the study area (about 195.71 hectares available within the study area). Vegetation planting and restoration would also be a feature of the project and would assist in replacing foraging resources over time (see **Table 8-13**).

A detailed assessment against significant impact criteria from DoE (2013) is shown included in **Annexure G** for both the Green and Gold Bell Frog and the Grey-headed Flying-fox. Grey-headed Flying-fox breeding habitat is not present within the study area and therefore no species credits are required to offset impacts to this species. Grey-headed Flying-fox foraging habitat would be removed; however, all foraging habitat would be offset by provision of ecosystem credits required for removal of vegetation. No further offsets are therefore required for impacts to the Grey-headed Flying-fox. The results of the assessment of impacts to the Grey-headed Flying-fox are summarised in **Table 8-13** below.

While the action does not contribute to recovery actions as identified in the draft recovery plan for this species (DoEE, 2017), it does not significantly impact on habitat critical to this species and therefore does not significantly interfere with the recovery of this species. Detailed assessment on this species and all EPBC Act listed fauna identified as potentially impacted is provided in **Annexure G**.

The Green and Golden Bell Frog was not recorded during targeted surveys and is not considered likely to occur within the study area.

Table 8-13 Summary of impacts to EPBC Act listed threatened fauna species

Threatened fauna species	Status		Area of habitat within the study area (ha)	Potential area of habitat to be impacted excluding certified areas (ha)
	TSC Act	EPBC Act		
Grey-headed Flying-fox	V	V	195.71 (foraging only)	55.20 (foraging only)

V = Vulnerable

8.4.3 Threatened ecological communities

Two TECs occur within the study area that meet the criteria for listing under the EPBC Act (**Chapter 5**). The construction footprint requires the removal of about 38.48 hectares of Cumberland Plain Shale Woodlands and Shale-Gravel Transition Forest and about 0.44 hectares of Western Sydney Dry Rainforest and Moist Woodland on Shale (**Table 8-14**) (**Annexure G**).

Table 8-14 Summary of direct impacts to TECs within the study area (see **Table 5-1** for PCT equivalency)

TEC Name (EPBC Act)	EPBC Act Status	Extent within study area (ha)	Area within construction footprint (ha)	Area within construction footprint excluding certified areas
Cumberland Plain Shale Woodlands and Shale-Gravel Transition Forest	CE	128.39 ha (includes 63.18 ha of revegetation)	45.96 ha (includes 22.21 ha of revegetation)	38.48 ha (includes 20.12 ha of revegetation)
Western Sydney Dry Rainforest and Moist Woodland on Shale	CE	4.97 ha	0.44 ha	0.44 ha
Total (ha)		**133.36**	**46.40**	**38.92**

CE = Critically Endangered, E = Endangered

Cumberland Plain Shale Woodlands and Shale-Gravel Transition Forest exists in a highly fragmented distribution across western Sydney, and only around nine per cent of the original area of this community exists (DECCW, 2011). The removal of 38.48 hectares of this community represents a significant impact to this community. For these reasons, the project was referred to the DoEE which determined the project to be a controlled action on 19 October 2018 (EPBC 2018/8286).

In contrast, the small area of Western Sydney Dry Rainforest and Moist Woodland on Shale to be cleared is already fragmented and edge-affected. For these reasons, it is unlikely that the project would significantly impact on this EPBC listed TEC.

8.4.4 Listed migratory species

An assessment of significance in accordance with the *Matters of National Environmental Significance Significant Impact Guidelines 1.1* (DoE, 2013) was completed for migratory species with a moderate likelihood of occurrence in the study area (**Table 8-15**). No migratory species were considered to have a high likelihood of occurrence in the study area (**Table 5-4**).

No migratory species were recorded in the study area during surveys. However, species such as the White-throated Needletail and Fork-tailed Swift often occur in the airspace above a location. As they are aerial foragers and do not breed in Australia (DoEE, 2018), project impacts are likely to be negligible, even the species occur. While the White-bellied Sea-Eagle is a listed marine species under the EPBC Act, it is no longer considered a migratory species and therefore was not assessed as a migratory species.

'Important habitat' (DoE, 2013) for migratory species is defined as:

- Habitat utilised by a migratory species occasionally or periodically within a region that supports an ecologically significant proportion of the population of the species
- Habitat that is of critical importance to the species at particular life-cycle stages
- Habitat utilised by a migratory species which is at the limit of the species range
- Habitat within an area where the species is declining.

An action is likely to have a significant impact[1] (DoE, 2013) on a migratory species if there is a real change or possibility that it would:

a) 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
b) Result in an invasive species that is harmful to the migratory species becoming established in an area of important habitat for the migratory species, or
c) Seriously disrupt the lifecycle (breeding, feeding, migration or resting behaviour) of an ecologically significant proportion of the population of a migratory species.

The study area does not contain any areas of important habitat for any of the listed migratory species (**Section 5.5**). As such, while the project is likely to result in the loss of occasional habitat for migratory species, it does not impact on important habitat, and is unlikely to result in a significant impact on migratory species listed under the EPBC Act (**Table 8-15**).

Table 8-15 Assessment of significance for migratory species with a moderate likelihood of occurrence in the study area

Scientific name	Common name	Important habitat	Significance assessment questions[1]			Likely significant impact?
			a	b	c	
Marine species						
Apus pacificus	Fork-tailed Swift	No	No	No	No	No. While there is potential aerial foraging habitat for the species, the study area does not contain areas of important habitat, and the species was not recorded

Scientific name	Common name	Important habitat	Significance assessment questions[1]			Likely significant impact?
			a	b	c	
						during current surveys. As such, the project is unlikely to result in a significant impact for the species.
Terrestrial species						
Hirundapus caudacutus	White-throated Needletail	No	No	No	No	No. While there is potential aerial foraging habitat for the species, the study area does not contain areas of important habitat, and the species was not recorded during current surveys. As such, the project is unlikely to result in a significant impact for the species.
Monarcha melanopsis	Black-faced Monarch	No	No	No	No	No. While there is potential foraging habitat for the species, such as shrubland and small patches of rainforest, the study area does not contain areas of important habitat, and the species was not recorded during current surveys. As such, the project is unlikely to result in a significant impact for the species.
Rhipidura rufifrons	Rufous Fantail	No	No	No	No	No. While there is potential foraging habitat for the species, such as Spotted Gum, the study area does not contain areas of important habitat, and the species was not recorded during current surveys. As such, the project is unlikely to result in a significant impact for the species.
Wetland species						
Calidris acuminata	Sharp-tailed Sandpiper	No	No	No	No	No. While there is potential foraging habitat for the species the study area does not contain areas of important habitat, and the species was not recorded during current surveys. As such, the project is unlikely to result in a significant impact for the species.
Calidris melanotos	Pectoral Sandpiper	No	No	No	No	No. While there is potential foraging habitat for the species, such as wetlands and floodplains, the study area does not contain areas of important habitat, and the species was not recorded during current surveys. As such, the project is unlikely to result in a significant impact for the species.
Gallinago hardwickii	Latham's Snipe	No	No	No	No	No. While there is potential foraging habitat for the species, such as artificial dams, the study area does not contain areas of important habitat, and the species was not recorded during current surveys. As such, the project is unlikely to result in a significant impact for the species.
Tringa nebularia	Common Greenshank	No	No	No	No	No. While there is potential foraging habitat for the species the study area does not contain areas of important habitat, and the species was not recorded during current surveys. As such, the project is unlikely to result in a significant impact for the species.

8.4.5 Commonwealth land

The project is located adjacent to Commonwealth land (ie the Western Sydney Airport). With the implementation of appropriate environmental controls as part of mitigation measures for the project (see **Chapter 10** for further detail), indirect biodiversity impacts would be minimised and a significant impact on the environment of Commonwealth land as defined in the *Significant Impact Guidelines*, Section 1.2 (Actions on, or impacting upon, Commonwealth land, and actions by Commonwealth agencies) (SEWPaC, 2013), is not expected from the project.

8.5 Other impacts

A majority of the below impacts, including changes to hydrology (**Section 8.5.3**), invasion and spread of pests (**Section 8.5.8**), and invasion and spread of pathogens and disease (**Section 8.5.9**) are recognised as Key Threatening Processes (KTPs) in accordance with the TSC Act, FM Act and/or EPBC Act. Activities associated with the project are likely to exacerbate KTPs, however these risks would be minimised through the management measures provided in **Chapter 10**. Further details on potential impacts of KTPs are documented in **Annexure G**.

8.5.1 Aquatic impacts

Permanent waterway crossings

Proposed structures at each of the 10 assessed waterways within the construction footprint are outlined in **Table 8-16**. Bridges are proposed at the five creeks: Cosgroves Creek, Badgerys Creek, South Creek, Kemps Creek and . Four of the five creeks provide moderate fish habitat and key fish habitat according to field assessment and RIAR mapping. Ropes Creek has been assessed as unlikely fish habitat.

Pipe culverts are proposed at three waterways which have been assessed as unlikely fish habitat. Crossing structures are not proposed for waterways where works are restricted to pavement only/tie-in works. The project footprint would intercept the unnamed tributary of Kemps Creek with an open drain that would convey flow to Kemps Creek. This waterway is also unlikely to provide fish habitat.

Table 8-16 Crossing structures proposed at each waterway assessed

Waterway	Structure	Waterway class (Fairfull and Witheridge, 2003)	Key Fish Habitat
Unnamed tributary of South Creek	Culvert 2 x 1050 mm diameter pipes 54 m long	4 – unlikely fish habitat	No
Cosgroves Creek	Bridge 151m long	2 – moderate fish habitat	Yes
Unnamed tributary of Cosgroves Creek	Culvert (eastbound off ramp) 3 x 1350 mm pipes 45 m long Culvert (main footprint) 3 x 1350 mm pipes 90 m long	4 – unlikely fish habitat	No
Unnamed tributary of Badgerys Creek	Existing bridge on Elizabeth Drive to be retained – no impact.	4 – unlikely fish habitat	No
Badgerys Creek	Twin bridges 265 m long	2 – moderate fish habitat	Yes
South Creek	Twin bridges 573 m long	2 – moderate fish passage	Yes
Kemps Creek	Twin bridges 241 m long	2 – moderate fish passage	Yes
Unnamed tributary of Kemps Creek	No crossing. The waterway would be intercepted by an open drain that conveys flow to Kemps Creek.	4 – unlikely fish habitat	No
Ropes Creek	Bridge 118 m long	4 – unlikely fish habitat	No
Unnamed tributary of Ropes Creek	Culvert 2 x 1200 mm diameter pipe 42m long 2 x 1200 mm diameter pipe 64 m long	4 – unlikely fish habitat	No

Temporary waterway crossings

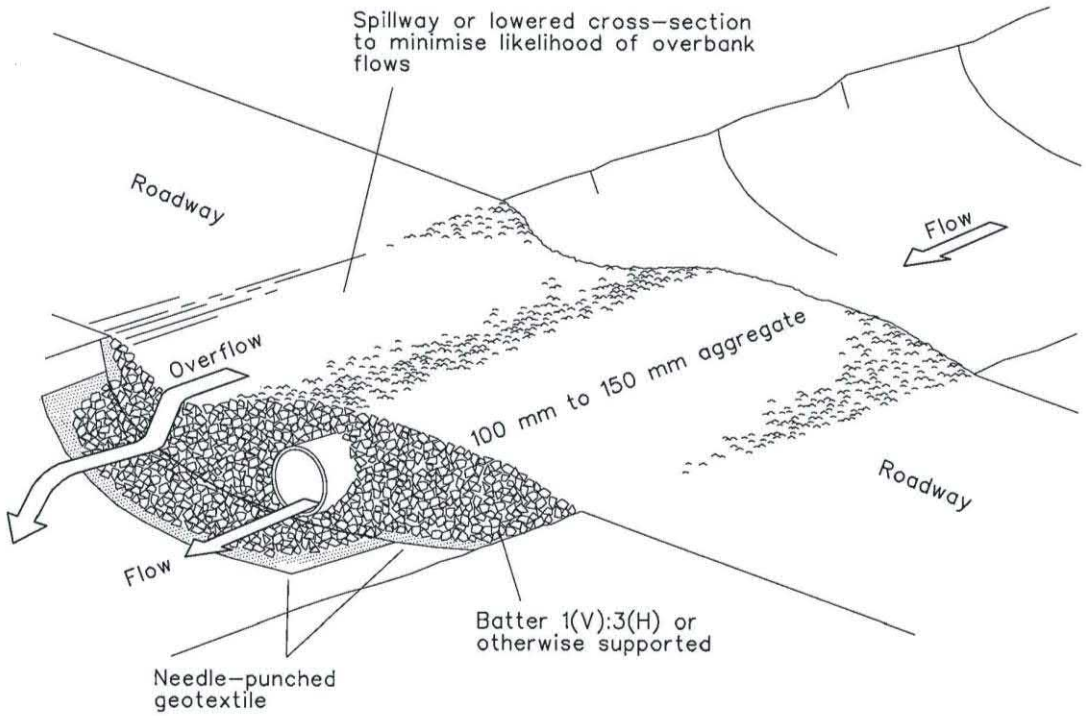
Temporary waterway crossings may be required for some or all waterways traversed by the project. The crossings are likely to comprise a temporary causeway built with rock and geotextile and pipe culverts to maintain flow.

An example of a typical temporary watercourse crossing is provided in **Figure 8-5**. If required, the temporary crossings would:

- Maintain low-flow conditions in the watercourse
- Be certified by the road designer to confirm no additional flooding impacts would occur during design flood events
- Be removed in full and the area rehabilitated following completion of construction.

Temporary waterway crossings would take into consideration the requirements of the Policy and guidelines for fish habitat conservation and management (DPI, 2013) and the *Guidelines for watercourse crossings on waterfront land* (DPI, 2012).

Temporary work platforms would be required at bridge sites to provide a working area for bridge pier and abutment construction including piling. These platforms would extend from the existing banks into the waterway to enable stable and safe access. Temporary work platforms have the potential to disrupt flow, detain water and increase inundation, and disturb creek beds resulting in sedimentation downstream.



Construction Notes

1. Prohibit all traffic until the access way is constructed.
2. Strip any topsoil and place a needle-punched textile over the base of the crossing.
3. Place clean, rigid, non polluting aggregate or gravel in the 100 mm to 150 mm size class over the fabric to a minimum depth of 200 mm.
4. Provide a 3-metre wide carriageway with sufficient length of culvert pipe to allow less than a 3(H): 1 (V) slope on side batters.
5. Install a lower section to act as an emergency spillway in greater than design storm events.
6. Ensure that culvert outlets extend beyond the toe of fill embankments.

TEMPORARY WATERWAY CROSSING **SD 5-1**

Figure 8-5 Typical temporary waterway crossing (Blue Book, 2004)

Creek adjustments

Permanent adjustments of waterways have been avoided where possible however, adjustments would be required at Badgerys Creek, South Creek and Kemps Creek; which would be permanently adjusted over a distance of 64 metres, 200 metres and 84 metres respectively. Creek adjustments are not proposed at Cosgroves Creek or Ropes Creek. At Cosgroves Creek, no instream habitat removal would occur as the bridge piers would be located outside the waterway. The adjustments are required to reduce the risk of erosion around bridge piers, coordinate with bridge pier locations, minimise bridge lengths, provide suitable flood conveyance, reduce the number of times the creeks would be disturbed during construction and minimise shading of the creeks. The need for, extent and design of the creek adjustments would be reconsidered during detailed design, taking into account potential environmental benefits from minimising the adjustments to the creeks' natural alignment and form. The creek adjustments are anticipated to result in minor and localised changes to flow volumes and velocities during normal flow conditions (see Appendix M of the EIS).

The proposed creek alignments would have a similar capacity to the existing creek channels and where possible would be designed and constructed in a way that mimics natural flow conditions. The adjustments would replace around 6,366 square metres of KFH in the channels with about 7,452 square metres of newly created channels, partially compensating for the loss. Detailed measurements of the creek adjustments are provided in **Table 8-17**. The creek corridors would be revegetated with native riparian vegetation suitable for the local area, in accordance with the requirements of the Policy and guidelines for fish habitat conservation and management (DPI, 2013). The creek channels would be rehabilitated to preconstruction conditions or better.

Table 8-17 Creek adjustment measurements

Waterway	Length	Depth	Base channel width	Cross sectional area	Area of KFH impacted	Adjusted area
Badgerys Creek	64 m	3.8 m	5 m	56.85 m^2	1,127 m^2	1,222 m^2
South Creek	200 m	4.3 m	12 m	154.80 m^2	3,339 m^2	4,567 m^2
Kemps Creek	84 m	2.4 m	12 m	86.40 m^2	1,900 m^2	1,662 m^2

Threatened fish

No potential habitat for threatened fish listed under the FM Act and EPBC Act occurs within the study area, therefore no impacts to threatened fish are anticipated to occur as a result of the project.

Fish passage

Fish passage would be maintained at all creek crossings during the construction period.
Bridge construction is unlikely to obstruct or alter fish passage as piers are not proposed in the creek channels, though three creeks would be adjusted, and reshaping of creek banks are required. Impacts from creek adjustments are likely to be minor as they would mimic natural flow conditions where possible and not result in any obstruction to fish movements. Culvert construction is unlikely to impact fish passage as the locations of all impacted waterways are unlikely to provide fish habitat.

Temporary creek crossings have the potential to impact fish by temporarily altering the hydrological regimes of the waterways, reducing stream width and reducing water quality from an increase in sedimentation and turbidity from the placement of material instream and vehicle/plant use of the crossing. Though fish passage would be altered, it would not be blocked for the construction of the waterway crossings.

Aquatic and riparian habitat impacts

Impacts to aquatic habitats would occur during construction from instream works, including bridge and culvert construction. Aquatic vegetation and snags would be removed from creek adjustments and culvert footprints. Riparian vegetation would be removed over an approximate area of 4.35 hectares. **Table 8-18** outlines the riparian vegetation impacts at each waterway assessed. The majority of the vegetation to be removed is in poor condition. Removal of riparian vegetation would be minimised, and vegetation connectivity retained across the riparian zone where possible. Upon completion of construction, riparian vegetation near creek works would be rehabilitated.

Table 8-18 Riparian vegetation impacts at assessed waterways

Waterway	Vegetation Zone	Area (ha)
Badgerys Creek	Forest Red Gum - Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney Basin Bioregion (Condition Class: Moderate/Good – Poor)	1.3
	Swamp Oak open forest on riverflats of the Cumberland Plain and Hunter valley (Condition Class: Moderate/Good – Poor)	0.05
	Total	**1.35**
Kemps Creek	Swamp Oak open forest on riverflats of the Cumberland Plain and Hunter valley (Condition Class: Moderate/Good – Poor)	0.58
	Forest Red Gum - Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney Basin Bioregion (Condition Class: Moderate/Good – Poor)	0.04
	Total	**0.62**
South Creek	Grey Box - Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin Bioregion (Condition Class: Moderate/Good – Moderate)	0.33
	Forest Red Gum - Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney Basin Bioregion (Condition Class: Moderate/Good – Poor)	0.16
	Swamp Oak open forest on riverflats of the Cumberland Plain and Hunter valley (Condition Class: Moderate/Good – Poor)	0.05
	Total	**0.54**
Cosgroves Creek	Swamp Oak open forest on riverflats of the Cumberland Plain and Hunter valley (Condition Class: Moderate/Good – Poor)	0.81
Unnamed tributary of Badgerys Creek	Forest Red Gum - Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney Basin Bioregion (Condition Class: Moderate/Good – Poor)	0.08
	Swamp Oak open forest on riverflats of the Cumberland Plain and Hunter valley (Condition Class: Moderate/Good – Poor)	0.09
	Total	**0.17**
Unnamed tributary of Kemps Creek	Forest Red Gum - Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney Basin Bioregion (Condition Class: Moderate/Good – Poor)	0.09
Unnamed tributary of South Creek	Grey Box - Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin Bioregion (Condition Class: Moderate/Good – Moderate)	0.09
	Swamp Oak open forest on riverflats of the Cumberland Plain and Hunter valley (Condition Class: Moderate/Good – Poor)	0.23
	Total	**0.32**
Unnamed tributary of Cosgroves Creek	Forest Red Gum - Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney Basin Bioregion (Condition Class: Moderate/Good – Poor)	0.11

Waterway	Vegetation Zone	Area (ha)
Unnamed tributary of Ropes Creek	Grey Box - Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin Bioregion (Condition Class: Moderate/Good – Moderate)	0.34
Grand Total		**4.35**

Water quality

There is potential for sedimentation and spills to affect water quality in the waterways during the construction process which could also affect native fish and frogs, including downstream of the construction footprint. Impacts are likely to be highest from creek adjustments, bridge construction works, temporary creek crossing construction and demolition of the existing bridge at South Creek.

The SEPP Coastal Wetland on Hinchinbrook Creek (ID 276) is approximately 2.3 kilometres from the southern extent of the construction footprint. Given the distance from the works and the presence of barriers to flow such as the rock wall on Hinchinbrook Creek upstream of the Coastal Wetland, sedimentation and spills during construction are unlikely to impact on the water quality of the Coastal Wetland. Two other Coastal Wetlands on the unnamed tributary of Hinchinbrook Creek (ID 113 and ID 114) are upstream of the confluence with Hinchinbrook Creek and do not have any connectivity to the construction footprint, with significant barriers in the landscape. Sedimentation and spills during construction are also unlikely to impact on the water quality of these Coastal Wetlands.

Water quality mitigation measures during construction would minimise the likelihood and extent of potential impacts to creeks using appropriate sediment and erosion control procedures and keeping high risk activities such as concrete pouring and earth works away from creek lines where practicable. Cosgroves Creek, Badgerys Creek, South Creek and Kemps Creek provide some limited fish habitat and management and mitigation would target these areas to reduce the likelihood of impacts to water quality. With good management of sediment and erosion in these areas the potential for impacts is low. The remaining waterways in the construction footprint are unlikely to provide fish habitat.

Changes in shading regime and temperature

Shading regimes would be altered at the creek crossings as a result of bridge and culvert structures over small and limited areas of creeks along the footprint. This shading would not be significantly above what fish would encounter in riparian forest areas and it is likely to have only minor impacts to fish movements. Water temperature would be reduced in these areas compared with unshaded areas; however, this reduction would also be minor and form part of a mosaic of micro differences in water temperature along the creek lines.

8.5.2 Groundwater dependent ecosystems

Potential Groundwater Dependent Ecosystems (GDEs) are located around the creeks of the project and to the east of the project (**Section 3.5**). The vegetation within the construction footprint is assumed to be removed at this stage in a worst case scenario, including underneath new bridges across these all creeks. These impacts are discussed as part of native vegetation impact assessment in **Section 8.2.1**. Where possible, vegetation under bridges would be retained. Strategic native vegetation planting would be implemented as part of landscaping of the project. Groundwater at creek crossings would not be abstracted and therefore no impacts on potential GDEs in these areas are expected.

The main project cut is located in the far western portion of the footprint at Ch1500 has the potential to go below the water table, with a maximum draw down to groundwater in this area of about 1.6 metres (JAJV, 2018). The maximum change, if it occurred would be at the base of the cut. The radius of influence from this cut would be about 60 metres at Ch1500. The closest GDE is about 240 metres from the western extent of the cut, four times further than the area of influence. On this basis, the project's groundwater drawdown is unlikely to contribute to impacts on vegetation (JAJV, 2018), although much of the vegetation that may be groundwater dependent will be cleared as part of the project. These are all included in impact assessment in other parts of this report (ie **Section 8.4.1** and **Section 8.4.3**).

The above assessment assumes no temporary bores are installed to provide non-potable water for the project, if this was the case, impacts to GDEs may need to be revised.

8.5.3 Changes to hydrology

Alterations to the natural flow regimes of rivers and streams is recognised as a major factor contributing to loss of biological diversity and ecological function in aquatic ecosystems and is recognised as a Key Threatening Process (KTP) under the TSC Act. Construction of bridges and culverts at waterways and creek adjustments would alter flow patterns at each waterway in the immediate vicinity of the crossings. The structures proposed at each waterway are listed in **Table 8-16**. The creek adjustments are anticipated to have minor and localised impacts on flow as discussed above in **Section 8.5.1**.

In addition to creek adjustments along the project, there would be minor redirection of localised drainage lines as part of construction of the road, to facilitate flow through culverts and the introduction of specific discharge points from sediment basins (construction only) and water quality basins (operation). Both these changes have the potential to slightly increase flow velocities in the local area and alter the timing of water flows reaching creeks (as water is captured, settled then released from the basins). Culvert construction would result in velocity increases though the area of impact would be localised – largely contained to the inlet and outlet of the culverts. Scour protection would be provided to prevent erosion.

These alterations to the local hydrology would have a negligible impact on aquatic species (eg fish), since this type of flow is ephemeral. However, it may change microhabitat features for common frog species. This potential impact would be minor for these species that are adapted to a disturbed peri-urban environment.

Further details on potential changes to hydrology are documented in Appendix M of the EIS.

8.5.4 Fragmentation of identified biodiversity links and habitat corridors

The project has the potential to impact habitat corridors as follows:

- Reduce the area of vegetation comprising habitat corridors
- Reduce the width of habitat corridors
- Increase the width of existing gaps in habitat corridors
- Create new gaps in habitat corridors
- Introduce or move edge effects in corridors.

Two areas mapped as ‘Regional Corridors’ in the EESG Biodiversity Investment Opportunities Map (BIOMAP) for the Cumberland IBRA subregion would be impacted by the project. These are:

- Woodland habitat along the east and west sides of the M7;
- Riparian Forest and adjacent Woodland habitat associated with Kemps, South and Badgerys Creeks.

Woodland habitat along the east and west sides of the M7 Motorway

This section of the regional corridor currently provides some limited north-south habitat connectivity (**Figure 4-1** and **Figure 8-4**). The existing M7 Motorway creates a significant barrier between the east and west portions of the corridor. Clearing of vegetation within the construction footprint is anticipated to increase the width of the existing M7 barrier.

The existing Elizabeth Drive currently provides a significant barrier and gap to north-south habitat connectivity in this portion of the regional corridor. Clearing of vegetation within the construction footprint is anticipated to result in the creation of an additional gap to north-south connectivity in this portion of the corridor.

Riparian Forest and adjacent Woodland habitat associated with Kemps, South and Badgerys Creeks

Kemps, South and Badgerys Creeks provide fragmented narrow linear north-south connectivity through the study area. The existing Elizabeth Drive currently provides the most significant barrier and gap to north-south habitat connectivity along these riparian corridors. Clearing of vegetation within the construction footprint is anticipated to result in an additional gap to north-south connectivity of the Kemps, South and Badgerys Creek riparian corridors.

The width of the Kemps, South and Badgerys Creek riparian corridors vary along their lengths where they pass through the study area. The construction footprint is anticipated to bisect these three riparian corridors to create gaps up to 110 metres or widen existing gaps. Revegetation of the riparian corridor would be undertaken adjacent to, and under bridges (where possible) to re-establish connectivity or minimise connectivity impacts along the riparian corridors post-construction.

Mapped regional corridors within the study area are significantly impacted by existing barriers including the M7 Motorway and Elizabeth Drive. The results of surveys indicate that fauna habitat within mapped regional corridors is already significantly impacted by fragmentation and edge effects.

It is anticipated that clearing of canopy trees and installation of fencing for the project may result in additional barriers to habitat connectivity for common species such as the Sugar Glider and large macropods. However, fencing would be located to reduce roadkill of fauna species and funnel animals to creek crossings where safe passage (including dry passage for terrestrial fauna) would be available. Fauna passage would be available at all four main creek lines (Cosgroves, South, Kemps and Badgerys Creeks).

One small terrestrial threatened fauna species (Cumberland Plain Land Snail – *Meridolum corneovirens*) is likely to occur within the study area, since it was recorded recently, in nearby similar habitat. The mapped regional corridor along Badgerys Creek is considered likely to provide connectivity between suitable habitat for this species to the north and south of the study area. The construction footprint bisects the riparian corridor along Badgerys Creek to create a gap up to 110 metres wide which may affect connectivity for the Cumberland Plain Land Snail. The Cumberland Plain Land Snail is known to exist in populations within a 350 metre radius, with most individuals occurring within a two metre radius (Clark & Richardson, 2002). Therefore, use of large-scale fauna corridors for this species is likely to be limited even when connected areas of suitable habitat are available. The current area is already highly fragmented as a result of existing infrastructure (especially Elizabeth Drive and M7). It is likely that the project would further fragment habitat for this species, but it is unlikely to significantly impact the local population. To further minimise impacts, revegetation of vegetation under bridges to promote leaf litter and minimise weeds would benefit this species.

All other remaining threatened fauna recorded or assumed present within the study area are highly mobile flying species. Clearing for the construction footprint is not anticipated to result in any significant barrier to connectivity for these fauna species.

Given the existing barriers and impacts to habitat within mapped regional corridors the project is not anticipated to result in impacts to movement and/or dispersal pathways for any threatened species or population.

8.5.5 Edge effects on adjacent native vegetation and habitat

Edge effects occur in any cleared or disturbed environment and refer to changes in population or vegetation structure that occur along the edges of habitats. Edge effects occur when environmental conditions are altered (eg light levels, wind speed and temperature) and consequently, can promote the growth of different vegetation types (including weeds), invasion by feral fauna, or change the behaviour of resident fauna (Moenting & Morris, 2006). The extent of influence of edge effects can vary, depending on the type and intensity of impact.

Edge effects have the potential to impact on a range of flora and fauna species identified as occurring or having the potential to occur within the study area. Studies of temperate eucalypt forests of south-eastern Australia show that noise and light penetration persisted until 350-380 metres from the road. Minor impacts extended as much as 1800 metres from the edge of the road (Pocock and Lawrence, 2005). Edge effects also vary depending on the species (Pocock and Lawrence, 2005), but have the greatest impact on sensitive species, such as those that have specific micro-habitat requirements and are less tolerant of disturbance (eg some plants, ground-dwelling mammals and small woodland birds).

Across most of the study area and construction footprint, most patches of vegetation are small, fragmented and contain no core habitat. Much of this vegetation is already situated adjacent to an existing cleared

edge, often a road. As such, many of the areas of vegetation within and directly adjacent to the construction footprint are already subject to considerable edge effects.

Edge effects include impacts to woodland birds by despotic native species such as the Noisy Miners (Barati *et al.*, 2016). The Noisy Miner is abundant throughout the woodland habitats of the study area. Given that this species is an edge specialist, this indicates that all areas within the study area are currently impacted to some extent by edge effects. Most of the flora and fauna species recorded in the study area are tolerant of disturbance.

In some areas of Western Sydney Parklands and along Clifton Avenue, the construction footprint crosses through some larger patches of native vegetation in Moderate/Good condition, including revegetated areas. Within these larger areas it is likely that the project would increase the potential for edge effects to occur. These edge effects are quantified in **Section 8.2.1**.

8.5.6 Injury and mortality of fauna

The primary existing causes of injury and mortality to native fauna within the study area are vehicle collisions along the M7 Motorway and Elizabeth Drive. Connecting minor roads such as Clifton Avenue and Badgerys Creek Road are also likely to contribute to fauna injury and mortality.

The project has the potential to result in an increase to injury and mortality of native fauna as follows:

- Increased widths to existing M7 Motorway resulting from the creation of new slipways etc
- Construction of new motorway through or adjacent to large habitat patches and/or linear habitat corridors.

Injury and mortality of fauna may occur at both construction and operation stages as described below.

Construction

The primary cause of increased fauna injury and mortality during the construction stage of the project would be as a result of vegetation clearing at the commencement of construction. The removal of fauna habitat has inherent risks that can, in part, be mitigated through implementing appropriate clearing procedures.

Many of the native and threatened fauna species that have habitat within the study area are highly mobile. These species typically vacate the vegetation in which they reside at the commencement of vegetation clearing. Other, typically ground dwelling, species are less mobile and at higher risk of construction phase mortality. Measures to reduce accidental injury or mortality to fauna are proposed in **Chapter 10**.

Operation

It is anticipated that the primary cause of fauna injury and mortality at the operational stage of the project would be vehicle collisions. These are most likely to occur where the project intersects an existing connecting link. The most susceptible species are ones that are common, mobile and gregarious, such as arboreal mammals (eg Common Brushtail Possum) or larger terrestrial mammals (eg Eastern Grey Kangaroo and Swamp Wallaby). The main connecting links that would be impacted by the project align with the major creek crossings. All of these crossings are by way of bridge structures, allowing some level of fauna connectivity to remain in operation. Mitigation measures designed to maximise the use of these connecting links, whilst protecting fauna and motorists from vehicle strike have been proposed in **Chapter 10**.

8.5.7 Invasion and spread of weeds

The invasion and spread of weeds pose a high risk to biodiversity and is a potential consequence of project activities when the appropriate management strategies are not implemented. Weeds present a high biodiversity risk as they compete with native vegetation and invade and transform ecosystems (Downey and Grice, Anthony, 2008). This is particularly harmful to threatened species and TECs which are already under environmental stress. Disturbance such as vegetation removal, is often an important precursor to the invasion of weeds (Adair, 1995) and project activities therefore have a particularly high risk of weed establishment.

Weed invasion and spread is an indirect impact of projects which is often caused during construction with the clearing of vegetation and movement of plant throughout the study area. The movement of plant aids in weed dispersal as seeds can become attached to the vehicles in areas of significant weed growth and deposited in relatively intact areas. Other project activities including earthworks and movement of soil can also result in the dispersal of weeds throughout the study area as well as the importation of new weeds into the study area.

Large areas of the study area have a high abundance of exotic species. The dispersal of weeds from these areas to relatively intact areas is therefore possible through the movement of plant across the study area. Management measures would be required to minimise the risk of introduction and spread of weeds. These are provided in **Chapter 10**.

Seventy three exotic species were identified in the study area. Eleven of these are declared as Priority Weeds for the Greater Sydney region under the *Biosecurity Act 2015.* Of these species, nine are also included on the Commonwealth list of 32 Weeds of National Significance (WoNS).

Nineteen additional exotic species recorded in the study area are considered by EESG (OEH, 2018) to be high threat weeds. The presence of high threat weeds is used when determining the integrity of vegetation, based on its composition. The names, classification and legal requirements for these species are outlined in **Table 8-19**.

Table 8-19 High threat weeds identified within the study area

Species	WoNS?	High Threat Weed	Biosecurity Act 2015	Legal requirement
Alternanthera philoxeroides	Yes	Yes	Prohibition on dealings	Must not be imported into the State or sold
			Biosecurity Zone	Within the Biosecurity Zone this weed must be eradicated where practicable, or as much of the weed destroyed as practicable, and any remaining weed suppressed. The local control authority must be notified of any new infestations of this weed within the Biosecurity Zone
			Regional Recommended Measure	Whole region: Land managers prevent spread from their land where feasible. Core infestation area: Land managers mitigate the risk of new weeds being introduced to their land. Land managers reduce the impact on priority assets
Anredera cordifolia	Yes	Yes	Prohibition on dealings	Must not be imported into the State or sold
Acetosa sagittata	No	Yes	N/A	N/A
Acetosella vulgaris	No	Yes	N/A	N/A
Ageratina adenophora	No	Yes	N/A	N/A
Araujia sericifera	No	Yes	N/A	N/A
Asparagus asparagoides	Yes	Yes	Prohibition on dealings	Must not be imported into the State or sold

Species	WoNS?	High Threat Weed	Biosecurity Act 2015	Legal requirement
Axonopus fissifolius	No	Yes	N/A	N/A
Bidens pilosa	No	Yes	N/A	N/A
Briza subaristata	No	Yes	N/A	N/A
Cardiospermum grandiflorum	No	Yes	N/A	N/A
Cestrum parqui	No	Yes	Regional Recommended Measure	Land managers should mitigate the risk of new weeds being introduced to land used for grazing livestock. Land managers should mitigate spread from their land. Plant should not be bought, sold, grown, carried or released into the environment
Chloris gayana	No	Yes	N/A	N/A
Cyperus eragrostis	No	Yes	N/A	N/A
Ehrharta erecta	No	Yes	N/A	N/A
Eragrostis curvula	No	Yes	N/A	N/A
Hypericum perforatum	No	Yes	N/A	N/A
Juncus acutus	No	Yes	N/A	N/A
Lantana camara	Yes	Yes	Prohibition on dealings	Must not be imported into the State or sold
Ligustrum lucidum	No	Yes	N/A	N/A
Ligustrum sinense	No	Yes	N/A	N/A
Lycium ferocissimum	Yes	Yes	Prohibition on dealings	Must not be imported into the State or sold
Nassella neesiana	Yes	Yes	Prohibition on dealings	Must not be imported into the State or sold
Olea europaea subsp. cuspidata	No	Yes	Regional Recommended Measure	Whole region: The plant or parts of the plant are not traded, carried, grown or released into the environment.

Species	WoNS?	High Threat Weed	Biosecurity Act 2015	Legal requirement
				Core infestation area: Land managers prevent spread from their land where feasible. Land managers reduce impacts from the plant on priority assets
Opuntia stricta	Yes	Yes	Prohibition on dealings	Must not be imported into the State or sold
Paspalum dilatatum	No	Yes	N/A	N/A
Romulea rosea	No	Yes	N/A	N/A
Rubus fruticosus (sp. agg)	Yes	Yes	Prohibition on dealings	Must not be imported into the State or sold
Senecio madagascariensis	Yes	Yes	Prohibition on dealings	Must not be imported into the State or sold
Tradescantia fluminensis	No	Yes	N/A	N/A

8.5.8 Invasion and spread of pests

Pest species pose some of the greatest threats to biodiversity as they can displace native species through predation and competition, and damage vegetation by overgrazing and trampling (Adair and Groves, 1998; Clarke, et al., 2000). The project may directly or indirectly result in the invasion and spread of pest species, and consequently, impact biodiversity in the study area.

A total of 14 introduced vertebrate fauna species have been recorded from the study area during surveys. These are:

- Cat *Felis catus*
- Common Myna *Acridotheres tristis*
- Common Starling *Sturnus vulgaris*
- Dog *Canis lupus familiaris*
- European Hare *Lepus europaeus*
- European Rabbit *Oryctolagus cuniculus*
- European Red Fox *Vulpes*
- Goat *Capra hircus*
- Horse *Equus caballus*
- House Sparrow *Passer domesticus*
- Red-whiskered Bulbul *Pycnonotus jocosus*
- Rock Dove *Columba livia domestica*
- Rooster *Gallus*
- Sheep *Ovis aries.*

Project activities have the potential to disperse pest species across the surrounding landscape and increase the ability of such species to utilise habitats during construction and operation phases due to vegetation clearing, habitat removal, increased noise and human presence. Particularly, vegetation clearing, and consequent fragmentation can result in the establishment of predator pest species such as the European Red Fox and Cat; which pose a high risk to birds and small terrestrial fauna.

Within the study area and construction footprint, most patches of vegetation are small and fragmented, and pest species are already well established. As such, many of the areas of vegetation and fauna habitat within and directly adjacent to the construction footprint are impacted by pest fauna. Consequently, while the pest species listed above are likely to capitalise on the disturbance associated with construction and

development activities, the project is unlikely to significantly increase the overall impact of pest species within the study area.

Two additional native species that were recorded in the study area are considered pest species. These are the Noisy Miner *Manorina melanocephala* and Bell Miner *Manorina melanophrys*. The Noisy miner is a native honeyeater that is known to defend habitat aggressively and exclude smaller birds from favoured habitat. As they prefer open structure at habitat edges, they thrive in extensively fragmented areas and smaller habitat patches. Aggressive exclusion of birds from potential woodland and forest habitat by over-abundant noisy miners has been listed as a KTP under the EPBC Act. As project activities would increase fragmentation in the study area, it is likely that the project would increase the abundance of Noisy Miner in the study area and exacerbate this KTP.

Within the study area, there is evidence of Bell Miner Associated Dieback (BMAD). This is caused by an overabundance of psyllids (sap-sucking insects that create a sugary excretion known as a lerp) in conjunction with Bell Miners (who feed on both the psyllids and lerp). Like the Noisy Miner, Bell Miners are aggressive and exclude other psyllid feeding species from their territories. As a result, psyllid populations increase and consequently, cause substantial canopy damage. In Western Sydney, Grey Box *Eucalyptus moluccana* appear to be the most affected, and areas within the north-eastern extent of the study area were recorded as having high Bell Miner abundance and increased dieback during surveys. During recent unseasonably dry weather, evidence of die back in the study area and surrounds has increased.

Grey Box is a key component of the critically endangered Cumberland Plain Woodland community, found within the study area, and so impacts on this species are likely to impact on this community. Over abundant psyllid populations and bell miner colonies are associated with landscape-level disturbance. As the Cumberland Plain has been heavily cleared and remaining vegetation exists in a highly fragmented condition, the conditions have allowed for BMAD to flourish.

As the project would result in further vegetation clearing and localised fragmentation, it could increase the prevalence and severity of BMAD in the locality. However, impacts are likely to be insignificant when compared to the broad-scale clearing that has occurred in the past as a result of agriculture and urban development. Further, the project would not interfere with any of the 10 priority actions identified to help recover species affected by BMAD (OEH, 2018).

8.5.9 Invasion and spread of pathogens and disease

The project has the potential to increase the spread of pathogens that threaten native biodiversity values. Pathogens specific to the project are; the soil-borne pathogen *Phytophthora cinnamomi* (Phytophthora), *Austropuccinia psidii* which causes the disease Myrtle rust, *Batrachochytrium dendrobatidis* (Chytrid fungus) and Psittacine beak and feather disease (PBFD). All four of these pathogens are listed as KTPs under the TSC Act.

Phytophthora infects roots and is associated with damage and death to native plants. It may be dispersed over large distances in flowing water, such as storm runoff, or may be spread within a site via mycelial growth from infected roots to roots of healthy plants. Propagules of Phytophthora may also be dispersed by vehicles (eg cars and earth moving equipment), animals, walkers and movement of soil (DAWR, 2018).

Myrtle rust causes deformed leaves and defoliation, reduced fertility, dieback and plant death of plant within the Myrtaceae family. This includes native Australian plants such as *Callistemon spp., Melaleuca spp*., and *Eucalyptus spp.* The spores of Myrtle rust can be easily dispersed via contaminated clothing, hair, skin and infected plant material as well as via wind dispersal and animal movement (DoEE, n.d.).

The project may increase the risk of dispersal of Phytophthora and Myrtle rust as a result of construction activities which involve the disturbance of soil and the movement of plant across the study area.

Chytrid fungus causes the infectious disease *Chytridiomycosis* (amphibian chytrid fungus disease) which affects amphibians worldwide. The disease causes sporadic deaths and has been implicated in the species extinctions of frogs since it was first discovered in Australia in 1993. Chytrid fungus is most likely to be spread through direct contact between frogs or tadpoles or through exposure to contaminated water (OEH,

2018). No threatened frogs are considered likely to occur within the study area, and chytrid fungus is therefore considered unlikely to have a significant impact within the study area.

PBFD is a highly infectious viral disease which affects parrots. It is an often fatal disease which causes feather, beak and skin abnormalities and is transmitted orally or in faeces or feathers. It can remain alive for years in nest hollows, making the virus extremely stable in the environment (DoEE, n.d.). PBFD can have a significant impact on threatened parrot species with small populations, however, larger populations of parrot species can sustain losses and develop immunity to the disease (DoEE, n.d.). Therefore, as there are no threatened parrot species likely to occur within the study area, PBFD is unlikely to have a major impact within the study area.

The risk of these pathogen being spread as a result of the project would be minimised through a number of management measures which are provided in **Chapter 10**.

8.5.10 Noise, light and vibration

Noise, dust, light, and vibration can impact on surrounding biodiversity during construction and operation of any project, and impacts from linear infrastructure, can extend well into vegetation on either side of the study area (see **Section 8.5.5**).

Noise and Vibration

Vegetation clearing, ground disturbance, machinery, vehicle movements and general human presence would increase noise within the study area and surrounding area during both construction and operational phases of the project. This would be particularly true during the construction phase of the project.

Noise impacts on fauna are difficult to quantify, especially in urban and semi-rural areas where there is a significant level of baseline noise from existing roads, residents and industry. Sudden additional noise does however have the potential to disrupt foraging, breeding or movement behaviours.

Impacts from noise and vibration are likely to be localised to construction areas. Fauna within and surrounding the study area would already be accustomed to noise associated with residential, light industrial and semi-rural areas. Noise sources include vehicles, light machinery and human activity.

The project would increase noise through increased vehicle activity on existing roads, new roads through areas currently considered semi-rural and construction noise. This is likely to create short term impacts on fauna, however remaining vegetation would provide refuges for fauna to retreat to, and impacts would be reduced after construction.

These impacts are not considered to have a significant, long-term impact on fauna, including threatened fauna. Within the area of impact, some sensitive species (eg woodland birds) may avoid the noise, while some more tolerant species (eg small mammals) would habituate over the longer-term (Byrnes, et al., 2012).

Light pollution

Light pollution including direct glare, chronic or periodic increased illumination and temporary unexpected fluctuations in lighting (eg from passing vehicles) can have adverse effects on wildlife and are known as ecological light pollution (Longcore & Rich, 2004) or photo pollution (Perry, et al., 2008). Photo pollution can both repel and attract animals, depending on the taxa. For example, amphibians are attracted to artificial light sources, due to increased availability of insects, however they are then often more susceptible to vehicle collisions (Perry et al., 2008).

Microchiropteran bats are also often attracted to new light sources but are less vulnerable to vehicle strike. Species with a wide ecological niche, such as pest species like cane toads are often more likely to congregate in areas impacted by artificial light, which can impact on the community structure of fauna populations (Perry et. al., 2008).

The project would increase artificial lighting within the study area and surrounds during the operation phase and night work lighting during construction. As such, the project may potentially affect nocturnal fauna by

interrupting their life cycle or impacting on species that can be more vulnerable to predation (eg some small mammals).

Roads within the locality are currently lit and the existing M7 Motorway and Elizabeth Drive experience increased photo pollution due to heavy traffic and regular road works. Fauna within the area would already be adapted to photo pollution and the increased artificial lighting associated with the project is unlikely to have a significant effect.

Overall, a majority of species, including threatened species, recorded or likely to occur within the study area are highly mobile or gregarious species that have adapted to, and in some instances are attracted to (eg Noisy Miner), vegetation edges.

Individuals that utilise resources within the study area would likely have become accustomed to background noise, light and vibration associated with existing roads and residential areas, due to the presence of the existing M7 Motorway, Elizabeth Drive and surrounding townships (eg Cecil Park, Kemps Creek, Badgerys Creek and Luddenham) and infrastructure like the SUEZ Elizabeth Drive Landfill, Brandown Quarries, Boral Badgerys Creek, and the Sydney International Shooting Centre.

8.6 Impact summary

A summary of biodiversity impacts is provided below in **Table 8-20**. The table also provides a summary of which impacts require offsetting.

Table 8-20 Summary of impacts

Impact	Biodiversity values	Nature of impact	Extent of impact excluding certified area	Duration	Does the project constitute or exacerbate a key threatening process?
Removal of native vegetation	Total native vegetation	Direct	73.65 ha	Long term During construction	• Clearing of native vegetation
	Cumberland Plain Woodland CEEC (TSC Act) Moist Shale Woodland EEC (TSC Act) River-flat Eucalypt Forest on Coastal Floodplains EEC (TSC Act) Shale Gravel Transition Forest EEC (TSC Act) Swamp oak floodplain forest EEC (TSC Act) Total TECs (TSC Act)	Direct	60.16 ha (including 18.07 ha of Derived grasslands on shale hills of the Cumberland Plain) 0.44 ha 3.23 ha 6.91 ha 2.53 ha 73.27 ha	Long term During construction	• Clearing of native vegetation
	Cumberland Plain Shale Woodlands and Shale-Gravel Transition Forest CEEC (EPBC Act) Western Sydney Dry Rainforest and Moist Woodland on Shale CEEC (EPBC Act) Total TECs (EPBC Act)	Direct	38.48 ha 0.44 ha 38.92 ha	Long term During construction	• Clearing of native vegetation •

Impact	Biodiversity values	Nature of impact	Extent of impact excluding certified area	Duration	Does the project constitute or exacerbate a key threatening process?
Removal of threatened fauna species habitat and habitat features	Eastern Freetail-bat Eastern Bentwing-bat Eastern False Pipistrelle Greater Broad-nosed Bat Cumberland Plain Land Snail Grey-headed Flying-fox Little Bentwing-bat Southern Myotis White-bellied Sea-Eagle Yellow-bellied Sheathtail-bat	Direct	55.58 ha (foraging) 55.58 ha (foraging) 55.58 ha (foraging) 55.58 ha (foraging) 1.86 ha 55.20 ha (foraging) 55.58 ha (foraging) 0.92 ha (breeding) 3.69 ha (foraging) One nest (breeding) 3.69 ha (foraging) 55.58 ha (foraging)	Long term During construction	• Clearing of native vegetation • Bushrock removal • Loss of hollow-bearing trees • Loss or degradation (or both) of sites used for hill-topping by butterflies • Removal of dead wood and dead trees

Impact	Biodiversity values	Nature of impact	Extent of impact excluding certified area	Duration	Does the project constitute or exacerbate a key threatening process?
Removal of threatened plants	*Dillwynia tenuifolia* *Grevillea juniperina* subsp. *juniperina* *Marsdenia viridiflora* subsp. *viridiflora* in the Bankstown, Camden, Campbelltown, Fairfield, Holroyd, Liverpool and Penrith Local Government Areas *Pimelea spicata* *Pultenaea parviflora*	Direct	244 individuals, area of occupancy 3.63 ha, and 13.38 ha of potential habitat 0 individuals, area of occupancy 0 ha, and 49.38 ha of potential habitat 0 individuals, area of occupancy 0 ha, and 55.2 ha of potential habitat 0 individuals, area of occupancy of 0 ha, and 42.53 ha of potential habitat 90 individuals, area of occupancy of 0 ha, and 7.29 ha of potential habitat	Long term During construction	• Clearing of native vegetation
Aquatic impacts	Waterway modification Water quality Removal of woody debris Instream barriers Pond dewatering	Direct	Temporary localised disturbance and potential loss of riparian habitat Increased turbidity and nutrients Impediment of fish movements	Short term During and post construction	• Removal of large woody debris or snags (FM Act)
Groundwater Dependent Ecosystems	Vegetation Fauna habitat	Indirect	Local	Minimal, or short term if temporary bores installed	No
Changes to hydrology	Waterways	Indirect	Considered minor and manageable	Short term During and post construction	• Alteration to the natural flow regimes of rivers and streams and their floodplains and wetlands

Impact	Biodiversity values	Nature of impact	Extent of impact excluding certified area	Duration	Does the project constitute or exacerbate a key threatening process?
Fragmentation of identified biodiversity links and habitat corridors	Wildlife Corridors	Direct and Indirect	Moderate and manageable	Short and long term During and post construction	• Land clearance (EPBC Act) • Clearing of native vegetation (TSC Act)
Edge effects on adjacent native vegetation and habitat	Vegetation to be fragmented	Indirect	12.73 ha of native vegetation (including 7.03 ha of revegetation) within Western Sydney Parklands and east of Clifton Avenue	Long term During and post construction	• Range of KTPs listed in this table associated with edge effects (ie invasion of exotic species)
Injury and mortality of fauna	Potentially all fauna species present	Direct	Local	Long term During and post construction	No
Invasion and spread of weeds	All vegetation adjacent to works	Indirect	Local in area of disturbance	Long term During and post construction	• Invasion and establishment of exotic vines and scramblers • Invasion and establishment of Scotch broom (*Cytisus scoparius*) • 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 Bitou bush and Boneseed *(Chrysanthemoides monilifera*) • 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

Impact	Biodiversity values	Nature of impact	Extent of impact excluding certified area	Duration	Does the project constitute or exacerbate a key threatening process?
Invasion and spread of pests	All vegetation adjacent to works	Indirect	Local	Long term During and post construction	• Competition and grazing by the feral European rabbit (*Oryctolagus cuniculus*) • Competition and habitat degradation by feral goats (*Capra hircus*) • Predation and hybridisation of feral dogs (*Canis lupus familiaris*) • Predation by the European red fox (*Vulpes vulpes*) • Predation by the feral cat (*Felis catus*) • Predation by Plague Minnow or Mosquito Fish (*Gambusia holbrooki*)
Invasion and spread of pathogens and disease	All vegetation adjacent to works	Indirect	Local	Long term During and post construction	• Infection of native plants by *Phytophthora cinnamomi* • Introduction and Establishment of Exotic Rust Fungi of the order Pucciniales pathogenic on plants of the family Myrtaceae • Infection by psittacine circoviral (beak and feather) disease affecting endangered psittacine species and populations • Infection of frogs by amphibian chytrid causing the disease chytridiomycosis
Noise, light and vibration	All local fauna species	Direct/indirect	Local	Short and long term During and post construction	No

9 Cumulative impacts

Cumulative biodiversity impacts may arise from the interaction of construction and operation activities of the project and other approved or proposed projects in the area. When considered in isolation, specific project impacts may be considered minor. These minor impacts may be more substantial, however, when the impact of multiple projects on the same receivers is considered. As such, the biodiversity impacts discussed in **Chapter 7**, above, were assessed in consideration of the following recently completed, ongoing and proposed projects:

- Western Sydney Airport.
- Sydney Metro Greater West.
- The Northern Road Upgrade
  - Stage 5 (Littlefields Road to Glenmore Park)
  - Stage 6 (Littlefields Road to Eaton Road).
- Other existing road network upgrades and potential road projects, including:
  - Elizabeth Drive Upgrade
  - Mamre Road Upgrade
  - Outer Sydney Orbital.
- Major land releases, including:
  - Western Sydney Aerotropolis
  - South West Growth Area
  - Western Sydney Employment Area.

The above projects are in varying stages of delivery and planning. This chapter provides an assessment of cumulative biodiversity impacts based on the most current and publicly available information on the above. In many instances this is a high-level qualitative assessment. The assessment of cumulative impacts per project is discussed in the sections that follow.

9.1 Western Sydney Airport

The Australian Government is currently constructing the Western Sydney Airport on the 1,780-hectare Commonwealth-owned land at Badgerys Creek. The airport will service both domestic and international markets and development will be staged in response to ongoing growth in aviation demand. Stage 1 includes the establishment of the following to provide operational capacity for about 10 million passengers per year and freight traffic:

- A single 3,700 metre runway in the north-western portion of the site
- A terminal
- Other support facilities
- Foundation for further expansion.

It is anticipated that the demand in relation to this airport will reach about 82 million passengers a year by 2063. To cater for this, a second parallel runway will be constructed at a later stage.

The EIS for the Western Sydney Airport was placed on display in October 2015 and finalised on 15 September 2016 with a Revised Draft Airport Plan. The assessment found that the airport would result in some adverse impacts on the environment and community, particularly in relation to the following:

- Air quality
- Biodiversity
- Health
- Noise
- Water quality.

Mitigation measures were proposed to reduce these potential impacts during construction.

9.1.1 Construction cumulative impacts

Construction of Western Sydney Airport is under way and the airport is set to open in 2026. Construction activities for Stage 1 involve three major work phases:

- Site preparation works, including:
  - Securing the construction impact zone
  - Establishing site services and construction facilities
  - Clearing vegetation
  - Undertaking major earthworks.
- Aviation infrastructure works, including construction of the:
  - Runway, taxiways and apron areas
  - Internal road network
  - Terminal complex
  - Air traffic control tower
  - Freight, cargo and maintenance facilities
  - Fuel farm.
- Site commissioning activities at the completion of the aviation infrastructure works
  - Involves testing and commissioning of all facilities in readiness for the operation.

The Western Sydney Airport project footprint is predicted to impact on about 280.8 hectares of native vegetation (GHD, 2016). When considered alongside the 55.58 hectares of native vegetation in moderate to good condition to be removed for the project, the projects will together remove over 336 hectares of native vegetation, including threatened ecological communities and habitat for threatened species.

There would be significant cumulative biodiversity impacts associated with the construction of the project and the Western Sydney Airport.

9.1.2 Operation cumulative impacts

The Western Sydney Airport and the project would be operational at the same time. As a result, impacts such as injury and mortality of fauna and noise, light and vibration may be greater than if the projects were operating in isolation.

There would likely be, at minimum, moderate cumulative biodiversity impacts associated with the operation of the project and the Western Sydney Airport.

9.2 Sydney Metro Greater West

Transport for NSW (TfNSW) recently identified recommended corridors for a rail option to provide a major transport link between the North West Growth Area, Western Sydney Airport, and the South West and Greater Macarthur Growth Area. This rail option would connect the existing Main South Line (T8) near Macarthur Station to the existing Main Western Line (T1) near St Marys Station, via the Western Sydney Airport.

This railway servicing the new Western Sydney Airport will be developed and delivered by Sydney Metro. It is referred to as the Sydney Metro Greater West. Planning for this project is currently underway and as such, environmental assessment results are not yet available.

9.2.1 Construction cumulative impacts

Construction timeframes for the Sydney Metro Greater West are likely to have some overlap with the construction of the project. During any timeframes where construction activities are concurrent, increased biodiversity impacts are likely. This will be dependent on the specific construction locations and the different construction activities, and the extent of biodiversity impacts.

Although there are no details available on the biodiversity impacts of the Sydney Metro Greater West project, given that the impacts of the project are significant, it is likely that there would be significant cumulative biodiversity impacts associated with the construction of the project and the Sydney Metro Greater West.

9.2.2 Operation cumulative impacts

The Sydney Metro Greater West and the project would both be operational in the longer term (ie opening of the Metro may occur after the opening of the project).

It is likely that there would be, at minimum, moderate cumulative biodiversity impacts associated with the operation of the project and the Sydney Metro Greater West.

9.3 The Northern Road Upgrade

An upgrade of the Northern Road was approved in May 2018 as part of the Western Sydney Infrastructure Plan. The upgrade will improve the capacity of the existing road and create about eight kilometres of new road between Mersey Road, Bringelly and just south of the existing Elizabeth Drive, Luddenham to realign the section of The Northern Road that currently runs through the Western Sydney Airport site. Once the upgrade is complete, The Northern Road will connect the project and the M4 Western Motorway and improve connectivity with the Western Sydney Airport (RMS, 2017). The upgrade is being carried out in six stages:

- Stage 1 – between The Old Northern Road, Narellan and Peter Brock Drive, Oran Park
  - Completed
- Stage 2 – between Peter Brock Drive, Oran Park and Mersey Road, Bringelly
  - Under construction
- Stage 3 – between Glenmore Parkway, Glenmore Park and Jamison Road, South Penrith
  - Under construction
- Stage 4 – between Mersey Road, Bringelly and Eaton Road, Luddenham
  - Under construction
- Stage 5 – between Littlefields Road, Luddenham and Glenmore Parkway, Glenmore Park
  - Construction to start early 2019
- Stage 6 – between Eaton Road, Luddenham and Littlefields Road, Luddenham
  - Construction to start mid-2019.

9.3.1 Construction cumulative impacts

Stages 1 through 4 of The Northern Road upgrade will be completed by the time construction of the project commences. The construction for Stage 5 is scheduled for early 2019 to end of 2022. The construction for Stage 6 is scheduled for mid-2019 to end of 2021. Construction activities associated with Stage 5 and 6 may overlap with the project construction. Both these stages are in the vicinity of the project.

It is anticipated that about 2.4 hectares of remnant native vegetation and up to 3.9 hectares of planted vegetation along the M4 Motorway would be impacted for the Northern Road upgrade (Jacobs, 2016). A further 59.2 hectares of native vegetation is likely to be impacted between Narellan and Bringelly (SKM, 2012). When considered alongside the 55.58 hectares of native vegetation in moderate to good condition to be removed for the project, the projects will together remove over 121 hectares of native vegetation, including threatened ecological communities and habitat for threatened species.

Given that the impacts of the project are significant, there would be significant cumulative biodiversity impacts associated with the construction of the project and The Northern Road Upgrade Stages 5 and 6.

9.3.2 Operation cumulative impacts

The Northern Road upgrade and the project would be operational at the same time. As a result, impacts such as injury and mortality of fauna and noise, light and vibration may be greater than if the projects were operating in isolation.

It is likely that there would be, at minimum, moderate cumulative biodiversity impacts associated with the operation of the project and The Northern Road Upgrade Stages 5 and 6.

9.4 Other road network upgrades

There are a number of other planned and potential road upgrade projects in the western Sydney area that may contribute to cumulative biodiversity impacts. These potential projects include:

- Elizabeth Drive upgrade – Roads and Maritime has started site investigations, including preliminary engineering, preliminary/strategic designs, environmental field investigations, and strategic modelling. These investigations are expected to be completed by mid-2019
- Mamre Road upgrade – the NSW Government has started early planning for a future upgrade of a 10 kilometre section of Mamre Road, between the M4 Motorway and Kerrs Road to support economic and residential growth in the area
- Outer Sydney Orbital – a future north-south motorway and freight rail line in Sydney's West to support the growth of western Sydney and the distribution of freight across Sydney and regional NSW. While the Outer Sydney Orbital is in early stages of planning, it would provide connections to the Western Sydney Airport.

In addition, the M7 Motorway was planned and constructed with enough width in the median to allow future widening to six lanes. While there are no plans yet to carry out this upgrade, it is noted that there is a potential for increase in traffic lanes in a connecting motorway.

These projects are currently at varying stages of planning and no design or environmental assessment information is currently publicly available.

9.4.1 Construction cumulative impacts

The timing for construction of the above projects has not yet been announced. However, there is potential for overlaps in construction timing between the project and some of these road upgrade works.

Although there are no details available on the biodiversity impacts of the other road network upgrades, given that the impacts of the project are significant, it is likely that there would be significant cumulative biodiversity impacts associated with the construction of the project and other road projects.

9.4.2 Operation cumulative impacts

It is likely that there would be, at minimum, moderate cumulative biodiversity impacts associated with the operation of the project and other road projects.

9.5 Growth areas

Western Sydney is the focus of a number of plans and policies to promote changes in land use and to increase employment opportunities, in particular within the following defined areas:

- Western Sydney Aerotropolis – The area surrounding the Western Sydney Airport that was previously known as the Western Sydney Airport Growth Area (see **Figure 1-1**). The Aerotropolis would establish a new high-skill jobs hub across aerospace and defence, manufacturing, healthcare, freight and logistics, agribusiness, education and research industries, and is expected to contribute to establishing 200,000 new jobs for Western Sydney (DPIE, 2018).

- South West Growth Area – The broader area surrounding the Western Sydney Airport (see **Figure 1-1**). This will guide new infrastructure investment, identify new homes and jobs close to transport, and coordinate services in the area. The NSW Government is currently at the early stages of investigations.
- Western Sydney Employment Area – The area north-east of the Western Sydney Growth Area (see **Figure 1-1**). Established by the NSW Government to be a new employment space, providing opportunities for local people to work closer to home.

The project would traverse the South West Growth Area and service the Western Sydney Aerotropolis, and indirectly, the Western Sydney Employment Area. The project would serve and facilitate the growth by providing increased road capacity and reducing congestion and travel times in the area.

In November 2018, the Commonwealth Minister for the Environment and the NSW Minister for Planning and Public Spaces agreed on a strategic assessment of the proposed urban development of Western Sydney around the Western Sydney Airport. The strategic assessment is designed to strike a balance between positive environmental outcomes and meeting the needs of an expanding western Sydney population. As part of the Western Sydney Growth Centre (WSGC) Strategic Assessment, the Cumberland Plain Conservation Plan is currently being developed and will take a holistic view of biodiversity of Western Sydney, covering approximately 200,000 hectares. By taking a larger, strategic view of potential impacts, biodiversity values and offset requirements, strategic conservation planning sets out to minimise impacts to biodiversity within the western Sydney area as a whole.

9.5.1 Construction cumulative impacts

The timing for the construction of developments within the above-mentioned growth areas has not yet been announced. There are potential of overlaps in construction timing between some developments and the project.

It is likely that there would be significant cumulative biodiversity impacts associated with the construction of the project and the development associated with the nearby growth areas.

9.5.2 Operation cumulative impacts

It is likely that there would be, at minimum, moderate cumulative biodiversity impacts associated with the operation of the project and the development associated with the nearby growth areas.

9.6 Conclusion

Overall, the project would have significant cumulative biodiversity impacts associated with the construction; and at minimum, moderate cumulative biodiversity impacts associated with operation of the project and the other ongoing and planned developments in the area.

10 Mitigation

Once all practicable steps to avoid or minimise impacts have been implemented at the design phase, mitigation measures would be implemented to further reduce the potential ecological impacts of the project.

Mitigation measures are to be implemented during the construction and operational phases. The Roads and Maritime guidelines and procedures identify a range of mitigation techniques to be applied, including managing the vegetation clearing process, re-establishment of native vegetation at the end of a project, weed management, provision of supplementary fauna habitat (eg nest boxes) and installation of erosion and sediment controls as appropriate. These measures would be included in a flora and fauna management plan as part of a construction environmental management plan for the project.

The following mitigation measures as outlined in the *Biodiversity Guidelines: Protecting and managing biodiversity RTA projects* (RTA, 2011) are recommended for implementation (see **Table 10-1**). The RIAR document Policy Guidelines for fish habitat conservation and management (2013 update) (DPI, 2013) has also been used as an example of best practice management measures.

Measures to avoid, minimise or manage biodiversity impacts as a result of the project are detailed in **Table 10-1**. The measures would ensure that threat abatement plans (eg for affected EPBC Act listed species or ecological communities) are not compromised. This is relevant to the threat abatement plans that relate to pest species, weeds and pathogens. Additional safeguards have been added to **Table 10-1** based on the project's specific impacts and measures required to ameliorate them.

Table 10-1 Environmental management measures (biodiversity)

Impact	Reference	Environmental management measure	Responsibility	Timing
All biodiversity impacts	B01	A Construction Flora and Fauna Management Plan (CFFMP) will be prepared. The measures in the CFFMP will include: • A site specific induction • Identification of clearing limits and exclusion fencing • Pre-clearance surveys • Vegetation clearing procedures • An unexpected finds procedure • Procedures for weed management and monitoring • A process for dewatering farm dams and the relocation of aquatic fauna • Provision of supplementary fauna habitat (eg nest boxes).	Contractor	Prior to construction
	B02	A Habitat Compensation Plan (HCP) will be prepared and implemented as part of the CFFMP for the project. The HCP will target those species that will be impacted by the loss of hollows. Measures will include: nest boxes, reuse of salvaged hollows and/or new technologies eg chainsaw hollows), as well as replacement of woody debris and bushrock with consideration to Guide 5 and Guide 8 of Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects (RTA, 2011).	Contractor	Prior to construction
Removal of native vegetation, threatened species, and threatened species habitat	B03	Native vegetation, threatened species and threatened species habitat removal will be minimised where practicable through detailed design. This will include avoiding the nest and surrounds of the White-bellied Sea-Eagle, where practicable.	Contractor	Detailed design
	B04	Biodiversity offsets for the project will be purchased and managed in accordance with the Biodiversity Offset Strategy prepared for the project.	Roads and Maritime	Prior to operation
	B05	Pre-clearing surveys will be undertaken in accordance with *Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects* (RTA, 2011) (*Guide 1: Pre-clearing process*). The following species identified on or near the study area will require particular attention: • White-bellied Sea-Eagle If design cannot avoid the White-bellied Sea-Eagle nest, then pre-clearing measures to avoid impact to the nest will be implemented. This will include pre-clearing survey to establish if it is currently being used and removal of the next by an ecologist experienced in similar procedures. The potential impacts of habitat removal will be minimised by removing the nest outside of the nesting period (typically lays between June and September, with young remaining in the nest for 70 days). Time will be allowed on either side of the nesting period to allow individuals to select and	Contractor	Prior to construction

Impact	Reference	Environmental management measure	Responsibility	Timing
		construct a new nest site prior to clearing. • Cumberland Plain Land Snail Pre-clearance surveys undertaken immediately prior to clearing works by a qualified ecologist in all vegetated areas to be disturbed that have been identified as known or potential habitat for Cumberland Plain Land Snail (see **Figure 4-2**). As identified in the CFFMP, all individual Cumberland Plain Land Snails found during pre-clearance surveys will be translocated to adjacent areas of suitable habitat.		
	B06	An unexpected threatened species finds procedure will be developed as part of the CFFMP and based on *Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects* (RTA, 2011) (*Guide 1: Pre-clearing process*). The procedure will include requirements for workers to be made aware of the potential flora and fauna species that may be encountered during construction (including training staff on species identification) and outline the process for the identification and management of unexpected flora and fauna. In the event that any threatened species are identified during construction, the following steps would be undertaken: 1. Stop work immediately in the location of the unexpected find to avoid any potential impacts. 2. Notify the environmental manager. 3. Environmental manger will arrange for an ecologist to conduct an assessment of significance of the likely impact, develop management options, and notify DPIE, EESG and DoEE as appropriate. 4. If a significant impact is unlikely to occur, recommence work and maintain regular site inspections. 5. If a significant impact is likely to occur: a. Consult with DPIE, EESG and DoEE as appropriate. b. Obtain approvals, licenses or permits as required. c. Recommence work once advice is sought and necessary approvals, licenses and permits are obtained. 6. Include species in subsequent inductions, toolbox talks and update the CEMP	Contractor	During construction

Impact	Reference	Environmental management measure	Responsibility	Timing
Removal of native vegetation and threatened species habitat	B07	Vegetation and habitat removal will be undertaken in accordance with Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects (RTA, 2011) (Guide 4: Clearing of vegetation and removal of bushrock).	Contractor	During construction
	B08	Revegetation will be undertaken in accordance with Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects (RTA, 2011) (Guide 3: Re-establishment of native vegetation) and the Landscape Plan prepared for the project.	Roads and Maritime/ Contractor	During construction
	B09	Habitat will be replaced or re-instated in accordance with Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects (RTA, 2011) (Guide 5: Re-use of woody debris and bushrock and Guide 8: Nest boxes). A Habitat Compensation Plan, as described in B02 will include this measure.	Contractor	During construction
Riparian vegetation	B10	Removal of riparian vegetation at creek crossings will be minimised and vegetation connectivity across the riparian zone will be maintained where possible.	Contractor	During construction
Riparian vegetation and aquatic impacts	B11	Measures to protect aquatic and riparian habitat will be outlined in the CFFMP and protected in accordance with *Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects* (RTA, 2011) (*Guide 10: Aquatic habitats and riparian zones*) and Section 3.3.2 *Standard precautions and mitigation measures* of the Policy and guidelines for fish habitat conservation and management Update 2013 (DPI, 2013).	Contractor	Prior to construction
Aquatic impacts	B12	Creek adjustments will be investigated and removed or minimised during detailed design where feasible. Proposed creek adjustments will be designed such that they result in minimal changes to flow velocities.	Contractor	Detailed design
	B13	Creek corridors will be revegetated with locally native riparian vegetation, in accordance with the requirements of the Policy and guidelines for fish habitat conservation and management (DPI, 2013) and in consideration of the *Guidelines for instream works on waterfront land* (DPI, 2012). The creek channels will be rehabilitated to preconstruction conditions or better.	Roads and Maritime/ Contractor	During construction
	B14	Bridge pier locations within instream (main waterway channel) or on creek banks will be avoided during detailed design at the South Creek, Cosgroves Creek, Badgerys Creek and Kemps Creek crossings. Where avoidance is not possible, further biodiversity assessment will be required.	Contractor	Detailed design
	B15	Large woody debris will be retained for creek crossing works where practicable. Any large woody debris placed in the realigned waterways will be relocated in consultation with an ecologist.	Contractor	During construction
	B16	Permanent and temporary waterway crossings will be designed and constructed to maintain fish passage in accordance with Why do Fish Need to Cross the Road? Fish Passage Requirements	Contractor	During construction

Impact	Reference	Environmental management measure	Responsibility	Timing
		for Waterway Crossings (DPI Fisheries, 2003). Crossing types should be matched to waterway type as per Table 1 in DPI Fisheries (2003).		
	B17	The temporary application of mulch during construction will be managed to avoid the potential for material and tannin run-off into waterways. This will include limiting the application of mulch near waterways where practicable. The application of mulch for permanent landscaping must be designed and planned to avoid material and tannin runoff.	Roads and Maritime/ Contractor	During construction
	B18	Emergency response protocols and procedures will be included in the Project Construction Environmental Management Plan Project (CEMP) and implemented in the event of a contaminant spill or leak.	Contractor	During construction
	B19	Spill kits will be located to allow for timely response to uncontained spills. Site inductions will include a briefing on the use of spill kits.	Contractor	During construction
Groundwater Dependent Ecosystems	B20	Interruptions to water flows associated with groundwater dependent ecosystems will be minimised through detailed design.	Contractor	Detailed design
Changes to hydrology	B21	Changes to existing surface water flows will be minimised through detailed design.	Contractor	Detailed design
Fragmentation of identified biodiversity links and habitat corridors	B22	Connectivity measures will be implemented in accordance with Wildlife Connectivity Guidelines for Road Projects (Roads and Maritime in prep). Fencing will be located to reduce roadkill of fauna species and funnel animals to creek crossings where safe passage will be available. Detailed design is to retain fauna passage at all four main creek lines (Cosgroves, South, Kemps and Badgerys Creeks).	Contractor	Detailed design and during construction
Edge effects on adjacent native vegetation and habitat	B23	Exclusion zones will be set up at the limit of clearing in accordance with Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects (RTA, 2011) (Guide 2: Exclusion zones).	Contractor	During construction
Injury and mortality of fauna	B24	Fauna will be managed in accordance with Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects (RTA, 2011) (Guide 9: Fauna handling).	Contractor	During construction
Invasion and spread of pest species	B25	Weed species will be managed in accordance with Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects (RTA, 2011) (Guide 6: Weed management).	Contractor	During construction
Invasion and spread of pathogens and disease	B26	Pathogens will be managed in accordance with Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects (RTA, 2011) (Guide 2: Exclusion zones).	Contractor	During construction

Impact	Reference	Environmental management measure	Responsibility	Timing
Noise, light and vibration	B27	Shading impacts will be minimised through detailed design of bridge and culvert structures. The need for artificial lighting during construction and operation will be minimised through detailed design where feasible, including directing lighting away from vegetated areas where practicable.	Contractor	Detailed design, during construction

11 Offsetting required

Under the Framework for Biodiversity Assessment (OEH, 2014), any residual impacts that cannot be avoided, minimised or mitigated, must be offset. An accredited assessor uses the Biobanking Calculator to determine the ecosystem and/or species credits required to offset the loss in value for each credit type.

Biobanking credits are split in to two broad categories; ecosystem credits and species credits. The number of credits required to offset a given impact is a based on several factors, including:

- Ecosystem credits – the loss in site value and the area over which that loss will occur
- Species credits – the number of individuals or the area of habitat that would be removed.

The number of ecosystem credits required for the potential direct impacts of the project are outlined in **Table 11-1** and the full credit report is provided in **Annexure C**. A detailed Biodiversity Offset Strategy (BOS) is included in **Annexure D** which provides greater detail regarding the potential mechanisms for meeting this offset obligation.

The indirect impacts of the project comprise native vegetation within Western Sydney Parklands and adjoining Clifton Avenue that would be subject to increased edge effects, due to the creation of one or more new edges within previously unfragmented vegetation and some small areas that would become unviable due to the small size of the remaining patches.

Offsets for indirect impacts were calculated in an additional FBA calculator file, using the same vegetation zone site values as for the areas of direct impacts. Offsets were calculated for non-viable patches by reducing site values for these areas to zero, effectively treating these areas as direct impacts.

For new edges, offsets were calculated by reducing the scores for two ground cover site attributes and the exotic plant cover site attribute within the indirect impact areas by one point each. This resulted in a reduction in site value of about 10 to 13 per cent for each vegetation zone. This level of reduction is likely to be appropriate given the generally low site values of vegetation across the construction footprint and the extent of proposed environmental management measures, which should mitigate much of the potential indirect impacts of the project. The number of ecosystem credits required for the potential indirect impacts of the project is 154, with details outlined in **Table 11-2** below. Total ecosystem credit requirements are 2,568. The full credit report is provided in **Annexure C**.

Table 11-1 Ecosystem credits summary – direct impacts

Vegetation Zone	PCT Name	Threatened species with highest credit requirement	Loss in landscape value	Loss in site value score	Total area impacted requiring offsets (ha)	Area impacted meeting EPBC TEC criteria (ha)	Total ecosystem credits required	Ecosystem credits required for EPBC TEC impacts
724 - Moderate/ Good_High	Broad-leaved Ironbark - Grey Box - Melaleuca decora grassy open forest on clay/gravel soils of the Cumberland Plain, Sydney Basin Bioregion	Masked Owl	24.75	74.64	3.50	3.02	218	188
724 - Moderate/ Good_Medium			24.75	55.07	2.96	1.84	141	88
724 - Moderate/ Good_Poor			24.75	28.99	0.45	0	13	0
830 - Moderate/ Good_Poor	Forest Red Gum - Grey Box shrubby woodland on shale of the southern Cumberland Plain, Sydney Basin Bioregion	Barking Owl	24.75	35.94	0.44	0.44	15	15
835 - Moderate/ Good_Poor	Forest Red Gum - Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney Basin Bioregion	Masked Owl	24.75	35.76	3.23	N/A – not listed	107	N/A
849 - Moderate/ Good_Medium	Grey Box - Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin Bioregion	Barking Owl	24.75	45.65	3.54	1.61	143	65
849 - Moderate/ Good_Poor			24.75	22.46	2.07	0	48	0
849 - Moderate/ Good_Other (Derived Shrubland)			24.75	26.09	0.48	0	12	0
850 - Moderate/ Good_High	Grey Box - Forest Red Gum grassy woodland on shale of the southern Cumberland Plain, Sydney Basin Bioregion	Barking Owl	24.75	50.97	3.21	3.21	143	143
850 - Moderate/ Good_Medium			24.75	42.03	10.14	8.68	382	327
850 - Moderate/ Good_Other (Revegetation)			24.75	57.97	22.65	20.12	1,125	999

Vegetation Zone	PCT Name	Threatened species with highest credit requirement	Loss in landscape value	Loss in site value score	Total area impacted requiring offsets (ha)	Area impacted meeting EPBC TEC criteria (ha)	Total ecosystem credits required	Ecosystem credits required for EPBC TEC impacts
1800 - Moderate/ Good_Poor	Swamp Oak open forest on riverflats of the Cumberland Plain and Hunter valley	Barking Owl	24.75	27.26	2.53	0	67	0
Total					**55.20**	**38.92**	**2,414**	**1,825**

Table 11-2 Ecosystem credits summary – indirect impacts

Vegetation Zone	PCT Name	Threatened species with highest credit requirement	Loss in landscape value	Loss in site value score	Area impacted (ha)	Area meeting EPBC TEC criteria impacted (ha)	Total ecosystem credits required	Ecosystem credits required for EPBC TEC impacts
Non-viable patches								
850 - Moderate/ Good_Medium	Grey Box - Forest Red Gum grassy woodland on shale of the southern Cumberland Plain, Sydney Basin Bioregion	Barking Owl	24.75	42.03	0.01	0.01	0	0
850 - Moderate/ Good_Other (Revegetation)			24.75	57.97	0.30	0.30	15	15
New edges								
724 - Moderate/ Good_High	Broad-leaved Ironbark - Grey Box - Melaleuca decora grassy open forest on clay/gravel soils of the Cumberland Plain, Sydney Basin Bioregion	Masked Owl	24.75	8.70	0.52	0.52	7	7
830 - Moderate/ Good_Poor	Forest Red Gum - Grey Box shrubby woodland on shale of the southern Cumberland Plain, Sydney Basin Bioregion	Barking Owl	24.75	4.17	0.54	0.54	5	5

Vegetation Zone	PCT Name	Threatened species with highest credit requirement	Loss in landscape value	Loss in site value score	Area impacted (ha)	Area meeting EPBC TEC criteria impacted (ha)	Total ecosystem credits required	Ecosystem credits required for EPBC TEC impacts
849 - Moderate/ Good_Medium	Grey Box - Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin Bioregion	Barking Owl	24.75	5.79	0.24	0.24	3	3
850 - Moderate/ Good_High	Grey Box - Forest Red Gum grassy woodland on shale of the southern Cumberland Plain, Sydney Basin Bioregion	Barking Owl	24.75	6.77	1.06	1.06	12	12
850 - Moderate/ Good_Medium			24.75	4.35	3.33	3.23	31	30
850 - Moderate/ Good_Other (Revegetation)			24.75	7.73	6.73	6.73	81	81
Total indirect impacts					**12.73**	**12.63**	**154**	**153**

Impacts to threatened species credit species and their associated species are summarised in **Table 11-3**. Species polygons for each threatened fauna species credit species are provided in **Figure 4-2**. The full credit report is provided in **Annexure C**.

Table 11-3 Species credits summary

Species name	TSC Act status	EPBC Act status	Threatened species offset multiplier	Loss of habitat (ha) or individuals	Species credits required
Dillwynia tenuifolia	Vulnerable	Not listed	1.8	244 individuals	4,392
Pultenaea parviflora Sydney Bush-pea	Endangered	Vulnerable	1.5	90 individuals	1,350
Meridolum corneovirens Cumberland Plain Land Snail	Endangered	Not listed	1.3	1.86 ha	24
Myotis macropus Southern Myotis	Vulnerable	Not listed	2.2	0.92 ha	20

The final offset requirement will be documented in the BOS and will be based on the impacts associated with the final detailed design. Whilst the offset requirement documented in this BAR is an indication of the likely credit requirement, it is subject to change following design development.

Impacts to threatened species listed under the FM Act are unlikely and therefore do not require offsets. Under the RIAR (DPI, 2013) Policy and guidelines for fish habitat conservation and management impacts to KFH are to be offset by compensatory works to ensure no net loss. RIAR (DPI, 2013) calculates habitat compensation on a minimum 2:1 basis for all KFH lost; a greater compensation ratio may be considered if offsets cannot be sourced in the vicinity of the impact or are not of the same habitat type as that impacted.

RIAR (DPI, 2013) uses a rate of $52 per square metre for offset payments. This rate is consistent with aquatic ecosystem services rates calculated by Costanza *et al.* (1997, cited in DPI, 2013), and is subject to annual inflation from 1 July each financial year. The rate above is from the 2013–2014 financial year. The cost per square metre would be confirmed with RIAR but for the purposes of this assessment the current rate has been estimated (from annual rates of CPI of 1.5 per cent in 2014-2015, 1.0 per cent in 2015-2016, 1.9 per cent 2016-2017 and 2.1 per cent in 2017-2018) to be $55 per square metre.

The project crosses four waterways (Badgerys Creek, Cosgroves Creek, Kemps Creek and South Creek) that are considered to meet the definition of KFH. Bridges are proposed at all four creeks. Badgerys Creek, South Creek and Kemps Creek would be permanently adjusted over distances of 64 metres, 200 metres and 84 metres respectively. The proposed creek alignments would have a similar capacity to the existing creek channels and would be designed and constructed in a way that mimics natural flow conditions. The creek corridors would be revegetated with locally native riparian vegetation, in accordance with the requirements of the Policy and guidelines for fish habitat conservation and management (DPI, 2013) and *Guidelines for instream works on waterfront land* (DPI, 2012). The creek channels would be rehabilitated to preconstruction conditions or better.

The adjustments would replace around 6,366 square metres of KFH in the channels with about 7,452 square metres of newly created channels, partially compensating for the loss. Based on a 2:1 offset ratio, about 5,281 square metres of KFH is still required to be offset following creek adjustments, which would cost about $290,455 assuming an offset cost of $55/square metre.

The offsets for aquatic habitat are limited to the area of KFH impacted and are considered separately from impacts offset under the FBA.

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Annexure A Species Recorded

Recorded fauna

Common Name	Scientific Name	Observation Type	Status		Ecosystem or species credit species?
			TSC Act	EPBC Act	
AMPHIBIANS					
Common Eastern Froglet	*Crinia signifera*	O/W	-	-	-
Eastern Dwarf Tree Frog	*Litoria fallax*	W	-	-	-
Eastern Sign-bearing Froglet	*Crinia parinsignifera*	W	-	-	-
Peron's Tree Frog	*Litoria peronii*	O/W	-	-	-
Striped Marsh Frog	*Limnodynastes peronii*	O/W	-	-	-
Whistling Tree Frog	*Litoria verreauxii*	W	-	-	-
BIRDS					
Australasian Grebe	*Tachybaptus novaehollandiae*	O	-	-	-
Australasian Pipit	*Anthus novaeseelandiae*	O	-	-	-
Australasian Shoveler	*Anas rhynchotis*	O	-	-	-
Australian Magpie	*Cracticus tibicen*	O/W	-	-	-
Australian Pelican	*Pelecanus conspicillatus*	O	-	-	-
Australian Raven	*Corvus coronoides*	O/W	-	-	-
Australian Reed-warbler	*Acrocephalus australis*	O	-	-	-
Australian White Ibis	*Threskiornis molucca*	O	-	-	-
Australian Wood Duck	*Chenonetta jubata*	O	-	-	-
Bell Miner	*Manorina melanophrys*	W	-	-	-
Black Swan	*Cygnus atratus*	O	-	-	-
Black-faced Cuckoo-shrike	*Coracina novaehollandiae*	O	-	-	-
Australasian Grebe	*Tachybaptus novaehollandiae*	O	-	-	-
Australasian Pipit	*Anthus novaeseelandiae*	O	-	-	-
Australasian Shoveler	*Anas rhynchotis*	O	-	-	-
Australian Magpie	*Cracticus tibicen*	O/W	-	-	-
Australian Pelican	*Pelecanus conspicillatus*	O	-	-	-
Australian Raven	*Corvus coronoides*	O/W	-	-	-
Australian Reed-warbler	*Acrocephalus australis*	O	-	-	-
Australian White Ibis	*Threskiornis molucca*	O	-	-	-
Australian Wood Duck	*Chenonetta jubata*	O	-	-	-

Common Name	Scientific Name	Observation Type	Status		Ecosystem or species credit species?
			TSC Act	EPBC Act	
Bell Miner	*Manorina melanophrys*	W	-	-	-
Black Swan	*Cygnus atratus*	O	-	-	-
Black-faced Cuckoo-shrike	*Coracina novaehollandiae*	O	-	-	-
Black-fronted Dotterel	*Elseyornis melanops*	O	-	-	-
Black-shouldered Kite	*Elanus axillaris*	O	-	-	-
Black-winged Stilt	*Himantopus himantopus*	O/W	-	-	-
Brown Quail	*Coturnix ypsilophora*	O	-	-	-
Cattle Egret	*Ardea ibis*	O	-	-	-
Channel-billed Cuckoo	*Acrocephalus australis*	W	-	-	-
Chestnut Teal	*Anas castanea*	O	-	-	-
Collared Sparrowhawk	*Accipiter cirrocephalus*	O	-	-	-
Common Myna	*Acridotheres tristis*	O/W	-	-	-
Common Starling	*Sturnus vulgaris*	O/W	-	-	-
Crested Pigeon	*Ocyphaps lophotes*	O	-	-	-
Dusky Moorhen	*Gallinula tenebrosa*	O	-	-	-
Eastern Barn Owl	*Tyto javanica*	O	-	-	-
Eastern Rosella	*Platycercus eximius*	O/W	-	-	-
Eastern Spinebill	*Acanthorhynchus tenuirostris*	W	-	-	-
Eastern Yellow Robin	*Eopsaltria australis*	O/W	-	-	-
Eurasian Coot	*Fulica atra*	O	-	-	-
Fairy Martin	*Petrochelidon ariel*	O/W	-	-	-
Fan-tailed Cuckoo	*Cacomantis flabelliformis*	O/W	-	-	-
Feral Pigeon	*Columba livia domestica*	O	-	-	-
Fuscous Honeyeater	*Ptilotula fusca*	O	-	-	-
Galah	*Eolophus roseicapillus*	O/W	-	-	-
Golden Whistler	*Pachycephala pectoralis*	O	-	-	-
Great Egret	*Ardea alba*	O	-	-	-
Grey Butcherbird	*Cracticus torquatus*	O/W	-	-	-
Grey Fantail	*Rhipidura albiscapa*	O/W	-	-	-
Grey Shrike-thrush	*Colluricincla harmonica*	O	-	-	-
Grey Teal	*Anas gracilis*	O	-	-	-
Hardhead	*Aythya australis*	O	-	-	-
Hoary-headed Grebe	*Poliocephalus poliocephalus*	O	-	-	-

Common Name	Scientific Name	Observation Type	Status		Ecosystem or species credit species?
			TSC Act	EPBC Act	
House Sparrow	*Passer domesticus*	O	-	-	-
Intermediate Egret	*Ardea intermedia*	O	-	-	-
Laughing Kookaburra	*Dacelo novaeguineae*	O	-	-	-
Little Black Cormorant	*Phalacrocorax sulcirostris*	O	-	-	-
Little Corella	*Cacatua sanguinea*	O/W	-	-	-
Little Egret	*Egretta garzetta*	O	-	-	-
Little Pied Cormorant	*Microcarbo melanoleucos*	O	-	-	-
Long-billed Corella	*Cacatua tenuirostris*	O	-	-	-
Magpie-lark	*Grallina cyanoleuca*	O/W	-	-	-
Masked Lapwing	*Vanellus miles*	O	-	-	-
Mistletoebird	*Dicaeum hirundinaceum*	O	-	-	-
Nankeen Kestrel	*Falco cenchroides*	O	-	-	-
Noisy Miner	*Manorina melanocephala*	O/W	-	-	-
Oriental Dollarbird	*Eurystomus orientalis*	O/W	-	-	-
Pacific Baza	*Aviceda subcristata*	O	-	-	-
Pacific Black Duck	*Anas superciliosa*	O	-	-	-
Pallid Cuckoo	*Cacomantis pallidus*	W	-	-	-
Pied Butcherbird	*Cracticus nigrogularis*	W	-	-	-
Pied Currawong	*Strepera graculina*	W	-	-	-
Purple Swamphen	*Porphyrio porphyrio*	O	-	-	-
Rainbow Lorikeet	*Trichoglossus haematodus*	O/W	-	-	-
Red Wattlebird	*Anthochaera carunculata*	W	-	-	-
Red-browed Finch	*Neochmia temporalis*	O	-	-	-
Red-kneed Dotterel	*Erythrogonys cinctus*	O	-	-	-
Red-rumped Parrot	*Psephotus haematonotus*	O	-	-	-
Red-whiskered Bulbul	*Pycnonotus jocosus*	W	-	-	-
Rooster	*Gallus gallus*	W	-	-	-
Royal Spoonbill	*Platalea regia*	O	-	-	-
Rufous Whistler	*Pachycephala rufiventris*	O/W	-	-	-
Shining Bronze Cuckoo	*Chrysococcyx lucidus*	W	-	-	-

Common Name	Scientific Name	Observation Type	Status		Ecosystem or species credit species?
			TSC Act	EPBC Act	
Silvereye	*Zosterops lateralis*	O/W	-	-	-
Southern Boobook	*Ninox novaeseelandiae*	O	-	-	-
Spotted Dove	*Spilopelia chinensis*	O	-	-	-
Spotted Pardalote	*Pardalotus punctatus*	O	-	-	-
Straw-necked Ibis	*Threskiornis spinicollis*	O	-	-	-
Striated Pardalote	*Pardalotus striatus*	O	-	-	-
Sulphur-crested Cockatoo	*Cacatua galerita*	O/W	-	-	-
Superb Fairywren	*Malurus cyaneus*	O/W	-	-	-
Tree Martin	*Petrochelidon nigricans*	O	-	-	-
Variegated Fairywren	*Malurus lamberti*	O/W	-	-	-
Wedge-tailed Eagle	*Aquila audax*	O	-	-	-
Welcome Swallow	*Hirundo neoxena*	O	-	-	-
White-bellied Sea Eagle	*Haliaeetus leucogaster*	E/O	V	-	-
White-browed Scrubwren	*Sericornis frontalis*	O/W	-	-	-
White-faced Heron	*Egretta novaehollandiae*	O	-	-	-
White-naped Honeyeater	*Melithreptus lunatus*	O/W	-	-	-
White-necked Heron	*Ardea pacifica*	O	-	-	-
White-plumed Honeyeater	*Lichenostomus penicillatus*	O	-	-	-
White-throated Treecreeper	*Cormobates leucophaea*	W	-	-	-
White-winged Chough	*Corcorax melanorhamphos*	O	-	-	-
Willie Wagtail	*Rhipidura leucophrys*	W	-	-	-
Yellow Thornbill	*Acanthiza nana*	O/W	-	-	-
Yellow-billed Spoonbill	*Platalea flavipes*	O	-	-	-
Yellow-faced Honeyeater	*Caligavis chrysops*	O/W	-	-	-
Yellow-rumped Thornbill	*Acanthiza chrysorrhoa*	O/W	-	-	-
INVERTEBRATES					
Garden Snail	*Cornus aspersum*	O	-	-	-
MAMMALS					
Cat	*Felis catus*	O/C	-	-	-
Common Brushtail Possum	*Trichosurus vulpecula*	O	-	-	-
Dog	*Canis lupus familiaris*	P	-	-	-
Eastern Grey Kangaroo	*Macropus giganteus*	O	-	-	-
European Hare	*Lepus europaeus*	O	-	-	-

Common Name	Scientific Name	Observation Type	Status		Ecosystem or species credit species?
			TSC Act	EPBC Act	
European Rabbit	*Oryctolagus cuniculus*	P/O	-	-	-
European Red Fox	*Vulpes vulpes*	O/V/FB	-	-	-
Goat	*Capra hircus*	P	-	-	-
Grey-headed Flying-fox	*Pteropus poliocephalus*	O/W	V	V	-
Horse	*Equus caballus*	P/F	-	-	-
Sheep	*Ovis aries*	P	-	-	-
Sugar Glider	*Petaurus breviceps*	O	-	-	-
Swamp Wallaby	*Wallabia bicolor*	O	-	-	-
REPTILES					
Eastern Snake-necked Turtle	*Chelodina longicollis*	K	-	-	-
Lace Monitor	*Varanus varius*	O	-	-	-
Unidentified *Varanus* sp.	*Varanus sp.*	F	-	-	-
MICROBATS					
Chocolate Wattled Bat	*Chalinolobus morio*	AR(De)	-	-	-
Eastern Bentwing-bat	*Miniopterus schreibersii oceanensis*	AR(De)	V	-	-
Eastern Freetail-bat	*Mormopterus norfolkensis*	AR(Pr)	V	-	-
Eastern Free-tailed Bat	*Mormopterus ridei*	AR(De)	-	-	-
Gould's Wattled Bat	*Chalinolobus gouldii*	AR(De)	-	-	-
Greater Broad-nosed Bat	*Scoteanax rueppellii*	AR(Pr)	V	-	Ecosystem
Little Bentwing-bat	*Miniopterus australis*	AR(Pr)	V	-	-
Little Forest Bat	*Vespadelus vulturnus*	AR(De)	-	-	-
Unidentified Long-eared Bat	*Nyctophilus sp.*	AR(De)	-	-	-
White-striped Freetail Bat	*Austronomus australis*	AR(De)	-	-	-
Yellow-bellied Sheathtail-bat	*Saccolaimus flaviventris*	AR(Pr)	V	-	Ecosystem

				724										830		835			
				Moderate/Good_High				Moderate/Good_Medium				Moderate/Good_Poor		Moderate/Good_Medium		Moderate/Good_Poor			
Family	Exotic	Scientific Name	Common Name	Q11_C	Q11_A	Q22_C	Q22_A	Q12_C	Q12_A	Q17_C	Q17_A	Q34_C	Q34_A	Q26_C	Q26_A	Q15_C	Q15_A	Q20_C	Q20_A
Pteridophytes																			
Pteridaceae		Cheilanthes sieberi	Rock Fern	1	100	1	100			1	50								
Dicotyledons																			
Acanthaceae		Brunoniella australis	Blue Trumpet, Blue Yam									1	10						
Acanthaceae		Brunoniella pumilio	Dwarf Blue Trumpet	1	10													1	100
Amaranthaceae	*	Alternanthera philoxeroides	Alligator Weed																
Apiaceae		Centella asiatica	Indian Pennywort															1	100
Apocynaceae	*	Araujia sericifera	Moth Vine, Cruel Plant							0.1	1					0.1	50		
Apocynaceae	*	Gomphocarpus fruticosus	Narrow-leaved Cotton Bush											1	50				
Asteraceae	*	Ageratina adenophora	Crofton Weed																
Asteraceae	*	Ambrosia artemisiifolia	Annual Ragweed																
Asteraceae	*	Bidens pilosa	Cobblers Pegs											1	20			5	500
Asteraceae	*	Bidens subalternans	Greater Beggar's Ticks																
Asteraceae		Cassinia aculeata	Dolly Bush							5	20								
Asteraceae	*	Cirsium vulgare	Black Thistle, Spear Thistle											1	50				
Asteraceae	*	Conyza bonariensis	Flaxleaf Fleabane																
Asteraceae	*	Conyza sumatrensis	Tall Fleabane																
Asteraceae	*	Hypochaeris radicata	Catsear, False Dandelion									1	50						
Asteraceae		Olearia microphylla		1	20														
Asteraceae		Ozothamnus diosmifolius	White Dogwood	1	20			70	300	1	6								
Asteraceae	*	Senecio madagascariensis	Fireweed, Madagascar Ragwort															1	20
Asteraceae	*	Senecio pterophorus	African Daisy-bush																
Asteraceae		Sigesbeckia australiensis	Pale Indian Weed																
Asteraceae	*	Soliva sessilis	Bindii, Bindi-eye, Jo-Jo																
Asteraceae	*	Sonchus oleraceus	Common Sow-thistle, Milk-thistle											1	5				
Asteraceae	*	Taraxacum officinale	Dandelion									1	50						
Asteraceae		Vernonia cinerea		1	3														
Basellaceae	*	Anredera cordifolia	Madeira Vine, Lamb's Tail																
Bignoniaceae		Pandorea pandorana	Wonga Vine																
Brassicaceae	*	Brassica oleracea																	
Brassicaceae	*	Lepidium africanum	Common Peppercress																
Cactaceae	*	Opuntia stricta	Prickly Pear, Common Pest Pear	1	2					1	3							1	5
Campanulaceae		Wahlenbergia gracilis	Sprawling Bluebell																
Campanulaceae		Wahlenbergia stricta																	
Caryophyllaceae	*	Stellaria media	Chickweed																
Casuarinaceae		Allocasuarina littoralis	Black She-Oak							3	2								
Casuarinaceae		Casuarina glauca	Swamp Oak, Swamp She-oak															1	1
Chenopodiaceae		Chenopodium sp.						1	5										
Chenopodiaceae		Einadia hastata	Berry Saltbush	1	1	1	5	1	25					1	5			1	5
Chenopodiaceae		Einadia nutans	Climbing Saltbush							1	50							1	100
Chenopodiaceae		Einadia trigonos	Fishweed									1	10						
Clusiaceae		Hypericum gramineum	Small St Johns-wort	1	100														
Clusiaceae	*	Hypericum perforatum	St Johns-wort																
Convolvulaceae		Dichondra repens	Kidney-weed, Mercury Bay Weed													3	500		
Dilleniaceae		Hibbertia obtusifolia	Guinea-flower	1	10														
Ericaceae Styphelioideae		Astroloma humifusum	Cranberry Heath							0.1	2								
Ericaceae Styphelioideae		Leucopogon juniperinus	Long-flowered Beard-heath			1	5												
Ericaceae Styphelioideae		Lissanthe strigosa	Peach Heath	1	10	1	25			0.1	2								
Fabaceae Caesalpinioideae	*	Senna pendula var. glabrata	Easter Cassia																
Fabaceae Faboideae		Daviesia ulicifolia	Gorse Bitter-pea	1	100	5	100	1	20	0.1	2								
Fabaceae Faboideae		Desmodium varians	Slender Tick-trefoil							0.1	1					0.5	20		
Fabaceae Faboideae		Dillwynia sieberi	Prickly Parrot-pea	1	2	1	25												
Fabaceae Faboideae		Dillwynia tenuifolia		1	20	1	25												
Fabaceae Faboideae		Glycine clandestina	Twining Glycine	1	100							1	5	1	20			1	100

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				Moderate/Good_High				Moderate/Good_Medium				Moderate/Good_Poor		Moderate/Good_Medium		Moderate/Good_Poor			
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Fabaceae Faboideae		Glycine tabacina								0.5	50					2	100		
Fabaceae Faboideae		Kennedia rubicunda	Dusky Coral-pea													0.5	50		
Fabaceae Faboideae	*	Lotus subbiflorus	Hairy Birds-foot Trefoil																
Fabaceae Faboideae	*	Medicago polymorpha	Burr Medic									1	50						
Fabaceae Faboideae		Pultenaea parviflora																	
Fabaceae Faboideae	*	Trifolium repens	White Clover																
Fabaceae Faboideae	*	Vicia sativa	Common Vetch																
Fabaceae Mimosoideae		Acacia decurrens	Black Wattle	1	10	1	5												
Fabaceae Mimosoideae		Acacia elongata	Swamp Wattle																
Fabaceae Mimosoideae		Acacia falcata	Sickle Wattle																
Fabaceae Mimosoideae		Acacia implexa	Hickory Wattle											1	1				
Fabaceae Mimosoideae		Acacia parramattensis	Parramatta Green Wattle			1	1												
Geraniaceae		Geranium homeanum	Rainforest Cranesbill											1	20				
Goodeniaceae		Goodenia hederacea subsp. hederacea	Ivy Goodenia	1	50	1	100												
Goodeniaceae		Scaevola aemula	Fairy Fan-flower																
Haloragaceae		Gonocarpus tetragynus	Common Raspwort	1	100														
Lamiaceae		Plectranthus parviflorus																	
Lobeliaceae		Pratia purpurascens	Whiteroot	1	50					0.5	15			1	50	0.2	20	1	100
Malvaceae	*	Malva parviflora	Small-flowered Mallow																
Malvaceae	*	Modiola caroliniana	Red-flower Mallow																
Malvaceae	*	Pavonia hastata																	
Malvaceae	*	Sida rhombifolia	Paddy's Lucerne					1	10			1	50					1	5
Myrsinaceae	*	Anagallis arvensis	Pimpernel											1	100				
Myrtaceae		Angophora floribunda	Rough-barked Apple													25	18		
Myrtaceae		Angophora subvelutina	Broad-leaved Apple																
Myrtaceae		Corymbia maculata	Spotted Gum																
Myrtaceae		Eucalyptus amplifolia	Cabbage Gum													5	2		
Myrtaceae		Eucalyptus baueriana	Blue Box																
Myrtaceae		Eucalyptus crebra	Narrow-leaved Ironbark																
Myrtaceae		Eucalyptus eugenioides	Thin-leaved Stringybark																
Myrtaceae		Eucalyptus fibrosa	Red Ironbark	10	3			15	4	10	4	2	1						
Myrtaceae		Eucalyptus moluccana	Grey Box							2	1			5	2	2	1		
Myrtaceae		Eucalyptus tereticornis	Forest Red Gum	1	1	30	40					1	1	5	8	7	3	20	5
Myrtaceae		Kunzea ambigua	Tick-bush																
Myrtaceae		Melaleuca decora	White Cloud Tree	10	25	20	50	5	10	10	10	15	10					3	5
Myrtaceae		Melaleuca nodosa	Ball Honey-myrtle	5	30	20	100	4	20	10	10							1	5
Myrtaceae		Melaleuca styphelioides	Prickly Paperbark													3	1		
Oleaceae	*	Ligustrum lucidum	Broad-leaved Privet, Glossy Privet																
Oleaceae	*	Ligustrum sinense	Small-Leaved Privet, Chinese Privet																
Oleaceae	*	Olea europaea subsp. cuspidata	African Olive											2	100	0.5	20		
Oxalidaceae	*	Oxalis articulata	Wood-Sorrel, Shamrock Oxalis																
Oxalidaceae	*	Oxalis corniculata	Yellow Wood-sorrel																
Oxalidaceae		Oxalis exilis	Creeping Oxalis																
Oxalidaceae		Oxalis perennans		1	10									1	100				
Oxalidaceae		Oxalis sp.																	
Phyllanthaceae		Breynia cernua																	
Phyllanthaceae		Breynia oblongifolia	Coffee Bush											1	20				
Phyllanthaceae		Glochidion ferdinandi	Cheese Tree																
Phyllanthaceae		Phyllanthus hirtellus	Thyme Spurge	1	30	1	100												
Phyllanthaceae		Phyllanthus virgatus																	
Pittosporaceae		Bursaria spinosa	Blackthorn	5	50	5	100	4	20	10	10	1	5			15	20	30	100
Plantaginaceae	*	Plantago lanceolata	Plantain, Ribwort									1	50					1	5
Plantaginaceae		Veronica plebeia	Creeping Speedwell																

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Polygonaceae	*	Acetosa sagittata	Rambling Dock, Turkey Rhubarb																
Polygonaceae	*	Acetosella vulgaris	Sheep Sorrel																
Polygonaceae		Rumex brownii	Slender Dock																
Ranunculaceae		Clematis aristata	Traveller's Joy, Old Man's Beard																
Ranunculaceae		Clematis glycinoides	Headache Vine, Traveller's Joy													1	20		
Rosaceae		Acaena novae-zelandiae	Bidgee-widgee, Biddy-biddy																
Rosaceae	*	Rubus fruticosus (sp. agg)	Blackberry													1	15		
Rosaceae		Rubus parvifolius	Native Raspberry, Small-leaf Bramble													0.2	5		
Rubiaceae		Asperula conferta	Common Woodruff																
Rubiaceae	*	Galium aparine	Cleavers, Goose-grass, Bedstraw													1	50		
Rubiaceae		Galium gaudichaudii	Rough Bedstraw																
Rubiaceae		Galium propinquum																	
Rubiaceae		Opercularia diphylla	Stinkweed	1	40														
Rubiaceae		Pomax umbellata	Pomax	1	20														
Rubiaceae	*	Richardia stellaris	Field Madder																
Santalaceae		Exocarpos cupressiformis	Cherry Ballart, Native Cherry																
Sapindaceae	*	Cardiospermum grandiflorum	Balloon Vine																
Sapindaceae		Dodonaea viscosa subsp. cuneata	Wedge-leaf Hopbush																
Solanaceae	*	Cestrum parqui	Green Cestrum																
Solanaceae	*	Lycium ferocissimum	African Boxthorn																
Solanaceae		Solanum americanum	Blackberry Nightshade																
Solanaceae		Solanum cinereum	Narrawa Burr																
Solanaceae	*	Solanum linnaeanum	Apple of Sodom																
Solanaceae	*	Solanum nigrum	Blackberry Nightshade																
Solanaceae		Solanum prinophyllum	Forest Nightshade					1	20										
Solanaceae	*	Solanum pseudocapsicum	Jerusalem Cherry													0.2	10		
Solanaceae	*	Solanum sp.														0.2	10	1	5
Verbenaceae		Clerodendrum tomentosum	Hairy Clerodendrum											5	20				
Verbenaceae	*	Lantana camara	Lantana											2	50				
Verbenaceae	*	Verbena bonariensis	Purpletop											1	5			1	5
Vitaceae		Cayratia clematidea	Slender Grape											1	20				
Monocotyledons																			
Anthericaceae		Arthropodium milleflorum	Pale Vanilla Lily	1	2														
Anthericaceae		Laxmannia gracilis	Slender Wire Lily	1	50	1	100												
Anthericaceae		Tricoryne elatior	Yellow Rush Lily																
Asparagaceae	*	Asparagus asparagoides	Bridal Creeper, Florists' Smilax											1	200				
Asparagaceae	*	Asparagus officinalis	Asparagus																
Commelinaceae		Commelina cyanea	Blue Spiderwort													0.1	10		
Commelinaceae	*	Tradescantia fluminensis	Wandering Jew													2	50	70	1000
Cyperaceae		Carex appressa	Tall Sedge																
Cyperaceae		Carex breviculmis																	
Cyperaceae		Carex inversa	Knob Sedge											1	20				
Cyperaceae	*	Cyperus eragrostis	Drain Flat-sedge, Umbrella Sedge																
Cyperaceae		Cyperus gracilis	Slender Sedge																
Cyperaceae		Fimbristylis dichotoma						1	5	0.5	10								
Cyperaceae		Lepidosperma laterale	Variable Sword-sedge	1	5														
Iridaceae	*	Romulea rosea	Onion Grass																
Juncaceae	*	Juncus acutus	Spiny Rush																
Juncaceae	*	Juncus cognatus	Argentine Rush									1	50						
Juncaceae		Juncus usitatus	Common Rush	1	10									2	200			1	10
Lomandraceae		Lomandra filiformis	Wattle Mat-rush	1	50	5	1000	1	5	1	5	1	20						
Lomandraceae		Lomandra longifolia	Spiny-headed Mat-rush			1	100												
Lomandraceae		Lomandra multiflora	Many-flowered Mat-rush	1	10	2	100	1	25	1	5								
Phormiaceae		Dianella longifolia	Smooth Flax-lily	1	10	1	20	1	2									1	5

				724										830		835			
				Moderate/Good_High				Moderate/Good_Medium				Moderate/Good_Poor		Moderate/Good_Medium		Moderate/Good_Poor			
Family	Exotic	Scientific Name	Common Name	Q11_C	Q11_A	Q22_C	Q22_A	Q12_C	Q12_A	Q17_C	Q17_A	Q34_C	Q34_A	Q26_C	Q26_A	Q15_C	Q15_A	Q20_C	Q20_A
Poaceae		Aristida ramosa	Wiregrass																
Poaceae		Aristida vagans	Threeawn Speargrass	2	100	1	500			1	100								
Poaceae		Austrostipa ramosissima	Bamboo Speargrass																
Poaceae	*	Axonopus fissifolius	Narrow-leaved Carpet Grass																
Poaceae		Bothriochloa macra	Redleg Grass							1	50								
Poaceae	*	Briza subaristata																	
Poaceae	*	Bromus catharticus	Prairie Grass																
Poaceae	*	Cenchrus clandestinus	Kikuyu					1	20	20	1000	20	1000						
Poaceae	*	Chloris gayana	Rhodes Grass											10	500				
Poaceae		Chloris truncata	Windmill Grass																
Poaceae		Chloris ventricosa	Tall Windmill Grass																
Poaceae		Cymbopogon refractus	Barbed Wire Grass																
Poaceae		Cynodon dactylon	Couch, Bermuda Grass									2	200						
Poaceae		Dichelachne micrantha	Shorthair Plumegrass																
Poaceae	*	Echinochloa crus-galli	Barnyard Grass																
Poaceae		Echinopogon caespitosus	Tufted Hedgehog Grass							1	100								
Poaceae		Echinopogon ovatus	Forest Hedgehog Grass	1	10														
Poaceae	*	Ehrharta erecta	Panic Veldtgrass					2	100							5	300	2	200
Poaceae		Entolasia marginata	Bordered Panic															1	50
Poaceae		Entolasia stricta	Wiry Panic	3	100	3	1000					1	50	1	50			1	100
Poaceae		Eragrostis brownii	Brown's Lovegrass	1	10														
Poaceae	*	Eragrostis curvula	African Lovegrass																
Poaceae		Eragrostis leptostachya	Paddock Lovegrass	2	100														
Poaceae		Imperata cylindrica	Blady Grass																
Poaceae	*	Megathyrsus maximus	Guinea Grass																
Poaceae		Microlaena stipoides	Weeping Grass, Meadow Rice-grass	5	300	2	1000	40	1000	5	250	10	500	20	1000	80	1000	10	1000
Poaceae	*	Nassella neesiana	Chilean Needle Grass																
Poaceae		Oplismenus aemulus	Broad-leaved Basket Grass											2	500	1	100	1	100
Poaceae		Panicum simile	Two-colour Panic																
Poaceae		Paspalidium distans		1	50														
Poaceae	*	Paspalum dilatatum	Paspalum									5	500						
Poaceae		Poa labillardierei	Tussock Grass	1	1														
Poaceae		Poa sieberiana	Snow Grass, Fine-leaf Tussock Grass			1	50			5	500			2	200				
Poaceae		Rytidosperma racemosum var. racemosum		1	10														
Poaceae	*	Setaria parviflora						20	500										
Poaceae	*	Sporobolus africanus	Rat-tail Grass, Parramatta Grass									5	500						
Poaceae		Sporobolus creber	Slender Rat's-tail Grass																
Poaceae		Themeda triandra	Kangaroo Grass	1	50	2	100									2	100		

				850																			
				Moderate/Good_High				Moderate/Good_Medium															
Family	Exotic	Scientific Name	Common Name	Q03_C	Q03_A	Q04_C	Q04_A	Q02_C	Q02_A	Q07_C	Q07_A	Q10_C	Q10_A	Q27_C	Q27_A	Q28_C	Q28_A	Q29_C	Q29_A	Q36_C	Q36_A
Pteridophytes																					
Pteridaceae		Cheilanthes sieberi	Rock Fern																		
Dicotyledons																					
Acanthaceae		Brunoniella australis	Blue Trumpet, Blue Yam					1	50	1	10	2	200	5	2000	2	500			1	200
Acanthaceae		Brunoniella pumilio	Dwarf Blue Trumpet	2	500																
Amaranthaceae	*	Alternanthera philoxeroides	Alligator Weed																		
Apiaceae		Centella asiatica	Indian Pennywort																		
Apocynaceae	*	Araujia sericifera	Moth Vine, Cruel Plant			1	10	1	10					1	50						
Apocynaceae	*	Gomphocarpus fruticosus	Narrow-leaved Cotton Bush																		
Asteraceae	*	Ageratina adenophora	Crofton Weed																		
Asteraceae	*	Ambrosia artemisiifolia	Annual Ragweed																		
Asteraceae	*	Bidens pilosa	Cobblers Pegs	5	200			1	50	1	50	2	200	1	50					1	50
Asteraceae	*	Bidens subalternans	Greater Beggar's Ticks															1	10		
Asteraceae		Cassinia aculeata	Dolly Bush																		
Asteraceae	*	Cirsium vulgare	Black Thistle, Spear Thistle	1	20					1	16	2	150			1	50				
Asteraceae	*	Conyza bonariensis	Flaxleaf Fleabane																		
Asteraceae	*	Conyza sumatrensis	Tall Fleabane									1	50								
Asteraceae	*	Hypochaeris radicata	Catsear, False Dandelion																		
Asteraceae		Olearia microphylla																			
Asteraceae		Ozothamnus diosmifolius	White Dogwood																		
Asteraceae	*	Senecio madagascariensis	Fireweed, Madagascar Ragwort							1	20	1	10	1	5	1	10				
Asteraceae	*	Senecio pterophorus	African Daisy-bush					5	100	1	5	1	50			1	10	1	10		
Asteraceae		Sigesbeckia australiensis	Pale Indian Weed																		
Asteraceae	*	Soliva sessilis	Bindii, Bindi-eye, Jo-Jo																		
Asteraceae	*	Sonchus oleraceus	Common Sow-thistle, Milk-thistle	1	20									1	50			1	50		
Asteraceae	*	Taraxacum officinale	Dandelion																		
Asteraceae		Vernonia cinerea																			
Basellaceae	*	Anredera cordifolia	Madeira Vine, Lamb's Tail																		
Bignoniaceae		Pandorea pandorana	Wonga Vine			1	5														
Brassicaceae	*	Brassica oleracea										2	200			1	100				
Brassicaceae	*	Lepidium africanum	Common Peppercress																		
Cactaceae	*	Opuntia stricta	Prickly Pear, Common Pest Pear																		
Campanulaceae		Wahlenbergia gracilis	Sprawling Bluebell																		
Campanulaceae		Wahlenbergia stricta																			
Caryophyllaceae	*	Stellaria media	Chickweed																		
Casuarinaceae		Allocasuarina littoralis	Black She-Oak																		
Casuarinaceae		Casuarina glauca	Swamp Oak, Swamp She-oak																		
Chenopodiaceae		Chenopodium sp.																			
Chenopodiaceae		Einadia hastata	Berry Saltbush																		
Chenopodiaceae		Einadia nutans	Climbing Saltbush							1	50	2	100								
Chenopodiaceae		Einadia trigonos	Fishweed	1	20			1	10												
Clusiaceae		Hypericum gramineum	Small St Johns-wort																		
Clusiaceae	*	Hypericum perforatum	St Johns-wort											1	100	1	100				
Convolvulaceae		Dichondra repens	Kidney-weed, Mercury Bay Weed	1	200	1	200	1	200	1	50	2	500			1	1000	1	200	1	200
Dilleniaceae		Hibbertia obtusifolia	Guinea-flower																		
Styphelioideae		Astroloma humifusum	Cranberry Heath																		
Styphelioideae		Leucopogon juniperinus	Long-flowered Beard-heath																		
Styphelioideae		Lissanthe strigosa	Peach Heath																		
Fabaceae	*	Senna pendula var. glabrata	Easter Cassia																		
Fabaceae Faboideae		Daviesia ulicifolia	Gorse Bitter-pea																		
Fabaceae Faboideae		Desmodium varians	Slender Tick-trefoil					1	20	1	10									1	20
Fabaceae Faboideae		Dillwynia sieberi	Prickly Parrot-pea																		
Fabaceae Faboideae		Dillwynia tenuifolia																			
Fabaceae Faboideae		Glycine clandestina	Twining Glycine	1	100	1	100	1	80	1	100	1	100	1	200						
Fabaceae Faboideae		Glycine tabacina		1	50							2	200			1	200	1	200		
Fabaceae Faboideae		Kennedia rubicunda	Dusky Coral-pea																		
Fabaceae Faboideae	*	Lotus subbiflorus	Hairy Birds-foot Trefoil																		

				850																			
				Moderate/Good_High				Moderate/Good_Medium															
Family	Exotic	Scientific Name	Common Name	Q03_C	Q03_A	Q04_C	Q04_A	Q02_C	Q02_A	Q07_C	Q07_A	Q10_C	Q10_A	Q27_C	Q27_A	Q28_C	Q28_A	Q29_C	Q29_A	Q36_C	Q36_A
Fabaceae Faboideae	*	Medicago polymorpha	Burr Medic																		
Fabaceae Faboideae		Pultenaea parviflora																			
Fabaceae Faboideae	*	Trifolium repens	White Clover									1	50								
Fabaceae Faboideae	*	Vicia sativa	Common Vetch													1	20				
Mimosoideae		Acacia decurrens	Black Wattle			2	5														
Mimosoideae		Acacia elongata	Swamp Wattle																		
Fabaceae		Acacia falcata	Sickle Wattle																		
Fabaceae		Acacia implexa	Hickory Wattle	5	12	5	10			2	5			1	20	1	10				
Mimosoideae		Acacia parramattensis	Parramatta Green Wattle			5	30											1	5		
Geraniaceae		Geranium homeanum	Rainforest Cranesbill	1	20			1	50	1	10	1	100	1	200	1	50				
Goodeniaceae		Goodenia hederacea subsp. hederacea	Ivy Goodenia																		
Goodeniaceae		Scaevola aemula	Fairy Fan-flower																		
Haloragaceae		Gonocarpus tetragynus	Common Raspwort																		
Lamiaceae		Plectranthus parviflorus		1	20																
Lobeliaceae		Pratia purpurascens	Whiteroot			1	50														
Malvaceae	*	Malva parviflora	Small-flowered Mallow															1	10		
Malvaceae	*	Modiola caroliniana	Red-flower Mallow															1	20		
Malvaceae	*	Pavonia hastata																			
Malvaceae	*	Sida rhombifolia	Paddy's Lucerne	5	500	1	50	5	200	5	200	5	200					2	500		
Myrsinaceae	*	Anagallis arvensis	Pimpernel																		
Myrtaceae		Angophora floribunda	Rough-barked Apple																		
Myrtaceae		Angophora subvelutina	Broad-leaved Apple			1	1														
Myrtaceae		Corymbia maculata	Spotted Gum			10	10			10	5	15	10							2	3
Myrtaceae		Eucalyptus amplifolia	Cabbage Gum																		
Myrtaceae		Eucalyptus baueriana	Blue Box																		
Myrtaceae		Eucalyptus crebra	Narrow-leaved Ironbark																		
Myrtaceae		Eucalyptus eugenioides	Thin-leaved Stringybark																		
Myrtaceae		Eucalyptus fibrosa	Red Ironbark																		
Myrtaceae		Eucalyptus moluccana	Grey Box	20	10	8	6	20	11			2	2	10	10	10	7	10	5	10	10
Myrtaceae		Eucalyptus tereticornis	Forest Red Gum					1	11							5	5				
Myrtaceae		Kunzea ambigua	Tick-bush																		
Myrtaceae		Melaleuca decora	White Cloud Tree																		
Myrtaceae		Melaleuca nodosa	Ball Honey-myrtle																		
Myrtaceae		Melaleuca styphelioides	Prickly Paperbark																		
Oleaceae	*	Ligustrum lucidum	Broad-leaved Privet, Glossy Pribet																		
Oleaceae	*	Ligustrum sinense	Small-Leaved Privet, Chinese Privet																		
Oleaceae	*	Olea europaea subsp. cuspidata	African Olive			1	1							15	50	1	2			1	20
Oxalidaceae	*	Oxalis articulata	Wood-Sorrel, Shamrock Oxalis																		
Oxalidaceae	*	Oxalis corniculata	Yellow Wood-sorrel																		
Oxalidaceae		Oxalis exilis	Creeping Oxalis					1	50	1	10										
Oxalidaceae		Oxalis perennans		1	50													1	10		
Oxalidaceae		Oxalis sp.																			
Phyllanthaceae		Breynia cernua																			
Phyllanthaceae		Breynia oblongifolia	Coffee Bush																		
Phyllanthaceae		Glochidion ferdinandi	Cheese Tree																		
Phyllanthaceae		Phyllanthus hirtellus	Thyme Spurge																		
Phyllanthaceae		Phyllanthus virgatus																			
Pittosporaceae		Bursaria spinosa	Blackthorn	1	3	5	30					1	1								
Plantaginaceae	*	Plantago lanceolata	Plantain, Ribwort	1	10			2	100	1	50	1	100			1	50				
Plantaginaceae		Veronica plebeia	Creeping Speedwell																		
Polygonaceae	*	Acetosa sagittata	Rambling Dock, Turkey Rhubarb															1	200		
Polygonaceae	*	Acetosella vulgaris	Sheep Sorrel																		
Polygonaceae		Rumex brownii	Slender Dock	1	10																
Ranunculaceae		Clematis aristata	Traveller's Joy, Old Man's Beard																		
Ranunculaceae		Clematis glycinoides	Headache Vine, Traveller's Joy, Old																		
Rosaceae		Acaena novae-zelandiae	Bidgee-widgee, Biddy-biddy																		

				850																			
				Moderate/Good_High				Moderate/Good_Medium															
Family	Exotic	Scientific Name	Common Name	Q03_C	Q03_A	Q04_C	Q04_A	Q02_C	Q02_A	Q07_C	Q07_A	Q10_C	Q10_A	Q27_C	Q27_A	Q28_C	Q28_A	Q29_C	Q29_A	Q36_C	Q36_A
Rosaceae	*	Rubus fruticosus (sp. agg)	Blackberry											2	100	1	10				
Rosaceae		Rubus parvifolius	Native Raspberry, Small-leaf Bramble											15	200	2	100				
Rubiaceae		Asperula conferta	Common Woodruff			1	20			1	100	2	200	1	200	1	100				
Rubiaceae	*	Galium aparine	Cleavers, Goose-grass, Bedstraw																		
Rubiaceae		Galium gaudichaudii	Rough Bedstraw																		
Rubiaceae		Galium propinquum		1	10																
Rubiaceae		Opercularia diphylla	Stinkweed																		
Rubiaceae		Pomax umbellata	Pomax																		
Rubiaceae	*	Richardia stellaris	Field Madder																		
Santalaceae		Exocarpos cupressiformis	Cherry Ballart, Native Cherry																		
Sapindaceae	*	Cardiospermum grandiflorum	Balloon Vine																		
Sapindaceae		Dodonaea viscosa subsp. cuneata	Wedge-leaf Hopbush			1	2														
Solanaceae	*	Cestrum parqui	Green Cestrum																		
Solanaceae	*	Lycium ferocissimum	African Boxthorn									1	1	1	25						
Solanaceae		Solanum americanum	Nightshade									1	50					1	10		
Solanaceae		Solanum cinereum	Narrawa Burr									1	10								
Solanaceae	*	Solanum linnaeanum	Apple of Sodom																		
Solanaceae	*	Solanum nigrum	Blackberry Nightshade			1	1														
Solanaceae		Solanum prinophyllum	Forest Nightshade																		
Solanaceae	*	Solanum pseudocapsicum	Jerusalem Cherry					1	2												
Solanaceae	*	Solanum sp.																1	10		
Verbenaceae		Clerodendrum tomentosum	Hairy Clerodendrum																		
Verbenaceae	*	Lantana camara	Lantana																		
Verbenaceae	*	Verbena bonariensis	Purpletop	1	50			5	200	1	10			1	5	1	100				
Vitaceae		Cayratia clematidea	Slender Grape																		
Monocotyledons																					
Anthericaceae		Arthropodium milleflorum	Pale Vanilla Lily																		
Anthericaceae		Laxmannia gracilis	Slender Wire Lily																		
Anthericaceae		Tricoryne elatior	Yellow Rush Lily																		
Asparagaceae	*	Asparagus asparagoides	Bridal Creeper, Florists' Smilax																		
Asparagaceae	*	Asparagus officinalis	Asparagus																		
Commelinaceae		Commelina cyanea	Blue Spiderwort																		
Commelinaceae	*	Tradescantia fluminensis	Wandering Jew																		
Cyperaceae		Carex appressa	Tall Sedge																		
Cyperaceae		Carex breviculmis																			
Cyperaceae		Carex inversa	Knob Sedge															1	100		
Cyperaceae	*	Cyperus eragrostis	Drain Flat-sedge, Umbrella Sedge													1	1				
Cyperaceae		Cyperus gracilis	Slender Sedge	1	50							1	20								
Cyperaceae		Fimbristylis dichotoma																			
Cyperaceae		Lepidosperma laterale	Variable Sword-sedge																		
Iridaceae	*	Romulea rosea	Onion Grass																		
Juncaceae	*	Juncus acutus	Spiny Rush																		
Juncaceae	*	Juncus cognatus	Argentine Rush																		
Juncaceae		Juncus usitatus	Common Rush													1	100				
Lomandraceae		Lomandra filiformis	Wattle Mat-rush							1	10									1	50
Lomandraceae		Lomandra longifolia	Spiny-headed Mat-rush																		
Lomandraceae		Lomandra multiflora	Many-flowered Mat-rush									1	20	1	5						
Phormiaceae		Dianella longifolia	Smooth Flax-lily			1	2					1	10	1	20						
Poaceae		Aristida ramosa	Wiregrass													20	2000				
Poaceae		Aristida vagans	Threeawn Speargrass							1	10	1	50								
Poaceae		Austrostipa ramosissima	Bamboo Speargrass											2	200						
Poaceae	*	Axonopus fissifolius	Narrow-leaved Carpet Grass																		
Poaceae		Bothriochloa macra	Redleg Grass																		
Poaceae	*	Briza subaristata																			
Poaceae	*	Bromus catharticus	Prairie Grass											1	10			1	100		
Poaceae	*	Cenchrus clandestinus	Kikuyu	1	50			10	100							2	200			75	1000

				850																			
				Moderate/Good_High				Moderate/Good_Medium															
Family	Exotic	Scientific Name	Common Name	Q03_C	Q03_A	Q04_C	Q04_A	Q02_C	Q02_A	Q07_C	Q07_A	Q10_C	Q10_A	Q27_C	Q27_A	Q28_C	Q28_A	Q29_C	Q29_A	Q36_C	Q36_A
Poaceae	*	Chloris gayana	Rhodes Grass													1	10				
Poaceae		Chloris truncata	Windmill Grass																		
Poaceae		Chloris ventricosa	Tall Windmill Grass	1	10					1	10			10	500	2	200				
Poaceae		Cymbopogon refractus	Barbed Wire Grass													1	20				
Poaceae		Cynodon dactylon	Couch, Bermuda Grass							1	50			5	1000			50	2000		
Poaceae		Dichelachne micrantha	Shorthair Plumegrass																		
Poaceae	*	Echinochloa crus-galli	Barnyard Grass																		
Poaceae		Echinopogon caespitosus	Tufted Hedgehog Grass																		
Poaceae		Echinopogon ovatus	Forest Hedgehog Grass																		
Poaceae	*	Ehrharta erecta	Panic Veldtgrass															2	500		
Poaceae		Entolasia marginata	Bordered Panic																		
Poaceae		Entolasia stricta	Wiry Panic																		
Poaceae		Eragrostis brownii	Brown's Lovegrass																		
Poaceae	*	Eragrostis curvula	African Lovegrass											1	50	2	200				
Poaceae		Eragrostis leptostachya	Paddock Lovegrass																		
Poaceae		Imperata cylindrica	Blady Grass													5	1000				
Poaceae	*	Megathyrsus maximus	Guinea Grass																		
Poaceae		Microlaena stipoides	Weeping Grass, Meadow Rice-grass	80	1000	95	1000	90	1000	70	1000	60	1000	60	2000	60	1000	30	1000	20	500
Poaceae	*	Nassella neesiana	Chilean Needle Grass											1	200			1	20		
Poaceae		Oplismenus aemulus	Broad-leaved Basket Grass																		
Poaceae		Panicum simile	Two-colour Panic																		
Poaceae		Paspalidium distans																			
Poaceae	*	Paspalum dilatatum	Paspalum	2	50	1	50	2	100	20	500	20	500	5	500	1	100	1	50		
Poaceae		Poa labillardierei	Tussock Grass																		
Poaceae		Poa sieberiana	Snow Grass, Fine-leaf Tussock Grass																		
Poaceae		Rytidosperma racemosum var. racemosum		2	100							1	50	2	200						
Poaceae	*	Setaria parviflora		2	200	1	50	2	100	10	200	2	200					2	500		
Poaceae	*	Sporobolus africanus	Rat-tail Grass, Parramatta Grass																		
Poaceae		Sporobolus creber	Slender Rat's-tail Grass																		
Poaceae		Themeda triandra	Kangaroo Grass	1	20									5	200	5	1000				

				850															
				Moderate/Good_Other (Revegetation)								Low (Derived Grassland)							
Family	Exotic	Scientific Name	Common Name	Q01_C	Q01_A	Q09_C	Q09_A	Q13_C	Q13_A	Q35_C	Q35_A	Q18_C	Q18_A	Q19_C	Q19_A	Q24_C	Q24_A	Q25_C	Q25_A
Pteridophytes																			
Pteridaceae		Cheilanthes sieberi	Rock Fern																
Dicotyledons																			
Acanthaceae		Brunoniella australis	Blue Trumpet, Blue Yam							1	200								
Acanthaceae		Brunoniella pumilio	Dwarf Blue Trumpet																
Amaranthaceae	*	Alternanthera philoxeroides	Alligator Weed																
Apiaceae		Centella asiatica	Indian Pennywort																
Apocynaceae	*	Araujia sericifera	Moth Vine, Cruel Plant	2	20	1	10	0.2	10	1	50								
Apocynaceae	*	Gomphocarpus fruticosus	Narrow-leaved Cotton Bush																
Asteraceae	*	Ageratina adenophora	Crofton Weed																
Asteraceae	*	Ambrosia artemisiifolia	Annual Ragweed					0.1	1										
Asteraceae	*	Bidens pilosa	Cobblers Pegs			5	200	5	300										
Asteraceae	*	Bidens subalternans	Greater Beggar's Ticks																
Asteraceae		Cassinia aculeata	Dolly Bush																
Asteraceae	*	Cirsium vulgare	Black Thistle, Spear Thistle			1	20					1	100			1	50	1	
Asteraceae	*	Conyza bonariensis	Flaxleaf Fleabane					0.1	10										
Asteraceae	*	Conyza sumatrensis	Tall Fleabane			1	20					1	10	1	20				
Asteraceae	*	Hypochaeris radicata	Catsear, False Dandelion					1	30			1	100	1	50	1	100	1	
Asteraceae		Olearia microphylla																	
Asteraceae		Ozothamnus diosmifolius	White Dogwood																
Asteraceae	*	Senecio madagascariensis	Fireweed, Madagascar Ragwort			1	50	1	30	1	200	15	500			1	20	1	
Asteraceae	*	Senecio pterophorus	African Daisy-bush	5	50	1	10			1	5								
Asteraceae		Sigesbeckia australiensis	Pale Indian Weed																
Asteraceae	*	Soliva sessilis	Bindii, Bindi-eye, Jo-Jo																
Asteraceae	*	Sonchus oleraceus	Common Sow-thistle, Milk-thistle	1	5	1	10	0.5	20			1	20			1	50		
Asteraceae	*	Taraxacum officinale	Dandelion																
Asteraceae		Vernonia cinerea																	
Basellaceae	*	Anredera cordifolia	Madeira Vine, Lamb's Tail																
Bignoniaceae		Pandorea pandorana	Wonga Vine																
Brassicaceae	*	Brassica oleracea																	
Brassicaceae	*	Lepidium africanum	Common Peppercress			1	5					1	20						
Cactaceae	*	Opuntia stricta	Prickly Pear, Common Pest Pear																
Campanulaceae		Wahlenbergia gracilis	Sprawling Bluebell	1	50														
Campanulaceae		Wahlenbergia stricta										1	20						
Caryophyllaceae	*	Stellaria media	Chickweed																
Casuarinaceae		Allocasuarina littoralis	Black She-Oak																
Casuarinaceae		Casuarina glauca	Swamp Oak, Swamp She-oak					40	20										
Chenopodiaceae		Chenopodium sp.																	
Chenopodiaceae		Einadia hastata	Berry Saltbush			1	10	1	100										
Chenopodiaceae		Einadia nutans	Climbing Saltbush	1	1														
Chenopodiaceae		Einadia trigonos	Fishweed			10	100												
Clusiaceae		Hypericum gramineum	Small St Johns-wort											1	100				
Clusiaceae	*	Hypericum perforatum	St Johns-wort																
Convolvulaceae		Dichondra repens	Kidney-weed, Mercury Bay Weed	2	500	1	200	3	500	1	500								
Dilleniaceae		Hibbertia obtusifolia	Guinea-flower																
Styphelioideae		Astroloma humifusum	Cranberry Heath																
Ericaceae		Leucopogon juniperinus	Long-flowered Beard-heath																
Styphelioideae		Lissanthe strigosa	Peach Heath																
Caesalpinioideae	*	Senna pendula var. glabrata	Easter Cassia																
Fabaceae Faboideae		Daviesia ulicifolia	Gorse Bitter-pea																
Fabaceae Faboideae		Desmodium varians	Slender Tick-trefoil	1	5					1	50	1	10						
Fabaceae Faboideae		Dillwynia sieberi	Prickly Parrot-pea	2	10					1	5								
Fabaceae Faboideae		Dillwynia tenuifolia																	
Fabaceae Faboideae		Glycine clandestina	Twining Glycine	1	100	1	50			1	50								
Fabaceae Faboideae		Glycine tabacina				1	50	0.1	50	1	100								
Fabaceae Faboideae		Kennedia rubicunda	Dusky Coral-pea																
Fabaceae Faboideae	*	Lotus subbiflorus	Hairy Birds-foot Trefoil																
Fabaceae Faboideae	*	Medicago polymorpha	Burr Medic																
Fabaceae Faboideae		Pultenaea parviflora																	
Fabaceae Faboideae	*	Trifolium repens	White Clover									1	50						
Fabaceae Faboideae	*	Vicia sativa	Common Vetch																
Fabaceae		Acacia decurrens	Black Wattle	2	10	2	5			1	1								
Fabaceae		Acacia elongata	Swamp Wattle																
Fabaceae		Acacia falcata	Sickle Wattle	1	1														

				850															
				Moderate/Good_Other (Revegetation)								Low (Derived Grassland)							
Family	Exotic	Scientific Name	Common Name	Q01_C	Q01_A	Q09_C	Q09_A	Q13_C	Q13_A	Q35_C	Q35_A	Q18_C	Q18_A	Q19_C	Q19_A	Q24_C	Q24_A	Q25_C	Q25_A
Mimosoideae		Acacia implexa	Hickory Wattle																
Mimosoideae		Acacia parramattensis	Parramatta Green Wattle			25	50												
Geraniaceae		Geranium homeanum	Rainforest Cranesbill	1	50	1	20												
Goodeniaceae		Goodenia hederacea subsp. hederacea	Ivy Goodenia																
Goodeniaceae		Scaevola aemula	Fairy Fan-flower																
Haloragaceae		Gonocarpus tetragynus	Common Raspwort																
Lamiaceae		Plectranthus parviflorus																	
Lobeliaceae		Pratia purpurascens	Whiteroot																
Malvaceae	*	Malva parviflora	Small-flowered Mallow																
Malvaceae	*	Modiola caroliniana	Red-flower Mallow					0.2	20										
Malvaceae	*	Pavonia hastata																	
Malvaceae	*	Sida rhombifolia	Paddy's Lucerne	40	500	60	1000			1	50								
Myrsinaceae	*	Anagallis arvensis	Pimpernel			1	5	0.1	10			1	10			1	20		
Myrtaceae		Angophora floribunda	Rough-barked Apple																
Myrtaceae		Angophora subvelutina	Broad-leaved Apple																
Myrtaceae		Corymbia maculata	Spotted Gum	10	5														
Myrtaceae		Eucalyptus amplifolia	Cabbage Gum																
Myrtaceae		Eucalyptus baueriana	Blue Box																
Myrtaceae		Eucalyptus crebra	Narrow-leaved Ironbark																
Myrtaceae		Eucalyptus eugenioides	Thin-leaved Stringybark			1	1												
Myrtaceae		Eucalyptus fibrosa	Red Ironbark																
Myrtaceae		Eucalyptus moluccana	Grey Box	10	4	13	2			2	2								
Myrtaceae		Eucalyptus tereticornis	Forest Red Gum	10	5	6	5			10	6								
Myrtaceae		Kunzea ambigua	Tick-bush																
Myrtaceae		Melaleuca decora	White Cloud Tree																
Myrtaceae		Melaleuca nodosa	Ball Honey-myrtle																
Myrtaceae		Melaleuca styphelioides	Prickly Paperbark																
Oleaceae	*	Ligustrum lucidum	Broad-leaved Privet, Glossy Privet																
Oleaceae	*	Ligustrum sinense	Small-Leaved Privet, Chinese Privet																
Oleaceae	*	Olea europaea subsp. cuspidata	African Olive	1	1					1	50								
Oxalidaceae	*	Oxalis articulata	Wood-Sorrel, Shamrock Oxalis																
Oxalidaceae	*	Oxalis corniculata	Yellow Wood-sorrel	1	50														
Oxalidaceae		Oxalis exilis	Creeping Oxalis			1	10												
Oxalidaceae		Oxalis perennans										1	50						
Oxalidaceae		Oxalis sp.																	
Phyllanthaceae		Breynia cernua																	
Phyllanthaceae		Breynia oblongifolia	Coffee Bush																
Phyllanthaceae		Glochidion ferdinandi	Cheese Tree																
Phyllanthaceae		Phyllanthus hirtellus	Thyme Spurge																
Phyllanthaceae		Phyllanthus virgatus																	
Pittosporaceae		Bursaria spinosa	Blackthorn									1	1						
Plantaginaceae	*	Plantago lanceolata	Plantain, Ribwort			1	10	1	20	1	200	1	100						
Plantaginaceae		Veronica plebeia	Creeping Speedwell																
Polygonaceae	*	Acetosa sagittata	Rambling Dock, Turkey Rhubarb																
Polygonaceae	*	Acetosella vulgaris	Sheep Sorrel																
Polygonaceae		Rumex brownii	Slender Dock																
Ranunculaceae		Clematis aristata	Traveller's Joy, Old Man's Beard																
Ranunculaceae		Clematis glycinoides	Headache Vine, Traveller's Joy, Old																
Rosaceae		Acaena novae-zelandiae	Bidgee-widgee, Biddy-biddy	1	5														
Rosaceae	*	Rubus fruticosus (sp. agg)	Blackberry					1	2										
Rosaceae		Rubus parvifolius	Native Raspberry, Small-leaf Bramble																
Rubiaceae		Asperula conferta	Common Woodruff	1	100					1	200							1	20
Rubiaceae	*	Galium aparine	Cleavers, Goose-grass, Bedstraw																
Rubiaceae		Galium gaudichaudii	Rough Bedstraw																
Rubiaceae		Galium propinquum																	
Rubiaceae		Opercularia diphylla	Stinkweed																
Rubiaceae		Pomax umbellata	Pomax																
Rubiaceae	*	Richardia stellaris	Field Madder																
Santalaceae		Exocarpos cupressiformis	Cherry Ballart, Native Cherry																
Sapindaceae	*	Cardiospermum grandiflorum	Balloon Vine																
Sapindaceae		Dodonaea viscosa subsp. cuneata	Wedge-leaf Hopbush	2	20														
Solanaceae	*	Cestrum parqui	Green Cestrum					0.1	10										
Solanaceae	*	Lycium ferocissimum	African Boxthorn					40	20										
Solanaceae		Solanum americanum	Blackberry Nightshade, Glossy																
Solanaceae		Solanum cinereum	Narrawa Burr																

				850															
				Moderate/Good_Other (Revegetation)								Low (Derived Grassland)							
Family	Exotic	Scientific Name	Common Name	Q01_C	Q01_A	Q09_C	Q09_A	Q13_C	Q13_A	Q35_C	Q35_A	Q18_C	Q18_A	Q19_C	Q19_A	Q24_C	Q24_A	Q25_C	Q25_A
Solanaceae	*	Solanum linnaeanum	Apple of Sodom																
Solanaceae	*	Solanum nigrum	Blackberry Nightshade					0.1	2										
Solanaceae		Solanum prinophyllum	Forest Nightshade																
Solanaceae	*	Solanum pseudocapsicum	Jerusalem Cherry					0.1	10										
Solanaceae	*	Solanum sp.				1	20												
Verbenaceae		Clerodendrum tomentosum	Hairy Clerodendrum																
Verbenaceae	*	Lantana camara	Lantana																
Verbenaceae	*	Verbena bonariensis	Purpletop	5	200					1	200								
Vitaceae		Cayratia clematidea	Slender Grape																
Monocotyledons																			
Anthericaceae		Arthropodium milleflorum	Pale Vanilla Lily																
Anthericaceae		Laxmannia gracilis	Slender Wire Lily																
Anthericaceae		Tricoryne elatior	Yellow Rush Lily											1	50				
Asparagaceae	*	Asparagus asparagoides	Bridal Creeper, Florists' Smilax																
Asparagaceae	*	Asparagus officinalis	Asparagus																
Commelinaceae		Commelina cyanea	Blue Spiderwort																
Commelinaceae	*	Tradescantia fluminensis	Wandering Jew																
Cyperaceae		Carex appressa	Tall Sedge																
Cyperaceae		Carex breviculmis																	
Cyperaceae		Carex inversa	Knob Sedge	1	50	2	100												
Cyperaceae	*	Cyperus eragrostis	Drain Flat-sedge, Umbrella Sedge																
Cyperaceae		Cyperus gracilis	Slender Sedge	1	100	1	50			1	200								
Cyperaceae		Fimbristylis dichotoma								1	50			1	50				
Cyperaceae		Lepidosperma laterale	Variable Sword-sedge																
Iridaceae	*	Romulea rosea	Onion Grass											1	50	1	100	5	
Juncaceae	*	Juncus acutus	Spiny Rush					15	100										
Juncaceae	*	Juncus cognatus	Argentine Rush																
Juncaceae		Juncus usitatus	Common Rush																
Lomandraceae		Lomandra filiformis	Wattle Mat-rush							1	50					1	50		
Lomandraceae		Lomandra longifolia	Spiny-headed Mat-rush																
Lomandraceae		Lomandra multiflora	Many-flowered Mat-rush																
Phormiaceae		Dianella longifolia	Smooth Flax-lily							1	50								
Poaceae		Aristida ramosa	Wiregrass							10	500	15	500	40	1000	60	1000	60	1000
Poaceae		Aristida vagans	Threeawn Speargrass	1	50														
Poaceae		Austrostipa ramosissima	Bamboo Speargrass																
Poaceae	*	Axonopus fissifolius	Narrow-leaved Carpet Grass											15	500				
Poaceae		Bothriochloa macra	Redleg Grass															5	200
Poaceae	*	Briza subaristata								1	100			1	50			1	
Poaceae	*	Bromus catharticus	Prairie Grass																
Poaceae	*	Cenchrus clandestinus	Kikuyu					2	30			20	500						
Poaceae	*	Chloris gayana	Rhodes Grass					20	500										
Poaceae		Chloris truncata	Windmill Grass					0.1	30										
Poaceae		Chloris ventricosa	Tall Windmill Grass																
Poaceae		Cymbopogon refractus	Barbed Wire Grass																
Poaceae		Cynodon dactylon	Couch, Bermuda Grass									20	500	2	100	3	500	10	500
Poaceae		Dichelachne micrantha	Shorthair Plumegrass																
Poaceae	*	Echinochloa crus-galli	Barnyard Grass					0.1	20										
Poaceae		Echinopogon caespitosus	Tufted Hedgehog Grass																
Poaceae		Echinopogon ovatus	Forest Hedgehog Grass																
Poaceae	*	Ehrharta erecta	Panic Veldtgrass																
Poaceae		Entolasia marginata	Bordered Panic																
Poaceae		Entolasia stricta	Wiry Panic																
Poaceae		Eragrostis brownii	Brown's Lovegrass																
Poaceae	*	Eragrostis curvula	African Lovegrass							3	100								
Poaceae		Eragrostis leptostachya	Paddock Lovegrass																
Poaceae		Imperata cylindrica	Blady Grass																
Poaceae	*	Megathyrsus maximus	Guinea Grass																
Poaceae		Microlaena stipoides	Weeping Grass, Meadow Rice-grass	80	1000	70	1000	10	1000	80	2000								
Poaceae	*	Nassella neesiana	Chilean Needle Grass																
Poaceae		Oplismenus aemulus	Broad-leaved Basket Grass					1	30										
Poaceae		Panicum simile	Two-colour Panic											1	20				
Poaceae		Paspalidium distans																	
Poaceae	*	Paspalum dilatatum	Paspalum	2	50	10	200	1	100			5	100	15	500	20	1000	30	
Poaceae		Poa labillardierei	Tussock Grass																
Poaceae		Poa sieberiana	Snow Grass, Fine-leaf Tussock Grass																

				850															
				Moderate/Good_Other (Revegetation)								Low (Derived Grassland)							
Family	Exotic	Scientific Name	Common Name	Q01_C	Q01_A	Q09_C	Q09_A	Q13_C	Q13_A	Q35_C	Q35_A	Q18_C	Q18_A	Q19_C	Q19_A	Q24_C	Q24_A	Q25_C	Q25_A
Poaceae		Rytidosperma racemosum var. racemosum																	
Poaceae	*	Setaria parviflora		2	50	2	200	3	200	1	50	1	20	1	50				
Poaceae	*	Sporobolus africanus	Rat-tail Grass, Parramatta Grass							2	200								
Poaceae		Sporobolus creber	Slender Rat's-tail Grass															2	100
Poaceae		Themeda triandra	Kangaroo Grass					2	500	5	200	15	100	35	1000	3	500		

				849										1800						N/A	N/A
				Moderate/Good_Medium				Moderate/Good_Poor				Moderate/Good_Other (Derived Shrubland)		Moderate/Good_Poor						N/A	N/A
Family	Exotic	Scientific Name	Common Name	Q05_C	Q05_A	Q30_C	Q30_A	Q33_C	Q33_A	Q31_C	Q31_A	Q16_C	Q16_A	Q14_C	Q14_A	Q21_C	Q21_A	Q23_C	Q23_A	Q32_C	Q32_A
Pteridophytes																					
Pteridaceae		Cheilanthes sieberi	Rock Fern									0.5	20								
Dicotyledons																					
Acanthaceae		Brunoniella australis	Blue Trumpet, Blue Yam			1	500	1	200												
Acanthaceae		Brunoniella pumilio	Dwarf Blue Trumpet	1	100																
Amaranthaceae	*	Alternanthera philoxeroides	Alligator Weed																		
Apiaceae		Centella asiatica	Indian Pennywort	1	50															1	100
Apocynaceae	*	Araujia sericifera	Moth Vine, Cruel Plant	1	20			1	100							1	20				
Apocynaceae	*	Gomphocarpus fruticosus	Narrow-leaved Cotton Bush																		
Asteraceae	*	Ageratina adenophora	Crofton Weed			1	2														
Asteraceae	*	Ambrosia artemisiifolia	Annual Ragweed																		
Asteraceae	*	Bidens pilosa	Cobblers Pegs	1	50			1	20			5	100	2	200						
Asteraceae	*	Bidens subalternans	Greater Beggar's Ticks																		
Asteraceae		Cassinia aculeata	Dolly Bush																		
Asteraceae	*	Cirsium vulgare	Black Thistle, Spear Thistle	1	10					1	20			1	10					1	200
Asteraceae	*	Conyza bonariensis	Flaxleaf Fleabane																		
Asteraceae	*	Conyza sumatrensis	Tall Fleabane																		
Asteraceae	*	Hypochaeris radicata	Catsear, False Dandelion									1	50							1	200
Asteraceae		Olearia microphylla																			
Asteraceae		Ozothamnus diosmifolius	White Dogwood																		
Asteraceae	*	Senecio madagascariensis	Fireweed, Madagascar Ragwort	1	5					1	50									5	1000
Asteraceae	*	Senecio pterophorus	African Daisy-bush			1	10							30	200						
Asteraceae		Sigesbeckia australiensis	Pale Indian Weed																		
Asteraceae	*	Soliva sessilis	Bindii, Bindi-eye, Jo-Jo																		
Asteraceae	*	Sonchus oleraceus	Common Sow-thistle, Milk-thistle					1	20											1	100
Asteraceae	*	Taraxacum officinale	Dandelion	1	5																
Asteraceae		Vernonia cinerea																			
Basellaceae	*	Anredera cordifolia	Madeira Vine, Lamb's Tail			1	10														
Bignoniaceae		Pandorea pandorana	Wonga Vine																		
Brassicaceae	*	Brassica oleracea																			
Brassicaceae	*	Lepidium africanum	Common Peppercress							1	5										
Cactaceae	*	Opuntia stricta	Prickly Pear, Common Pest Pear					1	5												
Campanulaceae		Wahlenbergia gracilis	Sprawling Bluebell																		
Campanulaceae		Wahlenbergia stricta																			
Caryophyllaceae	*	Stellaria media	Chickweed					1	50												
Casuarinaceae		Allocasuarina littoralis	Black She-Oak																		
Casuarinaceae		Casuarina glauca	Swamp Oak, Swamp She-oak													50	100	30	30		
Chenopodiaceae		Chenopodium sp.																			
Chenopodiaceae		Einadia hastata	Berry Saltbush			1	20	1	50	1	50										
Chenopodiaceae		Einadia nutans	Climbing Saltbush																		
Chenopodiaceae		Einadia trigonos	Fishweed					1	50	1	50			1	100						
Clusiaceae		Hypericum gramineum	Small St Johns-wort																		
Clusiaceae	*	Hypericum perforatum	St Johns-wort																		
Convolvulaceae		Dichondra repens	Kidney-weed, Mercury Bay Weed	1	200	1	200					5	1000	1	500						
Dilleniaceae		Hibbertia obtusifolia	Guinea-flower																		
Ericaceae Styphelioideae		Astroloma humifusum	Cranberry Heath																		
Ericaceae Styphelioideae		Leucopogon juniperinus	Long-flowered Beard-heath																		
Ericaceae Styphelioideae		Lissanthe strigosa	Peach Heath																		
Fabaceae Caesalpinioideae	*	Senna pendula var. glabrata	Easter Cassia																		
Fabaceae Faboideae		Daviesia ulicifolia	Gorse Bitter-pea																		
Fabaceae Faboideae		Desmodium varians	Slender Tick-trefoil							1	5										
Fabaceae Faboideae		Dillwynia sieberi	Prickly Parrot-pea																		
Fabaceae Faboideae		Dillwynia tenuifolia																			
Fabaceae Faboideae		Glycine clandestina	Twining Glycine	1	50									1	100						
Fabaceae Faboideae		Glycine tabacina				1	50	1	50	1	50										
Fabaceae Faboideae		Kennedia rubicunda	Dusky Coral-pea																		

				849										1800						N/A	N/A
				Moderate/Good_Medium				Moderate/Good_Poor				Moderate/Good_Other (Derived Shrubland)		Moderate/Good_Poor						N/A	N/A
Family	Exotic	Scientific Name	Common Name	Q05_C	Q05_A	Q30_C	Q30_A	Q33_C	Q33_A	Q31_C	Q31_A	Q16_C	Q16_A	Q14_C	Q14_A	Q21_C	Q21_A	Q23_C	Q23_A	Q32_C	Q32_A
Fabaceae Faboideae	*	Lotus subbiflorus	Hairy Birds-foot Trefoil																	1	50
Fabaceae Faboideae	*	Medicago polymorpha	Burr Medic																		
Fabaceae Faboideae		Pultenaea parviflora																			
Fabaceae Faboideae	*	Trifolium repens	White Clover																	1	100
Fabaceae Faboideae	*	Vicia sativa	Common Vetch																	1	200
Fabaceae Mimosoideae		Acacia decurrens	Black Wattle	1	1									2	15						
Fabaceae Mimosoideae		Acacia elongata	Swamp Wattle																		
Fabaceae Mimosoideae		Acacia falcata	Sickle Wattle																		
Fabaceae Mimosoideae		Acacia implexa	Hickory Wattle	1	1																
Fabaceae Mimosoideae		Acacia parramattensis	Parramatta Green Wattle																		
Geraniaceae		Geranium homeanum	Rainforest Cranesbill																		
Goodeniaceae		Goodenia hederacea subsp. hederacea	Ivy Goodenia																		
Goodeniaceae		Scaevola aemula	Fairy Fan-flower																		
Haloragaceae		Gonocarpus tetragynus	Common Raspwort																		
Lamiaceae		Plectranthus parviflorus																			
Lobeliaceae		Pratia purpurascens	Whiteroot	2	500			1	100												
Malvaceae	*	Malva parviflora	Small-flowered Mallow																		
Malvaceae	*	Modiola caroliniana	Red-flower Mallow																		
Malvaceae	*	Pavonia hastata		1	50																
Malvaceae	*	Sida rhombifolia	Paddy's Lucerne	2	200			1	50	1	50			20	500						
Myrsinaceae	*	Anagallis arvensis	Pimpernel																		
Myrtaceae		Angophora floribunda	Rough-barked Apple																		
Myrtaceae		Angophora subvelutina	Broad-leaved Apple					5	4												
Myrtaceae		Corymbia maculata	Spotted Gum	10	3	5	4							15	20						
Myrtaceae		Eucalyptus amplifolia	Cabbage Gum					10	12	10	3										
Myrtaceae		Eucalyptus baueriana	Blue Box																		
Myrtaceae		Eucalyptus crebra	Narrow-leaved Ironbark																		
Myrtaceae		Eucalyptus eugenioides	Thin-leaved Stringybark																		
Myrtaceae		Eucalyptus fibrosa	Red Ironbark											1	3						
Myrtaceae		Eucalyptus moluccana	Grey Box	10	10	2	4							1	1						
Myrtaceae		Eucalyptus tereticornis	Forest Red Gum	5	6	1	2							3	4	2	1				
Myrtaceae		Kunzea ambigua	Tick-bush																		
Myrtaceae		Melaleuca decora	White Cloud Tree					10	10	2	1										
Myrtaceae		Melaleuca nodosa	Ball Honey-myrtle					1	5												
Myrtaceae		Melaleuca styphelioides	Prickly Paperbark															1	2		
Oleaceae	*	Ligustrum lucidum	Broad-leaved Privet, Glossy Privet													2	5				
Oleaceae	*	Ligustrum sinense	Small-Leaved Privet																		
Oleaceae	*	Olea europaea subsp. cuspidata	African Olive	10	50	5	25											20	50		
Oxalidaceae	*	Oxalis articulata	Wood-Sorrel, Shamrock Oxalis																		
Oxalidaceae	*	Oxalis corniculata	Yellow Wood-sorrel																		
Oxalidaceae		Oxalis exilis	Creeping Oxalis	1	100																
Oxalidaceae		Oxalis perennans				1	50														
Oxalidaceae		Oxalis sp.										2	50								
Phyllanthaceae		Breynia cernua																			
Phyllanthaceae		Breynia oblongifolia	Coffee Bush																		
Phyllanthaceae		Glochidion ferdinandi	Cheese Tree			1	2														
Phyllanthaceae		Phyllanthus hirtellus	Thyme Spurge																		
Phyllanthaceae		Phyllanthus virgatus		1	10																
Pittosporaceae		Bursaria spinosa	Blackthorn	2	10	1	20	10	40			40	200								
Plantaginaceae	*	Plantago lanceolata	Plantain, Ribwort	2	100			1	20			1	20	1	10					1	50
Plantaginaceae		Veronica plebeia	Creeping Speedwell			1	20														
Polygonaceae	*	Acetosa sagittata	Rambling Dock, Turkey Rhubarb																		
Polygonaceae	*	Acetosella vulgaris	Sheep Sorrel																		
Polygonaceae		Rumex brownii	Slender Dock																		
Ranunculaceae		Clematis aristata	Traveller's Joy, Old Man's Beard															1	50		

				849										1800						N/A	N/A
				Moderate/Good_Medium				Moderate/Good_Poor				Moderate/Good_Other (Derived Shrubland)		Moderate/Good_Poor						N/A	N/A
Family	Exotic	Scientific Name	Common Name	Q05_C	Q05_A	Q30_C	Q30_A	Q33_C	Q33_A	Q31_C	Q31_A	Q16_C	Q16_A	Q14_C	Q14_A	Q21_C	Q21_A	Q23_C	Q23_A	Q32_C	Q32_A
Ranunculaceae		Clematis glycinoides	Headache Vine, Traveller's Joy																		
Rosaceae		Acaena novae-zelandiae	Bidgee-widgee, Biddy-biddy																		
Rosaceae	*	Rubus fruticosus (sp. agg)	Blackberry	2	20															1	20
Rosaceae		Rubus parvifolius	Native Raspberry, Small-leaf																		
Rubiaceae		Asperula conferta	Common Woodruff	1	200																
Rubiaceae	*	Galium aparine	Cleavers, Goose-grass, Bedstraw																		
Rubiaceae		Galium gaudichaudii	Rough Bedstraw									0.1	10								
Rubiaceae		Galium propinquum																			
Rubiaceae		Opercularia diphylla	Stinkweed																		
Rubiaceae		Pomax umbellata	Pomax																		
Rubiaceae	*	Richardia stellaris	Field Madder																		
Santalaceae		Exocarpos cupressiformis	Cherry Ballart, Native Cherry																		
Sapindaceae	*	Cardiospermum grandiflorum	Balloon Vine													2	20				
Sapindaceae		Dodonaea viscosa subsp. cuneata	Wedge-leaf Hopbush																		
Solanaceae	*	Cestrum parqui	Green Cestrum																		
Solanaceae	*	Lycium ferocissimum	African Boxthorn							1	2										
Solanaceae		Solanum americanum	Blackberry Nightshade																		
Solanaceae		Solanum cinereum	Narrawa Burr																		
Solanaceae	*	Solanum linnaeanum	Apple of Sodom																	1	20
Solanaceae	*	Solanum nigrum	Blackberry Nightshade																		
Solanaceae		Solanum prinophyllum	Forest Nightshade	1	5																
Solanaceae	*	Solanum pseudocapsicum	Jerusalem Cherry	1	20	1	50									1	20				
Solanaceae	*	Solanum sp.																			
Verbenaceae		Clerodendrum tomentosum	Hairy Clerodendrum																		
Verbenaceae	*	Lantana camara	Lantana	2	10	60	200									2	20				
Verbenaceae	*	Verbena bonariensis	Purpletop			1	20							1	50						
Vitaceae		Cayratia clematidea	Slender Grape	1	5	1	50														
Monocotyledons																					
Anthericaceae		Arthropodium milleflorum	Pale Vanilla Lily																		
Anthericaceae		Laxmannia gracilis	Slender Wire Lily																		
Anthericaceae		Tricoryne elatior	Yellow Rush Lily																		
Asparagaceae	*	Asparagus asparagoides	Bridal Creeper, Florists' Smilax		1	50	1	100													
Asparagaceae	*	Asparagus officinalis	Asparagus	1	20																
Commelinaceae		Commelina cyanea	Blue Spiderwort																		
Commelinaceae	*	Tradescantia fluminensis	Wandering Jew													90	1000	50	1000		
Cyperaceae		Carex appressa	Tall Sedge																	5	100
Cyperaceae		Carex breviculmis																			
Cyperaceae		Carex inversa	Knob Sedge			1	50														
Cyperaceae	*	Cyperus eragrostis	Drain Flat-sedge, Umbrella Sedge																		
Cyperaceae		Cyperus gracilis	Slender Sedge									1	50	1	100						
Cyperaceae		Fimbristylis dichotoma								1	50										
Cyperaceae		Lepidosperma laterale	Variable Sword-sedge																		
Iridaceae	*	Romulea rosea	Onion Grass																		
Juncaceae	*	Juncus acutus	Spiny Rush																		
Juncaceae	*	Juncus cognatus	Argentine Rush																		
Juncaceae		Juncus usitatus	Common Rush	1	20															1	50
Lomandraceae		Lomandra filiformis	Wattle Mat-rush																		
Lomandraceae		Lomandra longifolia	Spiny-headed Mat-rush																		
Lomandraceae		Lomandra multiflora	Many-flowered Mat-rush					1	20												
Phormiaceae		Dianella longifolia	Smooth Flax-lily	1	5			1	20												
Poaceae		Aristida ramosa	Wiregrass																		
Poaceae		Aristida vagans	Threeawn Speargrass									5	200								
Poaceae		Austrostipa ramosissima	Bamboo Speargrass																		
Poaceae	*	Axonopus fissifolius	Narrow-leaved Carpet Grass																		
Poaceae		Bothriochloa macra	Redleg Grass																		
Poaceae	*	Briza subaristata																			

				849										1800						N/A	N/A
				Moderate/Good_Medium				Moderate/Good_Poor				Moderate/Good_Other (Derived Shrubland)		Moderate/Good_Poor						N/A	N/A
Family	Exotic	Scientific Name	Common Name	Q05_C	Q05_A	Q30_C	Q30_A	Q33_C	Q33_A	Q31_C	Q31_A	Q16_C	Q16_A	Q14_C	Q14_A	Q21_C	Q21_A	Q23_C	Q23_A	Q32_C	Q32_A
Poaceae	*	Bromus catharticus	Prairie Grass																		
Poaceae	*	Cenchrus clandestinus	Kikuyu					40	1000	1	50	5	100								
Poaceae	*	Chloris gayana	Rhodes Grass	1	50	1	50							5	50						
Poaceae		Chloris truncata	Windmill Grass																		
Poaceae		Chloris ventricosa	Tall Windmill Grass																		
Poaceae		Cymbopogon refractus	Barbed Wire Grass																		
Poaceae		Cynodon dactylon	Couch, Bermuda Grass			2	200			40	1000	0.5	20	2	200					80	2000
Poaceae		Dichelachne micrantha	Shorthair Plumegrass																		
Poaceae	*	Echinochloa crus-galli	Barnyard Grass																		
Poaceae		Echinopogon caespitosus	Tufted Hedgehog Grass																		
Poaceae		Echinopogon ovatus	Forest Hedgehog Grass																		
Poaceae	*	Ehrharta erecta	Panic Veldtgrass			2	200	2	200	1	100	5	100					20	1000		
Poaceae		Entolasia marginata	Bordered Panic																		
Poaceae		Entolasia stricta	Wiry Panic																		
Poaceae		Eragrostis brownii	Brown's Lovegrass																		
Poaceae	*	Eragrostis curvula	African Lovegrass																		
Poaceae		Eragrostis leptostachya	Paddock Lovegrass																		
Poaceae		Imperata cylindrica	Blady Grass																		
Poaceae	*	Megathyrsus maximus	Guinea Grass											1	50						
Poaceae		Microlaena stipoides	Weeping Grass, Meadow Rice-	70	1000	25	1000	60	2000	10	1000	20	1000	50	500			1	100		
Poaceae	*	Nassella neesiana	Chilean Needle Grass																		
Poaceae		Oplismenus aemulus	Broad-leaved Basket Grass	5	500																
Poaceae		Panicum simile	Two-colour Panic																		
Poaceae		Paspalidium distans																			
Poaceae	*	Paspalum dilatatum	Paspalum	5	500															20	500
Poaceae		Poa labillardierei	Tussock Grass																		
Poaceae		Poa sieberiana	Grass																		
Poaceae		Rytidosperma racemosum var. racemosum																			
Poaceae	*	Setaria parviflora		5	500							2	50	20	500						
Poaceae	*	Sporobolus africanus	Rat-tail Grass, Parramatta Grass																		
Poaceae		Sporobolus creber	Slender Rat's-tail Grass																		
Poaceae		Themeda triandra	Kangaroo Grass									20	1000								

Vegetation condition assessment table

Site value	PCT 724					PCT 830	PCT 835		PCT 849	PCT 849			
Plot number:	**Q11**	**Q22**	**Q12**	**Q17**	**Q34**	**Q26**	**Q15**	**Q20**	**Q05**	**Q30**	**Q33**	**Q31**	**Q16**
Native plant species	43	25	14	24	11	17	17	17	20	15	13	9	10
Native overstorey cover (%)	25	3	18.5	15.5	1.5	6	43.5	14.5	26	6.5	15.5	24.5	0
Native midstorey cover (%)	6	28	9	19	9.5	0.5	19	6.5	2	0	3	0	45
Native ground cover - grass	44	24	64	18	8	12	82	36	72	40	54	26	36
Native ground cover – shrub (%)	6	2	36	6	0	0	0	0	0	0	2	0	0
Native ground cover – other (%)	8	4	22	0	2	20	4	6	10	2	0	0	2
Exotic plant cover (%)	8	0	18	8	9	16	10	58	35	42	20	10	54
Number of hollow trees	0	0	1	0	0	0	0	0	3	3	0	1	0
Canopy Regeneration (%)	100	100	100	0	0	33	0	50	100	100	0	0	0
Fallen logs (m)	0	0	6	4	11	15	2	6	2	6	35	18	0
Condition category	**Moderate/ Good_High**	**Moderate/ Good_High**	**Moderate/ Good_ Medium**	**Moderate/ Good_ Medium**	**Moderate/ Good_Poor**	**Moderate/ Good_ Medium**	**Moderate/ Good_Poor**	**Moderate/ Good_Poor**	**Moderate/ Good_ Medium**	**Moderate/ Good_ Medium**	**Moderate/ Good_Poor**	**Moderate/ Good_Poor**	**Moderate/Good_ Other (Derived Shrubland)**

Site value	PCT 850												
Plot number:	**Q03**	**Q04**	**Q02**	**Q07**	**Q10**	**Q27**	**Q28**	**Q29**	**Q36**	**Q01**	**Q09**	**Q13**	**Q35**
Native plant species	18	15	10	15	18	15	16	9	7	19	15	8	17
Native overstorey cover (%)	22	19.5	22	22	27.5	25.5	22.5	11	11.5	25	14	30.5	8
Native midstorey cover (%)	12	10	0	0	0	0	0.5	0	0	2	28	4	0
Native ground cover - grass	72	90	86	78	48	40	40	36	42	64	56	10	56
Native ground cover – shrub (%)	0	6	0	4	0	0	0	0	0	0	6	0	0
Native ground cover – other (%)	10	2	0	6	20	22	12	0	8	10	20	14	0
Exotic plant cover (%)	32	2	22	0	40	24	18	40	30	24	36	48	8
Number of hollow trees	3	0	1	0	1	3	1	4	1	0	0	0	0
Canopy Regeneration (%)	100	0	0	0	100	0	50	100	100	0	100	100	0
Fallen logs (m)	5	13	0	0	32	7	7	12	31	0	4	24	8
Condition category	**Moderate/ Good_ High**	**Moderate/ Good_ High**	**Moderate/ Good_ Medium**	**Moderate/ Good_ Medium**	**Moderate/ Good_ Medium**	**Moderate/ Good_ Medium**	**Moderate/ Good_ Medium**	**Moderate/ Good_ Medium**	**Moderate/ Good_ Medium**	**Moderate/ Good_ Other (Revegetation)**	**Moderate/ Good_ Other (Revegetation)**	**Moderate/ Good_ Other (Revegetation)**	**Moderate/ Good_ Other (Revegetation)**

Site value	PCT 850				PCT 1800			N/A
Plot number:	**Q18**	**Q19**	**Q24**	**Q25**	**Q14**	**Q21**	**Q23**	**Q32**
Native plant species	7	7	4	5	11	2	4	4
Native overstorey cover (%)	0	0	0	0	25	10	6.5	0
Native midstorey cover (%)	0	0	0	0	13	0	0	0
Native ground cover - grass	40	84	44	36	44	0	6	14
Native ground cover – shrub (%)	0	0	0	0	0	0	0	0
Native ground cover – other (%)	0	1	4	0	6	0	0	0
Exotic plant cover (%)	64	32	28	54	36	92	42	68
Number of hollow trees	0	0	0	0	0	0	0	0
Canopy Regeneration (%)	0	0	0	0	1	0	0	0
Fallen logs (m)	0	0	0	0	3	8	25	0
Condition category	**Low (Derived Grassland)**	**Low (Derived Grassland)**	**Low (Derived Grassland)**	**Low (Derived Grassland)**	**Moderate/ Good_Other (Revegetation)**	**Moderate/ Good_Poor**	**Moderate/ Good_Poor**	**N/A**

Annexure B – Habitat assessment table

Likelihood of occurrence criteria

Likelihood	Criteria
Recorded	The species was observed in the study area during the current survey.
High	It is highly likely that a species inhabits the study area and is dependent on identified suitable habitat (i.e. for breeding or important life cycle periods such as winter flowering resources), has been recorded recently in the locality (10km) and is known or likely to maintain resident populations in the study area. Also includes species known or likely to visit the study area during regular seasonal movements or migration.
Moderate	Potential habitat is present in the study area. Species unlikely to maintain sedentary populations, however, may seasonally use resources within the study area opportunistically or during migration. The species is unlikely to be dependent (i.e. for breeding or important life cycle periods such as winter flowering resources) on habitat within the study area, or habitat is in a modified or degraded state. Includes cryptic flowering flora species that were not seasonally targeted by surveys and that have not been recorded.
Low	It is unlikely that the species inhabits the study area and has not been recorded recently in the locality (10km). It may be an occasional visitor, but habitat similar to the study area is widely distributed in the local area, meaning that the species is not dependent (i.e. for breeding or important life cycle periods such as winter flowering resources) on available habitat. Specific habitat is not present in the study area or the species are a non-cryptic perennial flora species that were specifically targeted by surveys and not recorded.
None	Suitable habitat is absent from the study area.

Fauna

Common Name *(Scientific Name)*	Status	Habitat requirements	Number of records (source)	Likelihood of occurrence	
				Desktop	Final (after surveys)
Amphibians					
Giant Burrowing Frog (*Heleioporus australiacus*)	V – TSC Act V – EPBC Act Species Credit Species	The Giant Burrowing Frog is distributed in south eastern NSW and Victoria and appears to exist as two distinct populations: Northern (largely confined to the sandstone geology of the Sydney Basin, extending as far south as Ulladulla) and Southern (occurring from north of Narooma through to Walhalla, Victoria). The species is found in heath, woodland and open dry sclerophyll forest on a variety of soil types except those that are clay based. The Giant Burrowing Frog requires ephemeral and permanent freshwater wetlands, ponds and dams with an open aspect and fringed by Typha, as well as free from predatory fish. The species spends more than 95% of its time in non-breeding habitat; burrowing below the soil surface or in the leaf litter. Individuals occupy a series of burrow sites, some of which are used repeatedly. Non-breeding sites are usually located up to 300 m from breeding sites, and home ranges are approximately 0.04 ha in size.	1 – OEH Atlas BBCC PMST	Low. Very few OEH atlas records and no suitable habitat recorded from desktop assessment. Removed as candidate species and no further assessment undertaken.	Low. No suitable habitat recorded from field habitat assessment and not recorded during wetland or nocturnal surveys.
Green and Golden Bell Frog (*Litoria aurea*)	E – TSC Act V – EPBC Act Species Credit Species	The Green and Golden Bell Frog exists in approximately 50 recorded locations across NSW, most of which are small, coastal, or near coastal populations. These locations occur over the species' former range; however, they are widely separated and isolated. Large populations in NSW are located around the metropolitan areas of Sydney, Shoalhaven and the mid-north coast (with one island population). There is only one known population on the NSW Southern Tablelands.	23 – OEH Atlas BBCC PMST	Moderate. A number of OEH records from the locality. Potential foraging habitat predicted from desktop assessment.	Low. Marginal forage habitat considered present during field habitat assessments. Species not recorded during targeted surveys.

Common Name *(Scientific Name)*	Status	Habitat requirements	Number of records (source)	Likelihood of occurrence	
				Desktop	Final (after surveys)
		The species inhabits marshes, dams and stream-sides, particularly those containing bulrushes (*Typha* spp.) or spikerushes (*Eleocharis* spp.). Optimal habitat includes waterbodies that are unshaded, free of predatory fish such as Plague Minnow/Mosquito Fish (*Gambusia holbrooki*), have a nearby grassy area and available sheltering sites. Some sites, particularly in the Greater Sydney region, occur in highly disturbed areas.			
Littlejohn's Tree Frog (*Litoria littlejohni*)	V – TSC Act V – EPBC Act	The Littlejohn's Tree Frog is distributed on plateaus and eastern slopes of the Great Diving Range, from Watagan State Forest in NSW, to Buchan in Victoria. Most records are from within the Sydney Basin Bioregion, with only scattered records south to the Victorian border. This species has not been recorded in southern NSW within the last decade. Records are isolated and tend to be at higher altitudes. The species breeds in the upper reaches of permanent streams and in perched swamps. Non-breeding habitat is heath-based forests and woodlands where it shelters under leaf litter and low vegetation.	PMST	Low. No OEH atlas records and no suitable habitat recorded from desktop assessment. Removed as candidate species and no further assessment undertaken.	Low. No suitable habitat recorded from field habitat assessment and not recorded during wetland or nocturnal surveys.
Southern Bell Frog (*Litoria raniformis*)	E – TSC Act V – EPBC Act	In NSW, the Southern Bell Frog was once distributed along the Murray and Murrumbidgee Rivers and their tributaries, the southern slopes of the Monaro district, and the central southern tablelands as far north as Tarana, near Bathurst. Currently, the species is known to exist only in isolated populations in the Coleambally Irrigation Area, the Lowbidgee floodplain, and around Lake Victoria. In recent years, a few unconfirmed records have also	PMST	Low. Very few OEH atlas records and no suitable habitat recorded from desktop assessment.	Low. No suitable habitat recorded from field habitat assessment and not recorded during wetland or nocturnal surveys.

Common Name *(Scientific Name)*	Status	Habitat requirements	Number of records (source)	Likelihood of occurrence	
				Desktop	Final (after surveys)
		been made in the Murray Irrigation Area. The Southern Bell Frog is also found in Victoria, Tasmania and South Australia, where it has also become endangered. The species is usually found in or around permanent or ephemeral Black Box/Lignum/Nitre Goosefoot swamps, Lignum/Typha swamps and River Red Gum swamps or billabongs along floodplains and river valleys. They are also found in irrigated rice crops, particularly where there is no available natural habitat. During the breeding season, the Southern Bell Frog is found floating amongst aquatic vegetation (especially *Cumbungi* or Common Reeds) within or at the edge of slow-moving streams, marshes, lagoons, lakes, farm dams and rice crops. Outside of the breeding season, the species disperses away from the water and takes shelter beneath ground debris such as fallen timber and bark, rocks, grass clumps and in deep soil cracks.		Removed as candidate species and no further assessment undertaken.	
Stuttering Frog (*Mixophyes balbus*)	E – TSC Act V – EPBC Act	The Stuttering Frog occurs along the east coast of Australia from southern Queensland to north-eastern Victoria. The species is considered to have disappeared from Victoria and to have undergone considerable range contraction in NSW, particularly in south-east NSW. It is the only *Mixophyes* species that occurs in south-east NSW and in recent surveys it has only been recorded at three locations south of Sydney. The Dorrigo region, in north-east NSW, appears to be a stronghold for this species. The species is found in rainforest and wet, tall open forest in the foothills and escarpment on the eastern side of the Great Dividing Range. Outside of the breeding	PMST	Low. No OEH atlas records and no suitable habitat recorded from desktop assessment. Removed as candidate species and no further assessment undertaken.	Low. No suitable habitat recorded from field habitat assessment and not recorded during diurnal or nocturnal surveys.

Common Name *(Scientific Name)*	Status	Habitat requirements	Number of records (source)	Likelihood of occurrence	
				Desktop	Final (after surveys)
		season adults live in deep leaf litter and thick understorey vegetation on the forest floor.			
Red-crowned Toadlet (*Pseudophryne australis*)	V – TSC Act	The Red-crowned Toadlet is confined to the Sydney Basin, from Pokolbin in the north, Nowra to the south, and Mt Victoria in the Blue Mountains to the west. The species occurs in open forests, mostly on Hawkesbury and Narrabeen Sandstones. The Red-crowned Toadlet inhabits periodically wet drainage lines below sandstone ridges that often have shale lenses or capping, and shelters under rocks and amongst masses of dense vegetation or thick piles of leaf litter. Breeding congregations occur in dense vegetation and debris beside ephemeral creeks and gutters. The species has not been recorded breeding in waters that are even mildly polluted, or with a pH outside of 5.5 – 6.5.	11 – OEH Atlas	Low. Low number of OEH atlas records and no suitable habitat recorded from desktop assessment. Removed as candidate species and no further assessment undertaken.	Low. No suitable habitat recorded from field habitat assessment and not recorded during diurnal or nocturnal surveys.
Birds					
Regent Honeyeater (*Anthochaera phrygia*)	CE – TSC Act CE – EPBC Act Species Credit Species	The Regent Honeyeater mainly inhabits temperate woodlands and open forests of the inland slopes of south-east Australia. The species is also found in drier coastal woodlands and forests. The species range has contracted to between north-eastern Victoria and south-eastern Queensland. There are only three known key breeding regions remaining: North-east Victoria (Chiltern – Albury) and the Capertee Valley and Bundarra-Barraba region in NSW. In NSW, the distribution is very patchy and mainly confined to the two listed breeding areas and surrounding fragmented woodlands. In some years, flocks converge on flowering coastal woodlands and forests. The species inhabits dry open forest and woodland,	6 – OEH Atlas BBCC PMST	Moderate. Low number of OEH records from the locality. Potential habitat predicted from desktop assessment.	Low. Marginal forage habitat considered present during field habitat assessments. Targeted surveys undertaken in accordance with the Threatened biodiversity survey and assessment guidelines (TBSA) (DEC, 2004).

Common Name *(Scientific Name)*	Status	Habitat requirements	Number of records (source)	Likelihood of occurrence	
				Desktop	Final (after surveys)
		particularly Box-Ironbark woodland, and riparian forests of River Sheoak. Regent Honeyeaters inhabit woodlands that support a significantly high abundance and species richness of bird species; these woodlands generally have a large number of mature trees, high canopy cover, and an abundance of mistletoes. Non-breeding flocks are observed foraging in flowering coastal Swamp Mahogany and Spotted Gum forests, particularly on the Central Coast and occasionally on the upper North Coast. Individuals are occasionally seen on the South Coast. In the last decade, the species has been recorded in urban areas around Albury where Mugga Ironbark and Yellow Box were planted 20 years ago. Key eucalypt species include Mugga Ironbark, Yellow Box, White Box and Swamp Mahogany. Other tree species may be regionally important.			Species not recorded during targeted surveys.
Dusky Woodswallow (*Artamus cyanopterus cyanopterus*)	V – TSC Act	The Dusky Woodswallow is widespread in eastern, southern and south-western Australia. The species occurs throughout most of NSW, but is sparsely scattered in, or largely absent from, much of the upper western region. The species primarily inhabits dry, open eucalypt forests and woodlands, including mallee associations, with an open or sparse understorey of eucalypt saplings, acacias and other shrubs, and ground-cover of grasses, sedges and fallen woody debris. It has also been recorded in shrublands, heathlands and very occasionally in moist forest or rainforest. It has also been recorded in farmland, usually at the edges of forest or woodland.	39 – OEH Atlas	Moderate. OEH records from the locality. Potential habitat predicted from desktop assessment.	Low. Marginal forage habitat considered present during field habitat assessments. Targeted surveys undertaken in accordance with the TBSA guidelines. Species not recorded during targeted surveys.

Common Name *(Scientific Name)*	Status	Habitat requirements	Number of records (source)	Likelihood of occurrence	
				Desktop	Final (after surveys)
Australasian Bittern (*Botaurus poiciloptilus*)	E – TSC Act E – EPBC Act	The Australasian Bittern is widespread but uncommon across south-eastern Australia. In NSW, they can be found over most of the state except for the far north-west. The species favours permanent freshwater wetlands with tall, dense vegetation, particularly bulrushes (*Typha* spp.) and spikerushes (*Eleocharis* spp.).	1 – OEH Atlas PMST	Low. Very few OEH atlas records and no suitable habitat recorded from desktop assessment. Removed as candidate species and no further assessment undertaken.	Low. No suitable habitat recorded from field habitat assessment and not recorded during wetland bird surveys.
Bush Stone-curlew (*Burhinus grallarius*)	E – TSC Act Ecosystem Credit Species	The Bush Stone-curlew is found throughout Australia except for inland areas, the central southern coast, far south-east corner and Tasmania. In northern Australia the species is common, but in the south-east, it is either rare or extinct throughout its former range. The species inhabits open forests and woodlands with a sparse grassy groundlayer and fallen timber.	4 – OEH Atlas BBCC	Moderate. Low number of OEH records from the locality. Potential habitat predicted from desktop assessment.	Low. Marginal habitat considered present during field habitat assessments. Targeted surveys undertaken in accordance with the TBSA guidelines. Species not recorded during targeted surveys.
Curlew Sandpiper (*Calidris ferruginea*)	E – TSC Act CE – EPBC Act	The Curlew Sandpiper is distributed around most of the Australian coastline, including Tasmania. In NSW, it occurs along the entire coastline, particularly in the Hunter Estuary and sometimes in freshwater wetlands in the Murray-Darling Basin. Inland records are likely to be during the species migration, where they	PMST	Low. No OEH atlas records and no suitable habitat recorded from	Low. No suitable habitat recorded from field habitat assessment and not recorded

Common Name *(Scientific Name)*	Status	Habitat requirements	Number of records (source)	Likelihood of occurrence	
				Desktop	Final (after surveys)
		arrive in Australia for the non-breeding period between August and November, departing between March and mid-April. The Curlew Sandpiper generally occupies littoral and estuarine habitats. In NSW, it is mainly found in intertidal mudflats of sheltered coasts.		desktop assessment. Removed as candidate species and no further assessment undertaken.	during wetland bird surveys.
Gang-gang Cockatoo (*Callocephalon fimbriatum*)	V – TSC Act Ecosystem Credit Species	The Gang-gang Cockatoo is distributed from southern Victoria through south and central-eastern NSW. In NSW, the species is distributed from the south-east coast to the Hunter region, and inland to the Central Tablelands and south-west slopes. The Gang-gang Cockatoo occurs regularly in the ACT and is rare at the extremities of its range, with isolated records known from as far north as Coffs Harbour and as far west as Mudgee. During spring and summer, the species is generally found in tall mountain forests and woodlands, particularly in heavily timbered and mature wet sclerophyll forests. In autumn and winter, the species typically moves to lower altitudes to inhabit drier, open eucalypt forests and woodlands (particularly Box-Gum and Box-Ironbark assemblages) or in dry forest in coastal and urban areas. It may also occur in sub-alpine Snow Gum (*Eucalyptus pauciflora*) woodland, and occasionally in temperate rainforests. The species favours old growth forest and woodland for nesting and roosting.	9 – OEH Atlas BBCC	Moderate. OEH records from the locality. Potential habitat predicted from desktop assessment.	Low. Marginal forage habitat considered present during field habitat assessments. Targeted surveys undertaken in accordance with the TBSA guidelines. Species not recorded during targeted surveys.
Gang-gang Cockatoo population, Hornsby ad Ku-ring-gai Local Government Areas	EP – TSC Act Species Credit Species	The Gang-gang cockatoo population in the Hornsby and Ku-ring-gai Local Government Areas (LGAs) is endangered, and largely confined to an area bounded by Thornleigh and	BBCC	Low. The study area is not within the	Low. No suitable habitat recorded from field

Common Name *(Scientific Name)*	Status	Habitat requirements	Number of records (source)	Likelihood of occurrence	
				Desktop	Final (after surveys)
(*Callocephalon fimbriatum*)		Wahroonga in the north, Epping and North Epping in the south, Beecroft and Cheltenham in the west, and Turramurra/South Turramurra to the east. The population in known to inhabit areas of Lane Cove National Park, Pennant Hills Park and other forested gullies in the area. The population occurs within a variety of forest and woodland types, but usually frequents forested areas with old growth attributes required for nesting and roosting. The population also utilises less heavily timbered woodlands and urban fringe areas to forage but appears to favour well-timbered country through which it habitually flies as it moves about the landscape.		required LGAs for this population. No OEH atlas records and no suitable habitat recorded from desktop assessment. Removed as candidate species and no further assessment undertaken.	habitat assessment and not recorded during diurnal or nocturnal surveys.
Glossy Black-Cockatoo (*Calyptorhynchus lathami*)	V – TSC Act Ecosystem Credit Species	The Glossy Black-Cockatoo is widespread but uncommon throughout suitable forest and woodland habitats from the central Queensland coast to East Gippsland in Victoria, and inland to the southern tablelands and central western plains of NSW, with a small population in the Riverina. An isolated population also exists on Kangaroo Island in South Australia. The species inhabits open forest and woodlands of the coast and the Great Dividing Range where stands of Sheoak occur. The species feeds almost exclusively on *Casuarina* and *Allocasuarina* species, with Black Sheoak (*Allocasuarina littoralis*) and Forest Sheoak (*A. torulosa*) being important foraging resources for the species. Inland populations feed on a wider range of Sheoaks, and Belah may also be a critical food source for some populations. In the Riverina, birds are associated with hills and rocky rises supporting Drooping Sheoak and Belah.	17 – OEH Atlas BBCC	Moderate. OEH records from the locality. Potential habitat predicted from desktop assessment.	Low. Marginal forage habitat considered present during field habitat assessments. Targeted surveys undertaken in accordance with the TBSA guidelines. Species not recorded during targeted surveys.

Common Name *(Scientific Name)*	Status	Habitat requirements	Number of records (source)	Likelihood of occurrence	
				Desktop	Final (after surveys)
Speckled Warbler (*Chthonicola sagittata*)	V – TSC Act Ecosystem Credit Species	The Speckled Warbler has a patchy distribution throughout south-eastern Queensland, the eastern half of NSW and into Victoria, as far west as the Grampians. The species is most frequently reported from the hills and tablelands of the Great Dividing Range, and rarely from the coast. There has been a decline in population density throughout its range, with the decline exceeding 40% where no vegetation remnants larger than 100 ha survive. The Speckled Warbler lives in a wide range of *Eucalyptus* dominated communities that have a grassy understorey, often on rocky ridges or in gullies. Typical habitat would include scattered native tussock grasses, a sparse shrub layer, some eucalypt regrowth and an open canopy. Large, relatively undisturbed remnants are required for the species to persist in an area.	16 – OEH Atlas BBCC	Moderate. OEH records from the locality. Potential habitat predicted from desktop assessment.	Low. Marginal forage habitat considered present during field habitat assessments. Targeted surveys undertaken in accordance with the TBSA guidelines. Species not recorded during targeted surveys.
Spotted Harrier (*Circus assimilis*)	V – TSC Act Ecosystem Credit Species	The Spotted Harrier occurs throughout the Australian mainland, except in densely forested or wooded habitats of the coast, escarpment and ranges, and rarely in Tasmania. Individuals disperse widely in NSW and comprise a single population. The species inhabits grassy open woodland including *Acacia* and *Mallee* remnants, inland riparian woodland, grassland and shrub steppe. It is found most commonly in native grassland, but also occurs in agricultural land, foraging over open habitats including edges of inland wetlands.	2 – OEH Atlas BBCC	Moderate. OEH records from the locality. Potential habitat predicted from desktop assessment.	Low. Marginal forage habitat considered present during field habitat assessments. Targeted surveys undertaken in accordance with the TBSA guidelines. Species not recorded during targeted surveys.

Common Name *(Scientific Name)*	Status	Habitat requirements	Number of records (source)	Likelihood of occurrence	
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Brown Treecreeper (eastern subspecies) (*Climacteris picumnus* subsp. *victoriae*)	V – TSC Act Ecosystem Credit Species	The Brown Treecreeper is endemic to eastern Australia and occurs in eucalypt forest and woodlands of inland plains and slopes of the Great Diving Range. It is less common on coastal plans and ranges. The eastern subspecies lives in eastern NSW in eucalypt woodlands through central NSW and in coastal areas with drier, open woodlands such as the Snowy River Valley, Cumberland Plains, Hunter Valley and parts of the Richmond and Clarence Valleys. The species mainly inhabits woodlands dominated by stringybarks or other rough-barked eucalypts, usually with an open grassy understorey, sometimes with one or more shrub species. They can also be found in mallee and River Red Gum *(Eucalyptus camaldulensis*) Forest bordering wetlands with an open understorey of acacias, saltbush, lignum, cumbungi and grasses. Fallen timber is an important habitat component for foraging.	BBCC	Low. No OEH atlas records and no suitable habitat recorded from desktop assessment. Removed as candidate species and no further assessment undertaken.	Low. No suitable habitat recorded from field habitat assessment and not recorded during diurnal bird surveys.
Varied Sittella (*Daphoenositta chrysoptera*)	V – TSC Act Ecosystem Credit Species	The Varied Sittella is sedentary and inhabits most of mainland Australia except the treeless deserts and open grasslands. Distribution in NSW is nearly continuous from the coast to the far west. The Varied Sittella's population size in NSW is uncertain but is believed to have undergone a moderate reduction over the past several decades. The species inhabits eucalypt forests and woodlands, especially those containing rough-barked species and mature smooth-barked gums with dead branches, *Mallee* and *Acacia* woodland.	63 – OEH Atlas BBCC	Moderate. OEH records from the locality. Potential habitat predicted from desktop assessment.	Low. Marginal forage habitat considered present during field habitat assessments. Targeted surveys undertaken in accordance with the TBSA guidelines. Species not recorded during targeted surveys.

Common Name *(Scientific Name)*	Status	Habitat requirements	Number of records (source)	Likelihood of occurrence	
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Eastern Bristlebird (*Dasyornis brachypterus*)	E – TSC Act E – EPBC Act	The distribution of the Eastern Bristlebird has contracted to three disjunct areas of south-eastern Australia. There are three main populations: Northern (southern Queensland/northern NSW), Central (Barren Ground Nature Reserve, Budderoo Nature Reserve, Woronora Plateau, Jervis Bay National Park, Booderee National Park and Beecroft Peninsula) and Southern (Nadgee Nature Reserve and Croajingalong National Park near the NSW/Victorian border). Habitat for central and southern populations is characterised by dense, low vegetation including heath and open woodland with a heathy understorey. In northern NSW, habitat occurs in open forest with dense tussocky grass understorey and sparse mid-storey near rainforest ecotone; all of which are prone to fire. Age of habitat since fire is of paramount importance to this species.	PMST	Low. No OEH atlas records and no suitable habitat recorded from desktop assessment. Removed as candidate species and no further assessment undertaken.	Low. No suitable habitat recorded from field habitat assessment and not recorded during diurnal bird surveys.
Black-necked Stork (*Ephippiorhynchus asiaticus australis*)	E – TSC Act	The Black-necked Stork, species *Ephippiorhynchus asiaticus*, comprises two subspecies, with *E. a. australis* occurring in Australia and New Guinea. In Australia, the species is widespread in coastal and subcoastal northern and eastern Australia, as far south as central NSW (although vagrants may occur further south or inland). In NSW, the species becomes increasingly uncommon south of the Clarence Valley, and rarely occurs south of Sydney. The species inhabits floodplain wetlands, including swamps, billabongs, watercourses and dams, of the major coastal rivers. Secondary habitat includes minor floodplains, coastal sandplain wetlands and estuaries.	2 – OEH Atlas	Low. Very few OEH atlas records and no suitable habitat recorded from desktop assessment. Removed as candidate species and no further assessment undertaken.	Low. No suitable habitat recorded from field habitat assessment and not recorded during wetland bird surveys.

Common Name *(Scientific Name)*	Status	Habitat requirements	Number of records (source)	Likelihood of occurrence	
				Desktop	Final (after surveys)
Black Falcon (*Falco subniger*)	V – TSC Act	The Black Falcon is distributed widely but sparsely across NSW, mostly occurring in inland regions. In NSW, there is assumed to be a single population that is continuous with a broader continental population, as the species is highly mobile and commonly travels hundreds of kilometres. The species is found along tree-lined watercourses and in isolated woodlands, mainly in arid and semi-arid areas.	2 – OEH Atlas	Moderate. Low number of OEH records from the locality. Potential forage habitat predicted from desktop assessment.	Low. Marginal forage habitat considered present during field habitat assessments. Targeted surveys undertaken in accordance with the TBSA guidelines. Species not recorded during targeted surveys.
Little Lorikeet (*Glossopsitta pusilla*)	V – TSC Act Ecosystem Credit Species	The Little Lorikeet is distributed widely across the coastal and Great Divide regions of eastern Australia from Cape York to South Australia. In NSW, lorikeets are found westward as far as Dubbo and Albury, and the State provides a large portion of the species core habitat. The Little Lorikeet forages primarily in the canopy of open *Eucalyptus* forest and woodland, yet also finds food in *Angophora*, *Melaleuca* and other tree species. Riparian habitats are highly used, due to higher soil fertility and greater productivity. The species targets isolated flowering trees in open country, such as in paddocks or in roadside remnants and street trees; which help sustain viable populations.	12 – OEH Atlas BBCC	Moderate. OEH records from the locality. Potential habitat predicted from desktop assessment.	Low. Marginal forage habitat considered present during field habitat assessments. Targeted surveys undertaken in accordance with the TBSA guidelines. Species not recorded during targeted surveys.

Common Name *(Scientific Name)*	Status	Habitat requirements	Number of records (source)	Likelihood of occurrence	
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Painted Honeyeater (*Grantiella picta*)	V – TSC Act V – EPBC Act Ecosystem Credit Species	The Painted Honeyeater is nomadic and occurs at low densities throughout its range. The greatest concentrations of Painted Honeyeater, as well as all breeding events, occur on the inland slopes of the Great Dividing Range in NSW, Victoria and southern Queensland. During the winter, it is more likely to be found in the north of its range. The species inhabits Boree/Weeping Myall (*Acacia pendula*), Brigalow (*A. harpophylla*), Box-Gum Woodlands and Box-Ironbark Forests. The Painted Honeyeater is also a specialist feeder on the fruits of mistletoes growing on woodland eucalypts and acacias; preferring mistletoes of the genus *Amyema*.	BBCC PMST	Low. No OEH atlas records and no suitable habitat recorded from desktop assessment. Removed as candidate species and no further assessment undertaken.	Low. No suitable habitat recorded from field habitat assessment and not recorded during diurnal bird surveys.
White-bellied Sea-Eagle (*Haliaeetus leucogaster*)	V – TSC Act	The White-bellied Sea-eagle is distributed around the Australian coastline, including Tasmania, and well inland along rivers and wetlands of the Murray Darling Basin. In NSW, it is widespread along the east coast, and along all major inland rivers and waterways. Habitats are characterised by the presence of large areas of open water including larger rivers, swamps and lakes, as well as the ocean. The species occurs at sites near the sea or sea-shore, or in the vicinity of freshwater swamps, lakes, reservoirs, billabongs and saltmarshes. Terrestrial habitats include coastal dunes, tidal flats, grassland, heathland, woodland and forests (including rainforest). Breeding habitat consists of mature tall open forest, open forest, tall woodland, and swamp sclerophyll forest close to foraging habitat. Nest trees are typically large emergent eucalypts and often have dead emergent branches or large dead trees nearby which are used as guard roosts.	18 – OEH Atlas	Moderate. OEH records from the locality. Potential habitat predicted from desktop assessment.	**Recorded.** Recorded breeding at one nest site within the study area. Not recorded foraging within the study area. Marginal forage habitat considered present in the form of large dams.

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Little Eagle (*Hieraaetus morphnoides*)	V – TSC Act Ecosystem Credit Species	The Little Eagle is found throughout the Australian mainland, except the most densely forested parts of the Dividing Range escarpment. The Little Eagle occurs as a single population throughout NSW. The species occupies open eucalypt forest, woodland or open woodland, and uses Sheoak or Acacia woodlands and riparian woodlands of inland NSW.	31 – OEH Atlas BBCC	Moderate. OEH records from the locality. Potential habitat predicted from desktop assessment.	Low. Marginal forage habitat considered present during field habitat assessments. Targeted surveys undertaken in accordance with the TBSA guidelines. Species not recorded during targeted surveys.
Black Bittern (*Ixobrychus flavicollis*)	V – TSC Act Species Credit Species	The Black Bittern has a wide distribution from southern NSW to Cape York and along the north coast to the Kimberley region. The species also occurs in the south-west of Western Australia. In NSW, records of the species are scattered along the east coast, with individuals rarely being recorded south of Sydney or inland. The species inhabits both terrestrial and estuarine wetlands, generally in areas of permanent water and dense vegetation. Where permanent water is present, the species may occur in flooded grassland, forest, woodland, rainforest and mangroves.	2 – OEH Atlas BBCC	Moderate. Low number of OEH records from the locality. Potential forage habitat predicted from desktop assessment.	Low. Marginal forage habitat considered present during field habitat assessments. Targeted surveys undertaken in accordance with the TBSA guidelines. Species not recorded during targeted surveys.
Swift Parrot (*Lathamus discolor*)	E – TSC Act CE – EPBC Act Ecosystem Credit Species	The Swift Parrot breeds in Tasmania during spring and summer, migrating in the autumn and winter months to south-eastern Australia from Victoria and the eastern parts of South Australia to south-east Queensland. In NSW, it	26 – OEH Atlas BBCC PMST	Moderate. OEH records from the locality. Potential habitat	Low. Marginal forage habitat considered present during field

Common Name *(Scientific Name)*	Status	Habitat requirements	Number of records (source)	Likelihood of occurrence	
				Desktop	Final (after surveys)
		mostly occurs on the coast and south west slopes. On the mainland they occur in areas where eucalypts are flowering profusely or where there is abundant lerp (from sap-sucking bugs) infestations. Favoured feed trees include winter flowering species such as Swamp Mahogany (*Eucalyptus robusta*), Spotted Gum (*Corymbia maculata*), Red Bloodwood (*C. gummifera*), Mugga Ironbark (*E. sideroxylon*), and White Box (*E. albens*). Commonly used lerp infested trees include Inland Grey Box (*E. microcarpa*), Grey Box (*E. moluccana*) and Blackbutt (*E. pilularis*).		predicted from desktop assessment.	habitat assessments. Targeted surveys undertaken in accordance with the TBSA guidelines. Species not recorded during targeted surveys.
Black-tailed Godwit (*Limosa limosa*)	V – TSC Act	The Black-tailed Godwit is a migratory wader that breeds in Mongolia and Eastern Siberia and flies to Australia for the southern summer; arriving in August and leaving in March. In NSW, it is most frequently recorded at Kooragang Island (Hunter River estuary), with occasional records elsewhere along the coast and inland. Records in western NSW indicate that a regular inland passage is utilised by the species; occurring around any of the large lakes in western areas during the summer, when muddy shores are exposed. The species has also been recorded within the Murray-Darling Basin, on the western slopes of the Northern Tablelands and in the far north-western corner of the state. The Black-tailed Godwit is predominately a coastal species that is usually found in sheltered bays, estuaries and lagoons with large intertidal mudflats and/or sandflats. Further inland, the species can be found on mudflats and in water less than 10 cm deep around muddy lakes and swamps.	1 – OEH Atlas	Low. Very few OEH atlas records and no suitable habitat recorded from desktop assessment. Removed as candidate species and no further assessment undertaken.	Low. No suitable habitat recorded from field habitat assessment and not recorded during wetland bird surveys.

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				Desktop	Final (after surveys)
Square-tailed Kite (*Lophoictinia isura*)	V – TSC Act Ecosystem Credit Species	The Square-tailed Kite ranges along coastal and subcoastal areas from south-western to northern Australia, Queensland, NSW and Victoria. In NSW, scattered records of the species throughout the state indicate that the Square-tailed Kite is a regular resident in the north, north-east and along the major west-flowing river systems. It is a summer breeding migrant to the south-east, including the NSW south coast; arriving in September and leaving by March. The species is found in a variety of timbered habitats including dry woodlands and open forests and shows a preference for timbered watercourses. In arid north-western NSW, the species has been observed in stony country with a ground cover of chenopods and grasses, open *Acacia* scrub and patches of low open eucalypt woodland.	5 – OEH Atlas BBCC	Moderate. OEH records from the locality. Potential habitat predicted from desktop assessment.	Low. Marginal forage habitat considered present during field habitat assessments. Targeted surveys undertaken in accordance with the TBSA guidelines. Species not recorded during targeted surveys.
Hooded Robin (south-eastern form) (*Melanodryas cucullata* subsp. *cucullata*)	V – TSC Act Ecosystem Credit Species	The Hooded Robin is widespread across Australia, except for the driest deserts and wetter coastal areas which typically occur in northern and eastern coastal Queensland, and Tasmania. The south-eastern form is found from Brisbane to Adelaide and throughout much of inland NSW, which the exception of the extreme north-west, where it is replaced by subspecies *picata*. The species prefers lightly wooded country, usually open eucalypt woodland, acacia scrub and mallee, often in or near clearings or open areas. The Hooded Robin requires structurally diverse habitats featuring mature eucalypts, saplings, some small shrubs and a ground layer of moderately tall native grasses.	2 – OEH Atlas BBCC	Moderate. OEH records from the locality. Potential habitat predicted from desktop assessment.	Low. Marginal forage habitat considered present during field habitat assessments. Targeted surveys undertaken in accordance with the TBSA guidelines. Species not recorded during targeted surveys.

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Black-chinned Honeyeater (eastern subspecies) (*Melithreptus gularis* subsp. *gularis*)	V – TSC Act Ecosystem Credit Species	The Black-chinned Honeyeater has two subspecies, with only the nominated *gularis* occurring in NSW. This subspecies extends south from central Queensland, through NSW, Victoria and into South Australia, although it is very rare in the latter State. Within NSW, it is widespread, with records from the tablelands and western slopes of the Great Dividing Range to the north-west and central-west plains and the Riverina. It is rarely recorded east of the Great Dividing Range, although is regularly recorded from the Richmond and Clarence River areas, a few scattered sites in the Hunter and Central Coast regions, and rarely in the Illawarra. The species mostly occupies upper levels of drier open forests or woodlands dominated by box and ironbark eucalypts, especially Mugga Ironbark (*Eucalyptus sideroxylon*), White Box (*E. albens*), Inland Grey Box (*E. microcarpa*), Yellow box (*E. melliodora*), Blakely's Red Gum (*E. blakelyi*) and Forest Red Gum (*E. tereticornis*). Is also known to inhabit open forests of smooth-barked gums, stringybarks, ironbarks, river sheoaks (nesting habitat) and tea-trees.	1 – OEH Atlas BBCC	Moderate. Low number of OEH records from the locality. Potential forage habitat predicted from desktop assessment.	Low. Marginal forage habitat considered present during field habitat assessments. Targeted surveys undertaken in accordance with the TBSA guidelines. Species not recorded during targeted surveys.
Turquoise Parrot (*Neophema pulchella*)	V – TSC Act Ecosystem Credit Species	The Turquoise Parrot's range extends from southern Queensland through to northern Victoria, from the coastal plains to the western slopes of the Great Dividing Range. The species lives on the edges of eucalypt woodland adjoining clearings, timbered ridges and creeks in farmland.	1 – OEH Atlas BBCC	Moderate. OEH records from the locality. Potential habitat predicted from desktop assessment.	Low. Marginal forage habitat considered present during field habitat assessments. Targeted surveys undertaken in

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				Desktop	Final (after surveys)
					accordance with the TBSA guidelines. Species not recorded during targeted surveys.
Barking Owl (*Ninox connivens*)	V – TSC Act Ecosystem Credit Species	The Barking Owl is found throughout Australia except for the central arid regions. The species has greatly declined in southern Australia and now occurs in a wide but sparse distribution in NSW. Core populations exist on the western slopes and plains and some north-east coastal and escarpment forests. The species inhabits woodland and open forest, including fragmented remnants and partly cleared farmland. It is flexible in its habitat use and hunting can extend in to closed forest as well as more open areas. Occasionally, the species can breed successfully along timbered watercourses in heavily cleared habitats, such as in western NSW, due to the higher density of prey on these fertile riparian soils.	3 – OEH Atlas BBCC	Moderate. Low number of OEH records from the locality. Potential forage habitat predicted from desktop assessment.	Low. Marginal forage habitat considered present during field habitat assessments. Targeted surveys undertaken in accordance with the TBSA guidelines. Species not recorded during targeted surveys.
Powerful Owl (*Ninox strenua*)	V – TSC Act Ecosystem Credit Species	The Powerful Owl is endemic to eastern and south-eastern Australia, mainly on the coastal side of the Great Dividing Range from Mackay to south-western Victoria. In NSW, it is widely distributed throughout the eastern forests from the coast inland to tablelands, with scattered records on the western slopes and plains suggesting occupancy prior to land clearing. Throughout its eastern range is occurs at low densities and are rare along the Murray River. Former inland populations may never recover. The species inhabits a range of vegetation types, from woodland and open sclerophyll forest to tall open wet forest and rainforest. The	20 – OEH Atlas BBCC	Moderate. Low number of OEH records from the locality. Potential forage habitat predicted from desktop assessment.	Low. Marginal forage habitat considered present during field habitat assessments. Targeted surveys undertaken in accordance with the TBSA guidelines.

Common Name *(Scientific Name)*	Status	Habitat requirements	Number of records (source)	Likelihood of occurrence	
				Desktop	Final (after surveys)
		Powerful Owl typically requires large tracts of forest or woodland habitat with dense wet gullies and creek areas but can also occur in fragmented landscapes. The species breeds and hunts in open or closed sclerophyll forest of woodlands and occasionally hunts in open habitats. It roosts by day in dense vegetation comprising species such as Turpentine (*Syncarpia glomulifera*), Black She-oak (*Allocasuarina littoralis*), Blackwood (*Acacia melanoxylon*), Rough-barked Apple (*Angophora floribunda*), Cherry Ballart (*Exocarpos cupressiformis*) and a number of eucalypt species. The Powerful Owl requires large, mature trees with hollows for breeding, and dense areas of vegetation for foraging and roosting.			Species not recorded during targeted surveys.
Eastern Curlew (*Numenius madagascariensis*)	CE – EPBC Act	The Eastern Curlew migrates to Australia for the non-breeding season. Within Australia, the Eastern Curlew is found across all States, and has a primarily coastal distribution, with birds rarely recorded inland. In NSW, the species occurs across the entire coast but is mainly found in estuaries such as the Hunter River, Port Stephens, Clarence River, Richmond Ricer and Intermittently Closed and Open Lakes and Lagoons (ICOLLs) of the south coast. The species generally occupies coastal lakes, inlets, bays and estuarine habitats. In NSW, it is mainly found in intertidal mudflats and sometimes saltmarsh of sheltered coasts. Occasionally, the species is found on ocean beaches (often near estuaries) as well as coral reefs, rock platforms or rocky islets.	PMST	Low. No OEH atlas records and no suitable habitat recorded from desktop assessment. Removed as candidate species and no further assessment undertaken.	Low. No suitable habitat recorded from field habitat assessment and not recorded during wetland bird surveys.

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Eastern Osprey (*Pandion cristatus*)	V – TSC Act Species Credit Species	The Eastern Osprey occurs between Sulawesi (in Indonesia), Australia and New Caledonia. Eastern Ospreys are found around the coastline of mainland Australia, except for Victoria. The species is common around the northern coast, especially on rocky shorelines, islands and reefs. Eastern Osprey are uncommon to rare, or absent, from closely settled parts of south-eastern Australia. A few records exist inland. The species favours coastal areas, especially the mouths of large rivers, lagoons and lakes.	BBCC	Low. No OEH atlas records and no suitable habitat recorded from desktop assessment. Removed as candidate species and no further assessment undertaken.	Low. No suitable habitat recorded from field habitat assessment and not recorded during wetland bird surveys.
Scarlet Robin (*Petroica boodang*)	V – TSC Act Ecosystem Credit Species	The Scarlet Robin is found from south-east Queensland to south-east South Australia and in Tasmania, and south-west Western Australia. In NSW, it occurs from the coast to the inland slopes. After breeding, some Scarlet Robins disperse to the lower valleys and plains of the tablelands and slopes. Some birds may appear as far west as the eastern edges of the inland plains in autumn and winter. The species inhabits dry eucalypt forests and woodlands. The understorey is usually open and grassy with few scattered shrubs. The species lives in both mature and regrowth vegetation, occasionally occurring in mallee or wet forest communities, or in wetlands and tea-tree swamps. Abundant logs and fallen timber are key components of the species habitat. In autumn and winter, the Scarlet Robin may occupy open grassy woodlands and grasslands or grazed paddocks with scattered trees.	2 – OEH Atlas BBCC	Moderate. OEH records from the locality. Potential habitat predicted from desktop assessment.	Low. Marginal forage habitat considered present during field habitat assessments. Targeted surveys undertaken in accordance with the TBSA guidelines. Species not recorded during targeted surveys.

Common Name *(Scientific Name)*	Status	Habitat requirements	Number of records (source)	Likelihood of occurrence	
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Flame Robin (*Petroica phoenicea*)	V – TSC Act Ecosystem Credit Species	The Flame Robin is endemic to south-eastern Australia, ranging from the Queensland border to south-east South Australia and Tasmania. In NSW, it breeds in upland areas and in winter, many birds move to the inland slopes and plains. It is likely that there are two separate populations in NSW; one in the Northern Tablelands, and one ranging from the Central to Southern Tablelands. The species breeds in upland tall moist eucalypt forests and woodlands, often of ridges and slopes. The Flame Robin prefers clearings or areas with open understoreys and are often found in recently burnt areas. The species occasionally occurs in temperate rainforest, as well as herbfields, heathlands, shrublands and sedgelands at high altitudes. Breeding habitat is typically dominated by native grasses and the shrub layer may either be sparse or dense.	7 – OEH Atlas BBCC	Moderate. OEH records from the locality. Potential habitat predicted from desktop assessment.	Low. Marginal forage habitat considered present during field habitat assessments. Targeted surveys undertaken in accordance with the TBSA guidelines. Species not recorded during targeted surveys.
Australian Painted Snipe (*Rostratula australis*)	E – TSC Act E – EPBC Act	The Australian Painted Snipe is restricted to Australia. Most records are from the south-east, particularly surrounding the Murray Darling Basin. Scattered records exist across northern Australia and historical records exist around Perth in Western Australia. In NSW, many records are from the Murray-Darling Basin, including the Paroo wetlands, Lake Cowal, Macquarie Marshes, Fivebough Swamp and swamps surrounding Balldale and Wanganella. Other important locations include wetlands on the Hawkesbury River, and the Clarence and Lower Hunter Valleys. The species prefers fringes of swamps, dams and nearby marshes where there is a cover of grasses, lignum, low scrub or open timber.	1 – OEH Atlas PMST	Low. Very few OEH atlas records and no suitable habitat recorded from desktop assessment. Removed as candidate species and no further assessment undertaken.	Low. No suitable habitat recorded from field habitat assessment and not recorded during wetland bird surveys.

Common Name *(Scientific Name)*	Status	Habitat requirements	Number of records (source)	Likelihood of occurrence	
				Desktop	Final (after surveys)
Diamond Firetail (*Stagonopleura guttata*)	V – TSC Act Ecosystem Credit Species	The Diamond Firetail is endemic to south-eastern Australia, extending from central Queensland to the Eyre Peninsula in South Australia. In NSW, it is widely distributed, with concentrated records from the Northern, Central and Southern Tablelands, as well as the Northern, Central and South Western Slopes, North West Plains, and the Riverina. The species is not commonly found in coastal regions, though there are records from around Sydney and the Hunter and Bega Valleys. The species has a scattered distribution over the rest of NSW, though it is very rare west of the Darling River. The Diamond Firetail is found in grassy eucalypt woodlands, including Box-Gum Woodlands and Snow Gum *Eucalyptus pauciflora* Woodlands. They also occur in open forest, mallee, Natural Temperate Grassland, and in secondary grassland derived from other communities. The species is often found in riparian areas and sometimes in lightly wooded farmland.	3 – OEH Atlas BBCC	Moderate. Low number of OEH records from the locality. Potential habitat predicted from desktop assessment.	Low. Marginal habitat considered present during field habitat assessments. Targeted surveys undertaken in accordance with the TBSA guidelines. Species not recorded during targeted surveys.
Masked Owl (*Tyto novaehollandiae*)	V – TSC Act Ecosystem Credit Species	The Masked Owl is most abundant on the coast but extends to the western plains. About 90% of overall records occur within NSW; excluding the most arid north-western corner. The species occupies dry, eucalypt forests and woodlands up to 1,100 m altitude. The Masked Owl typically prefers open forest with low shrub density and requires old trees for roosting and nesting.	15 – OEH Atlas BBCC	Moderate. A number of OEH records from the locality. Potential forage habitat predicted from desktop assessment.	Low. Marginal forage habitat considered present during field habitat assessments. Targeted surveys undertaken in accordance with the TBSA guidelines.

Common Name *(Scientific Name)*	Status	Habitat requirements	Number of records (source)	Likelihood of occurrence	
				Desktop	Final (after surveys)
					Species not recorded during targeted surveys.
Sooty Owl (*Tyto tenebricosa*)	V – TSC Act	The Sooty Owl occupies the easternmost one-eighth of NSW, occurring on the coast, coastal escarpment and eastern tablelands. Territories are occupied permanently. The species inhabits rainforest, including dry rainforest, subtropical and warm temperate rainforest, as well as moist eucalypt forests.	3 – OEH Atlas	Low. Very few OEH atlas records and no suitable habitat recorded from desktop assessment. Removed as candidate species and no further assessment undertaken.	Low. No suitable habitat recorded from field habitat assessment and not recorded during diurnal or nocturnal surveys.
Fish					
Murray Cod (*Maccullochella peelii*)	V – FM Act V – EPBC Act	The Murray Cod was once abundant throughout the Murray-Darling river system. However, their numbers and range have been drastically reduced. The species generally prefers slow flowing, turbid water in streams and rivers, favouring deeper water around boulders, undercut banks, overhanging vegetation and logs. Small numbers and still present in the Nepean and Yarra Rivers. In NSW, introduced populations persist in Cataract Dam and the Nepean River system.	PMST	Low. No OEH atlas records and no suitable habitat recorded from desktop assessment. Removed as candidate species and no further assessment undertaken.	Low. Not recorded during aquatic surveys.
Macquarie perch (*Macquaria australasica*)	E – FM Act E – EPBC Act	The Macquarie Perch is a riverine, schooling species. The Macquarie Perch prefers clear water and deep, rocky holes with lots of cover	PMST	Low.	Low.

Common Name *(Scientific Name)*	Status	Habitat requirements	Number of records (source)	Likelihood of occurrence	
				Desktop	Final (after surveys)
		provided by aquatic vegetation, as well as large boulders, debris and overhanging banks. Spawning occurs just above riffles. Populations may survive in impoundments if able to access suitable spawning sites.		No OEH atlas records and no suitable habitat recorded from desktop assessment. Removed as candidate species and no further assessment undertaken.	Not recorded during aquatic surveys.
Australian Grayling (*Prototroctes maraena*)	V – FM Act V – EPBC Act	The Australian Grayling is diadromous; spending part of its lifecycle in freshwater, and at least part of its larval and/or juvenile stages in coastal areas. Adults (including pre-spawning and spawning adults) inhabit cool, clear, freshwater streams with gravel substrate and areas alternating between pools and riffle zones. The species has also been associated with clear, gravel-bottomed habitats as well as muddy-bottomed, heavily silted habitats. It can be found over 100 km upstream from the ocean.	PMST	Low. No OEH atlas records and no suitable habitat recorded from desktop assessment. Removed as candidate species and no further assessment undertaken.	Low. Not recorded during aquatic surveys.
Mammals					
Eastern Pygmy-possum (*Cercartetus nanus*)	V – TSC Act Species Credit Species	The Eastern Pygmy Possum is found in south-eastern Australia, from southern Queensland to eastern South Australia and in Tasmania. In NSW, the species is found from the coast to inland on the western slopes, around the Pilliga, Dubbo, Parkes and Wagga Wagga. The Eastern Pygmy Possum is found in a broad range of habitats from rainforest through	BBCC	Low. No OEH atlas records and no suitable habitat recorded from desktop assessment.	Low. No suitable habitat recorded from field habitat assessment and not recorded during diurnal or nocturnal surveys.

Common Name *(Scientific Name)*	Status	Habitat requirements	Number of records (source)	Likelihood of occurrence	
				Desktop	Final (after surveys)
		sclerophyll (including Box-Ironbark) forest and woodland to heath. Woodlands and heath appear to be preferred, except in north-eastern NSW where they are most frequently found in rainforests.		Removed as candidate species and no further assessment undertaken.	
Large-eared Pied Bat (*Chalinolobus dwyeri*)	V – TSC Act V – EPBC Act	The Large-eared Pied Bat is found mainly in areas with extensive cliffs and caves, and in well-timbered areas containing gullies, from Rockhampton in Queensland to Bungonia in the NSW Southern Highlands. In NSW, the species is generally rare with a very patchy distribution. Scattered records exist from the New England Tablelands and North West Slopes. The species roosts in cave entrances, crevices in cliffs, old mine workings and in the disused, bottle-shaped mud nests of Fairy Martins (*Petrochelidon ariel*), frequenting low to mid-elevation dry open forest and woodland close to these features.	6 – OEH Atlas PMST	Moderate (foraging). Low (breeding). Foraging - low number of OEH records from the locality. Potential foraging habitat predicted from desktop assessment. Breeding - no known breeding colonies or large winter congregations known from the locality.	Low (foraging). No ultrasonic calls of this species were recorded within the study area during targeted surveys. Low (breeding). No suitable breeding or winter torpor roost habitat recorded, and none are predicted to occur within the study area.
Spotted-tailed Quoll (*Dasyurus maculatus*)	V – TSC Act E – EPBC Act Ecosystem Credit Species	The range of the Spotted-tailed Quoll has contracted considerably since European settlement. It is now found in eastern NSW, eastern Victoria, south-east and north-eastern Queensland, and Tasmania. Only in Tasmania is it still considered relatively common. The species has been recorded across a range of habitat types, including rainforest, open forest,	4 – OEH Atlas BBCC PMST	Low. Very few OEH atlas records and no suitable habitat recorded from desktop assessment.	Low. No suitable habitat recorded from field habitat assessment and not recorded during diurnal or nocturnal surveys.

Common Name *(Scientific Name)*	Status	Habitat requirements	Number of records (source)	Likelihood of occurrence	
				Desktop	Final (after surveys)
		woodland, coastal heath and inland riparian forest, from the sub-alpine zone to the coastline. Individual animals use hollow-bearing trees, fallen logs, small caves, rock outcrops and rocky-cliff faces as den sites, and have communal latrine sites; often on flat rocks among boulder fields, rocky cliff-faces or along rocky stream beds or banks.		Removed as candidate species and no further assessment undertaken.	
Eastern False Pipistrelle (*Falsistrellus tasmaniensis*)	V – TSC Act Ecosystem Credit Species	The Eastern False Pipistrelle is found on the south-east coast and ranges of Australia, from southern Queensland to Victoria and Tasmania. The species prefers moist habitats, with trees over 20 m tall. The Eastern False Pipistrelle generally roosts in eucalypt hollows but has also been found under loose bark on trees, or in buildings.	19 – OEH Atlas BBCC	Moderate. A number of OEH records from the locality. Potential foraging habitat predicted from desktop assessment.	**Moderate**. Suitable forage habitat recorded from field habitat assessment and 'possible' ultrasonic calls of this species recorded during targeted microbat surveys.
Little Bentwing-bat (*Miniopterus australis*)	V – TSC Act	The Little Bentwing-bat occurs along the east coast of Australia, ranging from Cape York in Queensland to Wollongong in NSW. The species inhabits moist eucalypt forest, rainforest, vine thicket, wet and dry sclerophyll forest, Melaleuca swamps, dense coastal forests and Banksia scrub. The Little Bentwing-bat is generally found in well-timbered areas, and roosts in caves, tunnels, tree hollows, abandoned mines, stormwater drains, culverts, bridges and sometimes buildings.	5 – OEH Atlas	Moderate (foraging). Low (breeding). Foraging - low number of OEH records from the locality. Potential foraging habitat predicted from desktop assessment. Breeding - no known breeding	**Recorded** (foraging only). 'Probable' ultrasonic calls of this species during targeted surveys. Low (breeding). No suitable breeding or winter torpor roost habitat recorded, and none are predicted to

Common Name *(Scientific Name)*	Status	Habitat requirements	Number of records (source)	Likelihood of occurrence	
				Desktop	Final (after surveys)
				colonies or large winter congregations known from the locality.	occur within the study area.
Eastern Bentwing-bat (*Miniopterus schreibersii oceanensis*)	V – TSC Act Ecosystem Credit Species (foraging) Species Credit Species (breeding)	The Eastern Bentwing-bat occurs along the east and north-west coasts of Australia. Their primary roosting habitat are caves, but the species is also known to use derelict mines, stormwater tunnels, buildings and other man-made structures.	101 – OEH Atlas	High (foraging). Low (breeding). Foraging - large number of OEH records from the locality. Potential foraging habitat predicted from desktop assessment. Breeding - no known breeding colonies or large winter congregations known from the locality.	**Recorded** (foraging only). 'Probable' ultrasonic calls of this species during targeted surveys. Low (breeding). No suitable breeding or winter torpor roost habitat recorded, and none are predicted to occur within the study area.
Eastern Freetail-bat (*Mormopterus norfolkensis*)	V – TSC Act Ecosystem Credit Species	The Eastern Freetail-bat is found along the east coast from south Queensland to southern NSW. The species occurs in dry sclerophyll forest, woodland, swamp forests and mangrove forests east of the Great Dividing Range. The Eastern Freetail-bat roosts mainly in tree hollows but has also been recorded roosting under bark or in man-made structures.	85 – OEH Atlas BBCC	High. A large number of OEH records from the locality. Potential foraging habitat predicted from desktop assessment.	**Recorded.** 'Probable' ultrasonic calls of this species during targeted surveys.

Common Name *(Scientific Name)*	Status	Habitat requirements	Number of records (source)	Likelihood of occurrence	
				Desktop	Final (after surveys)
Southern Myotis (*Myotis macropus*)	V – TSC Act	The Southern Myotis is found in the coastal band from the north-west of Australia, across the top-end and south to western Victoria. It is rarely found more than 100 km inland, except along major rivers. The species generally roosts in groups of 10 - 15 close to water in caves, mine shafts, hollow-bearing trees, storm water channels, buildings, under bridges and in dense foliage.	67 – OEH Atlas	Moderate. A number of OEH records from the locality. Potential foraging habitat predicted from desktop assessment.	Moderate. Suitable forage habitat recorded from field habitat assessment and 'possible' ultrasonic calls of this species recorded during targeted microbat surveys.
Greater Glider (*Petauroides volans*)	V – EPBC Act	The Greater Glider is endemic to eastern Australia, ranging from Windsor Tableland in far northern Queensland to the Wombat Forest in central Victoria, except in altitudes above 1,200 m. The species is largely restricted to eucalypt forests and woodlands, with higher abundances occurring in taller, denser, montane, moist eucalypt forests with old trees and abundant hollows.	7 – OEH Atlas PMST	Low. Low number of OEH atlas records and no suitable habitat recorded from desktop assessment. Removed as candidate species and no further assessment undertaken.	Low. No suitable habitat recorded from field habitat assessment and not recorded during diurnal or nocturnal surveys.
Yellow-bellied Glider (*Petaurus australis*)	V – TSC Act Ecosystem Credit Species	The Yellow-bellied Glider is found along the eastern coast to the western slopes of the Great Dividing Range, from southern Queensland to Victoria. The species occurs in tall mature eucalypt forest generally in areas with high rainfall and nutrient rich soils. Forest type preferences vary with latitude and elevation; mixed coastal forests to dry escarpment forests in the north; moist coastal	5 – OEH Atlas BBCC	Low. Very few OEH atlas records and no suitable habitat recorded from desktop assessment.	Low. No suitable habitat recorded from field habitat assessment and not recorded during diurnal or nocturnal surveys.

Common Name *(Scientific Name)*	Status	Habitat requirements	Number of records (source)	Likelihood of occurrence	
				Desktop	Final (after surveys)
		gullies and creek flats to tall montane forests in the south.		Removed as candidate species and no further assessment undertaken.	
Squirrel Glider (*Petaurus norfolcensis*)	V – TSC Act Species Credit Species	The Squirrel Glider is widely though sparsely distributed in eastern Australia, from northern Queensland to western Victoria. The species inhabits mature or old growth Box, Box-Ironbark woodlands and River Red Gum forest west of the Great Dividing Range and Blackbutt-Bloodwood forest with heath understorey in coastal areas. The Squirrel Glider prefers mixed species stands with a shrub or *Acacia* Midstorey and requires abundant tree hollows for refuge and nest sites.	BBCC	Low. No OEH atlas records and no suitable habitat recorded from desktop assessment. Removed as candidate species and no further assessment undertaken.	Low. No suitable habitat recorded from field habitat assessment and not recorded during diurnal or nocturnal surveys.
Brush-tailed Rock-wallaby (*Petrogale penicillata*)	E – TSC Act V – EPBC Act	The Brush-tailed Rock-wallaby is distributed from south-east Queensland to the Grampians in western Victoria, roughly following the lines of the Great Diving Range. In NSW, the species occurs from the Queensland border in the north, to Shoalhaven in the south. The population in the Warrumbungle Ranges is the western limit of the species range. Brush-tailed Rock-wallaby occupy rocky escarpments, outcrops and cliffs with a preference for complex structures with fissures, caves and ledges often facing north.	2 – OEH Atlas PMST	Low. Very few OEH atlas records and no suitable habitat recorded from desktop assessment. Removed as candidate species and no further assessment undertaken.	Low. No suitable habitat recorded from field habitat assessment and not recorded during diurnal or nocturnal surveys.
Koala (*Phascolarctos cinereus*)	V – TSC Act V – EPBC Act	The Koala has a fragmented distribution throughout eastern Australia from north-east	15 – OEH Atlas	Moderate.	Low.

Common Name *(Scientific Name)*	Status	Habitat requirements	Number of records (source)	Likelihood of occurrence	
				Desktop	Final (after surveys)
	Species Credit Species	Queensland to the Eyre Peninsula in South Australia. In NSW, it mainly occurs on the central and north coasts with some populations in the west of the Great Dividing Range. It also has sparse and possibly disjunct populations in the Southern Tablelands. The Koala is also known from several sites on the Southern Tablelands. The species inhabits eucalypt woodlands and forests, and feeds on select species; about 70 eucalypt species and 30 non-eucalypt species but will select preferred browse species in any one area.	BBCC PMST	A number of OEH records from the locality. Potential habitat predicted from desktop assessment.	Marginal habitat considered present during field habitat assessments. Targeted surveys undertaken in accordance with guidelines (DECC, 2009). Species not recorded during targeted surveys.
New Holland Mouse (*Pseudomys novaehollandiae*)	V – EPBC Act	The New Holland Mouse has a fragmented distribution across Tasmania, Victoria, NSW and Queensland. The species is known to inhabit open heathlands, woodlands and forests with a heathland understorey and vegetated sand dunes.	PMST	Low. No OEH atlas records and no suitable habitat recorded from desktop assessment. Removed as candidate species and no further assessment undertaken.	Low. No suitable habitat recorded from field habitat assessment and not recorded during diurnal or nocturnal surveys.
Grey-headed Flying-fox (*Pteropus poliocephalus*)	V – TSC Act V – EPBC Act	The Grey-headed Flying-fox is generally found within 200 km of the coast in eastern Australia, from Rockhampton in Queensland to Adelaide in South Australia. In times of natural resource shortages, the species can occur in unusual locations. The Grey-headed Flying-fox occurs in subtropical and temperate rainforests, tall sclerophyll forests and woodlands, heaths and	148 – OEH Atlas PMST	High (foraging). Low (breeding). Foraging - large number of OEH records from the locality. Potential	**Recorded** (foraging only). Recorded foraging within the study area during nocturnal surveys.

Common Name *(Scientific Name)*	Status	Habitat requirements	Number of records (source)	Likelihood of occurrence	
				Desktop	Final (after surveys)
		swamps as well as urban gardens and cultivated fruit crops. Roosting camps are generally located within 20 km of regular food sources, and are commonly found in gullies, close to water, in vegetation with a dense canopy. Site fidelity to camps are high, and the species travels up to 50 km from these camps to forage, typically commuting distances up to 20 km from the camp site.		foraging habitat predicted from desktop assessment. Breeding and roosting - closest camp is approximately 7km to the east (Wetherill Park).	Low (breeding and roosting). No camps recorded during surveys. No suitable breeding or roosting habitat recorded, and none is predicted to occur within the study area.
Yellow-bellied Sheathtail-bat (*Saccolaimus flaviventris*)	V – TSC Act Ecosystem Credit Species	The Yellow-bellied Sheathtail-bat is a wide-ranging species found across northern and eastern Australia. In the most southerly part of its range (most of Victoria, south-western NSW and adjacent South Australia) it is a rare visitor in late summer and autumn. There are scattered records of this species across the New England Tablelands and North West Slopes. The species roosts in tree hollows and buildings. In treeless areas, they are known to utilise mammal burrows.	2 – OEH Atlas BBCC	Moderate. A low number of OEH records from the locality. Potential foraging habitat predicted from desktop assessment.	**Recorded.** 'Probable' ultrasonic calls of this species during targeted surveys.
Greater Broad-nosed Bat (*Scoteanax rueppellii*)	V – TSC Act Ecosystem Credit Species	The Greater Broad-nosed Bat is found mainly in the gullies and river systems that drain the Great Diving Range, from north-eastern Victoria to the Atherton Tableland. The species extends to the coast over much of its range. In NSW, the Greater Broad-nosed Bat is widespread over the New England Tablelands, however it does not occur at altitudes above 500 m. The species utilises a variety of habitats from woodland through to moist and dry eucalypt forest and rainforest, though it is most commonly found in tall wet forest. Although the	53 – OEH Atlas BBCC	Moderate. A number of OEH records from the locality. Potential foraging habitat predicted from desktop assessment.	**Recorded.** 'Probable' ultrasonic calls of this species during targeted surveys.

Common Name *(Scientific Name)*	Status	Habitat requirements	Number of records (source)	Likelihood of occurrence	
				Desktop	Final (after surveys)
		species predominantly roosts in tree hollows, it has also been recorded roosting in buildings.			
Molluscs					
Cumberland Plain Land Snail (*Meridolum corneovirens*)	E – TSC Act Species Credit Species	The Cumberland Plain Land Snail lives in small areas on the Cumberland Plain west of Sydney, from Richmond and Windsor south to Picton and from Liverpool west to the Hawkesbury and Nepean Rivers at the base of the Blue Mountains. The species is known from over 100 different locations, but not all are currently occupied, and they are usually isolated from each other because of land use patterns. The species primarily inhabits the Critically Endangered Ecological Community (CEEC) Cumberland Plain Woodland. This community is characterised by grassy, open woodland with occasional dense patches of shrubs. It is also known from Shale Gravel Transition Forests, Castlereagh Swamp Woodlands and the margins of River-flat Eucalypt Forest; all of which are also listed Threatened Ecological Communities (TECs).	541 – OEH Atlas BBCC	High. Large number of OEH records from the locality. Potential habitat predicted from desktop assessment.	**High**. Marginal habitat considered present during field habitat assessments. Targeted surveys undertaken in accordance with survey guidelines (NSW NPWS, 2000). Species not recorded within the study area during targeted surveys. Species recorded adjacent to the study area during subsequent surveys.
Dural Land Snail (*Pommerhelix duralensis*)	E – TSC Act E – EPBC Act	The Dural Land Snail is a shale-influenced-habitat specialist, which occurs in low densities along the western and northwest fringes of the Cumberland IBRA subregion, on shake-sandstone transitional landscapes. Currently, there is a degree of uncertainty about the distribution and identity of the snails in this and related species. The species is found, with certainty, within the Local Government Areas (LGAs) of The Hills Shire, Hawkesbury Shire and Hornsby Shire. Records from the Blue	PMST	Low. No OEH atlas records and no suitable habitat recorded from desktop assessment. Removed as candidate species	Low. No suitable habitat recorded from field habitat assessment and not recorded during snail surveys.

Common Name *(Scientific Name)*	Status	Habitat requirements	Number of records (source)	Likelihood of occurrence	
				Desktop	Final (after surveys)
		Mountains, Penrith and Parramatta Cities may represent this species. The Dural Land Snail has a strong affinity for communities in the interface region between shale-derived and sandstone-derived soils, with forest habitats that have a good native cover and contain woody debris. It favours sheltering under rocks or inside curled-up bark and has been observed resting in exposed areas such as on rocks or leaf litter. It is also known to shelter beneath leaves, rocks and light woody debris.		and no further assessment undertaken.	

Flora

Common Name *(Scientific Name)*	TSC Act	EPBC Act	Ecosystem or species credit species?	Habitat requirements	Number of records (source)	Likelihood of occurrence
Bynoe's Wattle (*Acacia bynoeana*)	E	V	Species	Bynoe's wattle is found in central eastern NSW, from the Hunter District south to the Southern Highlands and west to the Blue Mountains. Found in heath or dry sclerophyll forest on sandy soils, often in slightly disturbed areas, in association with *Corymbia gummifera, Eucalyptus haemastoma, Eucalyptus parramattensis, Banksia serrata* and *Angophora bakeri.*	BBCC PMST	Moderate. There are no records of this species in the locality, but marginal potential habitat is present in Shale/Gravel Transition Forest (PCT 724), and the species is known to occur in disturbed ground and road edges.
Downy Wattle (*Acacia pubescens*)	V	V	Species	Occurs on alluviums, shales and between shales and sandstones in open woodland and forest. Concentrated around the Bankstown-Fairfield-Rookwood area and the Pitt Town area, with outliers occurring at Barden Ridge, Oakdale and Mountain Lagoon. Occurs in A variety of plant communities including, Cooks River/Castlereagh Ironbark Forest, Shale/Gravel Transition Forest and Cumberland Plain Woodland.	183 – OEH Atlas BBCC PMST	**High.** This species is known to occur in Shale/Gravel Transition Forest (PCT 724) and on the fringes of Cumberland Plain Woodland (PCTs 849 and 850). Previous records (most recent 2017) occur nearby the study area.
Allocasuarina glareicola	E	E	Species	The species is largely restricted to the NW Cumberland Plain. It grows in Castlereagh woodland on lateritic soil and is often found in open woodland with *Eucalyptus parramattensis, Eucalyptus fibrosa, Angophora bakeri, Eucalyptus sclerophyl*la and *Melaleuca decora*. Common associated understorey species include *Melaleuca nodosa, Hakea dactyloides, Hakea sericea, Dillwynia tenuifolia, Micromyrtus minutiflora, Acacia elongata, Acacia brownei, Themeda australis* and *Xanthorrhoea minor.*	BBCC PMST	Low. There are no records of this species in the locality. Only marginal habitat exists for this species within the study area in the form of Shale Gravel Transition Forest (PCT 724) and Castlereagh Scribbly Gum Woodland (PCT 883). However, much of this vegetation has been recently cleared and only exists in small, fragmented and low quality patches.

Common Name *(Scientific Name)*	TSC Act	EPBC Act	Ecosystem or species credit species?	Habitat requirements	Number of records (source)	Likelihood of occurrence
Asterolasia elegans	E	E	Species	Found in the Baulkham Hills, Hawkesbury and Hornsby local government areas north of Sydney. Occurs on Hawkesbury sandstone in sheltered forests on mid-lower slopes and valleys. Canopy species often include *Syncarpia glomulifera* subsp*. glomulifera, Angophora costata, Eucalyptus piperita, Allocasuarina torulosa* and *Ceratopetalum gummiferum.*	PMST	Low. There are no records of this species in the locality and the study area does not overlap with its distribution. This species is associated with sandstone derived soils that contain a varying amount of enrichment which are not present in the study area. No habitat is present.
Netted Bottle Brush *(Callistemon linearifolius)*	V	-	Species	Populations occur from Georges River to Hawkesbury River and north to Nelson Bay. Currently only 5-6 populations in the Sydney area, recently sighted in Hornsby Plateau. Three populations are in Ku-ring-gai Chase NP, Lion Island Nature Reserve and Spectacle Island Nature Reserve. Grows in dry sclerophyll forest on the coast and adjacent ranges.	2 – OEH Atlas BBCC	Low. This species has a fairly well known and restricted distribution which does not extend into western Sydney. There is also no suitable habitat in the study area.
Leafless Tongue Orchid *(Cryptostylis hunteriana)*	V	V	Species	Can occur almost the entire NSW eastern coast with recent records between Batemans Bay and Nowra. It is found in a range of communities, including swamp-heath and woodland. Larger populations often occur in woodlands dominated by *Eucalyptus sclerophylla, E. sieberi, Corymbia gummifera* and *Allocasuarina littoralis* with populations preferring open areas in the understorey of this type of community.	PMST	Low. The study area is outside the species known distribution and there are no records in the locality. This species is associated with sandstone derived soils which are not present in the study area. There is therefore no suitable habitat present.
White-flowered Wax Plant (*Cynanchum elegans*)	E	E	Species	This species is restricted to eastern NSW from Brunswick Heads to Gerroa. Locations include Cumberland Plain, the Forster area, Manning Valley, Hunter Valley, Yabbra State Forest, Brunswick Heads, Gerroa, Merriwa and	2 – OEH Atlas BBCC PMST	**Moderate.** While there are no recent records of this species in the locality (most recent from 1993) this species could

Common Name *(Scientific Name)*	TSC Act	EPBC Act	Ecosystem or species credit species?	Habitat requirements	Number of records (source)	Likelihood of occurrence
				northeast of Tenterfield. It is most common in the Kempsey region. The species occurs on a variety of lithologies and soil types, usually on steep slopes with varying degrees of soil fertility. It occurs mainly at the ecotone between dry subtropical rainforest and sclerophyll forest/woodland communities.		occur in the Moist Shale Woodland (PCT 830) that is present in the study area.
Dillwynia tenuifolia	V	-	Species	Distributed from the Cumberland Plain from Windsor to Penrith, east to Dean Park near Colebee as well as in the Liverpool and Penrith LGA's. Abundant within scrubby/dry heath areas within Castlereagh Ironbark Forest and Shale Gravel Transition Forest on tertiary alluvium or laterised clays. *Eucalyptus fibrosa* is often the dominant canopy species. *Eucalyptus globoidea, E. longifolia, E. parramattensis, E. sclerophylla* and *E. sideroxylon* may also be present or codominant.	682 – OEH Atlas BBCC	**Recorded.** This species was recorded in the central region of the study area in Shale/Gravel Transition Forest (PCT 724) and Shale Plains Woodland (PCT 849).
Dillwynia tenuifolia endangered population, Kemps Creek	EP	-	Species	The endangered population is situated in Kemps Creek in an area bounded by Elizabeth Drive, Western Road, Devonshire Road and Cross Street. The site supports a transition from Castlereagh Ironbark Forest to Castlereagh Scribbly Gum Woodland. Portions of the site contain a form of Shale Gravel Transition Forest.	BBCC	**Recorded.** This species was recorded in the central region of the study area in Shale/Gravel Transition Forest (PCT 724) and Shale Plains Woodland (PCT 849).
Buttercup Doubletail *(Diuris aequalis)*	E	V	Species	Populations occur in Kanangra-Boyd NP, Gurnang State Forest, Wombeyan Caves, Goulburn and the ranges between Braidwood, Tarago and Bungendore. The species has been recorded in forest, low open woodland with grassy understory and secondary grassland.	1 – OEH Atlas	Low. This species distribution does not overlap the study area and there is only one historical record (1905) in the locality.

Common Name *(Scientific Name)*	TSC Act	EPBC Act	Ecosystem or species credit species?	Habitat requirements	Number of records (source)	Likelihood of occurrence
Black Gum *(Eucalyptus aggregata)*	V	-	Species	In NSW, the species occurs in the South Eastern Highlands Bioregion and on the western fringe of the Sydney Basin Bioregion. It has a moderately narrow distribution, occurring in the wetter, cooler and higher parts of the tablelands such as Blayney, Crookwell, Goulburn, Braidwood and Bungendore districts.	PMST	Low. This species distribution does not overlap the study area and there are no previous records in the locality. The study area also does not have suitable habitat or environmental conditions.
Camden White Gum *(Eucalyptus benthamii)*	V	V	Species	Known from two main locations: Bents Basin and Kedumba Valley. Other populations scattered along the Nepean River, Camden, Cobbitty, Werriberri Creek and Nattai River. Requires deep alluvial sands and flooding regime that permits seedling establishment. Juveniles most successful on bare silt deposits in river systems. Occurs in open forests on alluvial flats usually between 60 to 300m ASL.	89 – OEH Atlas PMST	Low. While there are numerous records of this species to the west of the study area, this species has a well-known distribution which does not overlap the study area. This species has a specific habitat which is not present in the study area.
Narrow-leaved Black Peppermint *(Eucalyptus nicholii)*	V	V	Species	This species is sparsely distributed but widespread on the New England Tablelands from Nundle to north of Tenterfield, being most common in central portions of its range. Found largely on private property and roadsides, and occasionally in conservation reserves. Grows in dry grassy woodland, on shallow soils of slopes and ridges, on granite or metasedimentary rock.	2 – OEH Atlas	None. This species occurs on the New England Tablelands and while it is commonly planted as a street tree, it does not occur naturally in the Sydney Basin, including in the study area.
Wallangarra White Gum *(Eucalyptus scoparia)*	E	V	Species	Known in Tenterfield and Bald Rock NP in NSW with three occurrences in QLD. Grows in open eucalypt forest, woodland and heaths on well drained granite/rhyolite hilltops, slopes and rocky outcrops and typically at high altitudes. At lower elevations it occurs in less rocky soils in damp situations.	1 – OEH Atlas	None. This species occurs on the New England Tablelands and while it is often planted as a street tree, it does not occur naturally in the Sydney Basin, including in the study area.

Common Name *(Scientific Name)*	TSC Act	EPBC Act	Ecosystem or species credit species?	Habitat requirements	Number of records (source)	Likelihood of occurrence
Bauer's Midge Orchid *(Genoplesium baueri)*	E	E	Species	Populations occur between Ulladulla and Port Stephens with historic recordings in Sydney suburbs. Likely to be in Berowra Valley Regional Park, Royal NP and Lane Cove NP. It may occur in the Woronora, O'Hares, Metropolitan and Warragamba Catchments. Grows in dry sclerophyll forest and moss gardens over sandstone.	PMST	Low. This species distribution does not overlap the study area and there are no previous records in the locality. The species occurs on sandstone derived soils which are not present in the study area.
Juniper-leaved Grevillea (*Grevillea juniperina* subsp. *juniperina*)	V	-	Species	Native to Western Sydney, bounded by Blacktown, Erskine Park, Londonderry and Windsor. Outlier populations occur at Kemps Creek and Pitt Town. Grows on reddish clay to sandy soils derived from Wianamatta Shale and Tertiary alluvium containing lateritic gravels. Associated with canopy species within Cumberland Plain Woodland and Shale/Gravel Transition Forest including *Eucalyptus tereticornis, E. moluccana, E. crebra, E. fibrosa* and *E. eugenioides.*	135 – OEH Atlas BBCC	**Recorded.** This species has been recorded within regenerating Cumberland Plain Woodland (PCTs 849 and 850) within the study area.
Small-flower Grevillea (*Grevillea parviflora* subsp. *parviflora*)	V	V	Species	Distributed throughout the Sydney Basin with populations in Picton, Appin, Bargo and the Cessnock-Kurri Kurri area of the Hunter. Separate populations known from Putty to Wyong and Lake Macquarie. Grows in sandy or light clay soils over thin shales, with lateritic ironstone gravels and nodules. Occurs in heath and shrubby woodland or open forest and often in open, slightly disturbed sites such as along tracks. Associated with a range of Eucalypt and Angophora spp.	16 – OEH Atlas BBCC PMST	**Moderate.** There are multiple records of this species in close proximity to the study area. Suitable habitat is present in the study area within the Shale Gravel Transition Forest (PCT 724) and Castlereagh Scribbly Gum Woodland (PCT 883).
Gyrostemon thesioides	E	-	Species	Recorded in three sites near the Colo, Georges and Nepean Rivers. The most recent record is of a single individual near the Colo River, but it has not been recorded from the	16 – OEH Atlas BBCC	Low. There are no recent records of this species in the locality (most record

Common Name *(Scientific Name)*	TSC Act	EPBC Act	Ecosystem or species credit species?	Habitat requirements	Number of records (source)	Likelihood of occurrence
				Nepean and Georges Rivers for 90 and 30 years respectively. It grows on hillsides and riverbanks and is likely to be restricted to fine sandy soils.		from 1967). There is also no suitable habitat present in the study area.
Square Raspwort *(Haloragis exalata* subsp. *exalata)*	V	V	Species	Occurs in 4 widely scattered localities in eastern NSW including the Central Coast, South Coast and North Western Slopes botanical subdivisions of NSW. Requires protected and shaded damp situations in riparian habitats.	PMST	Low. There are no records of this species in the locality. This species is more typically associated with Swamp Sclerophyll Forest and heath and swamps, none of which are present in the study area.
Hibbertia sp. Bankstown (synonym of *H. puberula subsp. glabrescens)*	CE	CE	Species	Currently known to occur in only one population at Bankstown Airport in Bankstown LGA. At this site it only grows on Tertiary alluvial soil with a high silt content.	BBCC	Low. There are no records of this species in the locality. Associated soils are also not present in the study area.
Isotoma fluviatilis subsp. *fluviatilis* (synonym of *Hypsela sessiliflora*)	-	X	N/A	*Hypsela sessiliflora* was previously listed as Endangered under the TSC Act. An assessment of the taxonomic status of *Hypsela sessiliflora* by Albrecht (2015) using morphological and molecular data determined that it is a synonym of *Isotoma fluviatilis* subsp. *fluviatilis*, a widespread taxon not listed under the Act. The species has subsequently been removed from the schedules of the TSC Act but remains listed as Extinct under the EPBC Act. A proposal to delete *Hypsela sessiliflora* from the EPBC Act is currently under consideration by the Threatened Species Scientific Committee.	8 – OEH Atlas	Not applicable – does not require assessment.
Woronora Beard-heath	V	V	Species	The species has a small range and is found along the upper Georges River area and in	PMST	Low.

Common Name *(Scientific Name)*	TSC Act	EPBC Act	Ecosystem or species credit species?	Habitat requirements	Number of records (source)	Likelihood of occurrence
(Leucopogon exolasius)				Heathcote NP. Grows in woodland on sandstone and flowers August and September.		This species has not been recorded in the locality. It occurs on sandstone derived soils that are not present in the study area and therefore there is not suitable habitat present.
Marsdenia viridiflora subsp. *viridiflora* in the Bankstown, Blacktown, Camden, Campbelltown, Fairfield, Holroyd, Liverpool and Penrith Local Government Areas	EP	-	Species	Recent records are from Prospect, Bankstown, Smithfield, Cabramatta Creek and St Marys. Previously known north from Razorback Range. Grows in vine thickets and open shale woodland.	278 – OEH Atlas BBCC	**High.** There are a high number of recent (2017) records of this species scattered around the study area. Potential habitat is present; the species is associated with most PCTs within the study area.
Deane's Paperbark *(Melaleuca deanei)*	V	V	Species	Species occurs in two distinct areas, Ku-ring-gai/Berowra and Holsworthy/Wedderburn. There are also isolated occurrences in Springwood, Wollemi NP, Yalwal and Central Coast. Species occurs mostly in ridgetop woodland with only 5% of sites in heath on sandstone.	PMST	Low. This species does not occur on the Cumberland Plain and it has no records in the locality. Habitat in the study area is not suitable.
Micromyrtus minutiflora	E	V	Species	Restricted to the general area between Richmond and Penrith, growing in Castlereagh Scribbly Gum Woodland, Ironbark Forest, Shale/Gravel Transition Forest, open forest on tertiary alluvium and consolidated river sediments.	2 – OEH Atlas BBCC	**Moderate.** While there is suitable habitat in the study area, this species has a restricted distribution which does not overlap the study area.
Omeo stork's-bill *(Pelargonium sp. Striatellum)*	E	E	Species	Known from only 4 locations in NSW, with three on lake-beds on the basalt plains of the Monaro and one at Lake Bathurst. It occurs at	PMST	Low.

Common Name *(Scientific Name)*	TSC Act	EPBC Act	Ecosystem or species credit species?	Habitat requirements	Number of records (source)	Likelihood of occurrence
				altitudes between 680 to 1030m. It has a narrow habitat that is usually just above the high-water level of irregularly inundated or ephemeral lakes, in the transition zone between surrounding grasslands or pasture and the wetland or aquatic communities. It sometimes colonises exposed lake beds during dry periods.		The highly specific habitat characteristics of this species are not present in the study area. The study area is also outside the species known distribution.
Tall Knotweed (*Persicaria elatior*)	V	V	Species	Species recorded in south-eastern NSW at Moruya State Forest, Upper Avon River and Picton Lakes. In northern NSW, it is found near Raymond Terrace and Grafton. The species normally grows in damp places, especially beside streams and lakes, and occasionally found in swamp forest or associated with disturbance.	BBCC	Low. There are no records of this species in the locality. This species is more typically associated with coastal swamps and woodlands, none of which are present in the study area.
Needle Geebung *(Persoonia acerosa)*	V	V	Species	Species records exist on the central coast and Blue Mountains from Mt Tomah to Hill Top (now believed extinct here). Mainly grows in Katoomba/Wentworth Falls/Springwood Area. Occurs in dry sclerophyll forest, scrubby low-woodland and heath on low fertility soils.	PMST	Low. This species does not occur in western Sydney and no habitat is present in the study area.
Bargo Geebung (*Persoonia bargoensis*)	E	V	Species	Species is restricted to a small area south-west of Sydney on the western edge of Woronora Plateau and the northern edge of the Southern Highlands. Occurs in woodland or dry sclerophyll forest on sandstone and on heavier, well drained, loamy, gravelly soils of Wianamatta Shale and Hawkesbury Sandstone. Favours interface soil landscapes and is often associated with Shale/Sandstone Transition Forest.	BBCC	Low. This species has a restricted distribution which does not overlap the study area. It is more commonly associated with Shale/Sandstone Transition Forest which is not present in the study area.
Hairy Geebung	E	E	Species	Species has a scattered distribution around Sydney, from Singleton to Bargo and west	PMST	Low.

Common Name *(Scientific Name)*	TSC Act	EPBC Act	Ecosystem or species credit species?	Habitat requirements	Number of records (source)	Likelihood of occurrence
(Persoonia hirsuta)				towards the Blue Mountains. Found in sandy soils in dry sclerophyll open forest, woodland and heath on sandstone.		There are no records of this species in the locality. It is associated with soils derived from sandstone which are not present in the study area. Therefore, there is no suitable habitat present.
Nodding Geebung (*Persoonia nutans*)	E	E	Species	Restricted to the Cumberland Plain in western Sydney between Richmond and Macquarie Fields. Most individuals occur in the north of the species range (Agnes Banks, Londonderry, Castlereagh, Berkshire Park and Windsor Downs areas) in Penrith and Hawkesbury LGA's. Isolated populations occur in Liverpool, Campbelltown, Bankstown and Blacktown LGA's. Northern populations grow on aeolian and alluvial sediments in sclerophyll forest and woodland vegetation. Southern populations grow on tertiary alluvium and shale sandstone transition communities.	16 – OEH Atlas BBCC PMST	**High.** This species has been recorded recently (2013) approximately 500m outside the study area. There is also potential habitat for this species in the Shale Gravel Transition Forest (PCT 724) and the Castlereagh Scribbly Gum Woodland (PCT 883) that occurs in the study area.
Austral Pillwort (*Pilularia novae-hollandiae*)	E	-	Species	Recorded from suburban Sydney, Khancoban, the Riverina between Albury and Urana, Oolambeyan NP and Lake Cowal. The only known extant populations in NSW are in Oolambeyan and Lake Cowal. It grows in shallow swamps and waterways, often among grasses and sedges. It is likely to be ephemeral as it most frequently appears in drying muds when soils are moistened by rain.	BBCC	Low. There are no records of this species in the locality and the only known extant populations of the species are not in proximity to the study area.
Pimelea curviflora subsp. *curviflora*	V	V	Species	Confined to the coastal area of the Sydney and Illawarra regions and between Sydney and Maroota in the north-west. A new population has been discovered at Croom Reserve near Albion Park in August 2011. Grows on shaley/lateric soils over sandstone and	BBCC PMST	Low. This species is associated with shale caps over sandstone and soils containing laterite and/or shale

Common Name *(Scientific Name)*	TSC Act	EPBC Act	Ecosystem or species credit species?	Habitat requirements	Number of records (source)	Likelihood of occurrence
				shale/sandstone transition soils. Occurs on ridgetops and upper slopes.		enrichment. No suitable habitat is present.
Spiked Rice-flower (*Pimelea spicata*)	E	E	Species	Occurs in two populations; the Cumberland Plain (Marayong, Prospect Reservoir, Narellan and Douglas Park) and the Illawarra (Landsdowne, Shellharbour and Kiama). Species is found on well-structured clay soils. In the Cumberland population, it is associated with the canopy species *Eucalyptus moluccana, E. tereticornis* and *E. crebra.* Other co-occurring species include *Bursaria spinosa* and *Themeda australis.* In the Illawarra population, it is associated with coastal woodland and coastal grassland species.	165 – OEH Atlas BBCC PMST	**Recorded.** This species has been recorded in the study area. Habitat is present in the Cumberland Plain Woodland vegetation (PCTs 849 and 850) and the Moist Shale Woodland vegetation (PCT 830).
Pomaderris brunnea	V	V	Species	Has a limited distribution from the area around the Colo, Nepean and Hawkesbury Rivers, including the Bargo area and near Camden. Grows in moist woodland or forest on clay and alluvial soils or flood plains and creek lines.	BBCC PMST	Low. There are no records of the species in the locality. The riparian habitat within the study area is unlikely to provide habitat for this species.
Illawarra Greenhood *(Pterostylis gibbosa)*	E	E	Species	Known in Milbrodale, Albion Park, Yallah and the Shoalhaven region. Grows in open forest or woodland, on flat or gently sloping land with poor drainage. In the Illawarra region the species grows in woodland dominated by *Eucalyptus tereticornis, E. longifolia* and *Melaleuca decora*. In Nowra it grows amongst *Corymbia maculata, Eucalyptus tereticornis* and *E. paniculata*. In the Hunter it grows amongst *E. crebra*, *E. tereticornis* and *Callitris endlicheri.*	PMST	Low. This species is now extinct in Western Sydney. No records exist in the locality.
Dark Greenhood *(Pterostylis nigricans)*	V	-	Species	In NSW, the species occurs in north-east of the state, north from Evans Head. Grows in coastal heathland with *Banksia ericifolia* and	1 – OEH Atlas	Low.

Common Name *(Scientific Name)*	TSC Act	EPBC Act	Ecosystem or species credit species?	Habitat requirements	Number of records (source)	Likelihood of occurrence
				lower-growing heath with lichen-encrusted and relatively undisturbed soil surfaces, on sandy soils.		This species occurs in northern NSW, a great distance away from the study area. There is only one historical record (1967) in the locality which is unreliable. There is also no suitable habitat in the study area.
Sydney Plains Greenhood (*Pterostylis saxicola*)	E	E	Species	Restricted to western Sydney between Freemans Reach to Picton. Most commonly found growing in small pockets of shallow soil in depressions on sandstone rock shelves above cliff lines. The vegetation communities above the shelves are sclerophyll forest or woodland on shale/sandstone transition soils or shale soils.	1 – OEH Atlas BBCC	Low. This species has specific habitat requirements that are not present in the study area.
Smooth Bush-Pea *(Pultenaea glabra)*	V	V	Species	Restricted to the upper altitudes of the Blue Mountains area and known in the Katoomba-Hazelbrook and Mount Victoria areas. It is associated with riparian or swamp habitat on sandstone derived soils. Grows in swamp margins, hillslopes, gullies and creekbanks and occurs within dry sclerophyll forest and tall damp heath.	PMST	None. This species does not occur in Western Sydney and no habitat is present in the study area.
Pultenaea parviflora	E	V	Species	Endemic to the Cumberland Plain, mainly distributed from Windsor to Penrith and east to Dean Park with outlier populations from Kemps Creek and Wilberforce. Can be locally abundant in scrubby/dry heath areas within Castlereagh Ironbark Forest and Shale Gravel Transition Forest on tertiary alluvium or laterised clays. Could be common in transitional areas where these communities join Castlereagh Scribbly Gum Woodland. Dominant canopy species is often *Eucalyptus fibrosa* with associated species of *Eucalyptus*	252 – OEH Atlas BBCC PMST	**Recorded.** This species has been recorded in the Shale Gravel Transition Forest (PCT 724) in the study area.

Common Name *(Scientific Name)*	TSC Act	EPBC Act	Ecosystem or species credit species?	Habitat requirements	Number of records (source)	Likelihood of occurrence
				globoidea, E. longifolia, E. parramattensis, E. sclerophylla and *E. sideroxylon*.		
Matted Bush-pea (*Pultenaea pedunculata*)	E	-	Species	Populations occur on the Cumberland Plain, and on the coast between Tathra and Bermagui and Windellama. The species generally occurs among woodland vegetation, but plants have been found on road batters and coastal cliffs. In the Windellama area it is largely confined to loamy soils in dry gullies. Associated species in the Sydney area include *Eucalyptus moluccana, E. fibrosa, E. crebra, E. longifolia* and *Melaleuca decora.*	13 – OEH Atlas BBCC	**Moderate.** The nearest records of this species exist approximately 6.5 km from the study area and are dated 2005. There is potential habitat for this species in the Shale Gravel Transition Forest (PCT 724) and Cumberland Plain Woodland (PCT 849 and 850).
Magenta Lilly Pilly *(Syzygium paniculatum)*	E	V	Species	Found only in a narrow, linear coastal strip from Upper Lansdowne to Conjola State Forest. On the south coast the species occurs on grey soils over sandstone, in remnant stands of littoral rainforest. On the central coast, populations occur on gravels, sands, silts and clays in riverside gallery rainforests and remnant littoral rainforest communities.	1 – OEH Atlas PMST	None. This species is associated with rainforest vegetation types that are not present in the study area. While it is widely planted as an ornamental tree, it would not naturally occur in the study area.
Tetratheca glandulosa	V	-	Species	150 populations exist in Baulkham Hills, Gosford, Hawkesbury, Hornsby, Ku-ring-gai, Pittwater, Ryde, Warringah and Wyong. From north to south the population ranges 65km and is associated with shale-sandstone transition habitat where shale-cappings occur over sandstone, with associated soil landscapes. The plant occupies ridgetops, upper-slopes and to a lesser extent mid-slope sandstone benches. Vegetation structure varies from heath and scrub to woodland/open woodland and open forest. Associated species include *Corymbia gummifera, C. eximia, Eucalyptus*	1 – OEH Atlas	Low. There is only one record of the species in the locality from 2006 and the study area does not overlap with the species distribution. The species is more commonly associated with ridgetops on shale-sandstone transition habitat in the northern extent of the Sydney Basin.

Common Name *(Scientific Name)*	TSC Act	EPBC Act	Ecosystem or species credit species?	Habitat requirements	Number of records (source)	Likelihood of occurrence
				haemastoma, E. punctata, E. racemosa, and/or *E. sparsifolia.*		
Thelymitra kangaloonica	CE	CE	Species	*Thelymitra sp. Kangaloon* is a terrestrial orchid endemic to New South Wales and is known from three locations near Robertson in the Southern Highlands. The swamp habitat in which the species occurs has an extent of occurrence of 300 km2 and an area of occupancy of 10 km2. The three swamps are Butlers Swamp, Stockyard Swamp and Wildes Meadow Swamp, and are all located above what is known as the Kangaloon aquifer. The species grows amongst tall sedges and rushes in seasonally swampy sedgeland on grey silty clay loam at 600-700 m above sea level.	PMST	None. This species has specific habitat requirements that are not present in the study area. It also has a well-documented distribution which is not in close proximity to the Cumberland Plain.
Austral Toadflax *(Thesium australe)*	V	V	Species	Found in very small populations scattered across eastern NSW, and from the Northern to Southern Tablelands. Populations occur in grassland on coastal headlands or grassland and grassy woodland away from the coast. Grows with *Themeda Australis*.	PMST	Low. While this species has a scattered distribution across eastern NSW, there are no records within the locality. The species has not been found in the Sydney region for a long time and the vegetation types in the study area are unlikely to provide habitat for this species.

Annexure C – Biodiversity credit report

Biodiversity credit report

This report identifies the number and type of biodiversity credits required for a major project.

Date of report: 29/04/2019 Time: 2:04:45PM Calculator version: v4.0

Major Project details

Proposal ID:	0023/2017/4578MP
Proposal name:	M12 Motorway
Proposal address:	Elizabeth Drive Kemps Creek NSW
Proponent name:	Roads and Maritime Services
Proponent address:	Argyle Street Parramatta NSW
Proponent phone:	131782
Assessor name:	Jane Rodd
Assessor address:	Level 5, 141 Walker Street NORTH SYDNEY NSW 2060
Assessor phone:	8907 8266
Assessor accreditation:	0023

Summary of ecosystem credits required

Plant Community type	Area (ha)	Credits created
Broad-leaved Ironbark - Grey Box - Melaleuca decora grassy open forest on clay/gravel soils of the Cumberland Plain, Sydney Basin Bioregion	6.91	372.00
Forest Red Gum - Grey Box shrubby woodland on shale of the southern Cumberland Plain, Sydney Basin Bioregion	0.44	15.00
Forest Red Gum - Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney Basin Bioregion	3.23	107.00
Grey Box - Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin Bioregion	6.09	203.46
Grey Box - Forest Red Gum grassy woodland on shale of the southern Cumberland Plain, Sydney Basin Bioregion	54.07	1,650.38
Swamp Oak open forest on riverflats of the Cumberland Plain and Hunter valley	2.53	67.38
Total	73.27	2,415

Credit profiles

1. Forest Red Gum - Grey Box shrubby woodland on shale of the southern Cumberland Plain, Sydney Basin Bioregion, (HN524)

Number of ecosystem credits created	15
IBRA sub-region	Cumberland - Hawkesbury/Nepean

Offset options - Plant Community types	Offset options - IBRA sub-regions
Forest Red Gum - Grey Box shrubby woodland on shale of the southern Cumberland Plain, Sydney Basin Bioregion, (HN524) Grey Box - Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin Bioregion, (HN528) Grey Box - Forest Red Gum grassy woodland on shale of the southern Cumberland Plain, Sydney Basin Bioregion, (HN529)	Cumberland - Hawkesbury/Nepean and any IBRA subregion that adjoins the IBRA subregion in which the development occurs

2. Grey Box - Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin Bioregion, (HN528)

Number of ecosystem credits created	203
IBRA sub-region	Cumberland - Hawkesbury/Nepean

Offset options - Plant Community types	Offset options - IBRA sub-regions
Grey Box - Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin Bioregion, (HN528)	Cumberland - Hawkesbury/Nepean and any IBRA subregion that adjoins the IBRA subregion in which the development occurs

3. Grey Box - Forest Red Gum grassy woodland on shale of the southern Cumberland Plain, Sydney Basin Bioregion, (HN529)

Number of ecosystem credits created	1,650
IBRA sub-region	Cumberland - Hawkesbury/Nepean

Offset options - Plant Community types	Offset options - IBRA sub-regions
Grey Box - Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin Bioregion, (HN528) Grey Box - Forest Red Gum grassy woodland on shale of the southern Cumberland Plain, Sydney Basin Bioregion, (HN529)	Cumberland - Hawkesbury/Nepean and any IBRA subregion that adjoins the IBRA subregion in which the development occurs

4. Grey Box - Forest Red Gum grassy woodland on shale of the southern Cumberland Plain, Sydney Basin Bioregion, (HN529)

Number of ecosystem credits created	0
IBRA sub-region	Cumberland - Hawkesbury/Nepean

Offset options - Plant Community types	Offset options - IBRA sub-regions
Grey Box - Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin Bioregion, (HN528) Grey Box - Forest Red Gum grassy woodland on shale of the southern Cumberland Plain, Sydney Basin Bioregion, (HN529)	Cumberland - Hawkesbury/Nepean and any IBRA subregion that adjoins the IBRA subregion in which the development occurs

5. Broad-leaved Ironbark - Grey Box - Melaleuca decora grassy open forest on clay/gravel soils of the Cumberland Plain, Sydney Basin Bioregion, (HN512)

Number of ecosystem credits created	218
IBRA sub-region	Cumberland - Hawkesbury/Nepean

Offset options - Plant Community types	Offset options - IBRA sub-regions
Broad-leaved Ironbark - Grey Box - Melaleuca decora grassy open forest on clay/gravel soils of the Cumberland Plain, Sydney Basin Bioregion, (HN512) Broad-leaved Ironbark - Melaleuca decora shrubby open forest on clay soils of the Cumberland Plain, Sydney Basin Bioregion, (HN513) Turpentine - Grey Ironbark open forest on shale in the lower Blue Mountains, Sydney Basin Bioregion, (HN604) Narrow-leaved Ironbark - Broad-leaved Ironbark - Grey Gum open forest of the edges of the Cumberland Plain, Sydney Basin Bioregion, (HN556)	Cumberland - Hawkesbury/Nepean and any IBRA subregion that adjoins the IBRA subregion in which the development occurs

6. Broad-leaved Ironbark - Grey Box - Melaleuca decora grassy open forest on clay/gravel soils of the Cumberland Plain, Sydney Basin Bioregion, (HN512)

Number of ecosystem credits created	154
IBRA sub-region	Cumberland - Hawkesbury/Nepean

Offset options - Plant Community types	Offset options - IBRA sub-regions
Broad-leaved Ironbark - Grey Box - Melaleuca decora grassy open forest on clay/gravel soils of the Cumberland Plain, Sydney Basin Bioregion, (HN512) Broad-leaved Ironbark - Melaleuca decora shrubby open forest on clay soils of the Cumberland Plain, Sydney Basin Bioregion, (HN513) Turpentine - Grey Ironbark open forest on shale in the lower Blue Mountains, Sydney Basin Bioregion, (HN604) Narrow-leaved Ironbark - Broad-leaved Ironbark - Grey Gum open forest of the edges of the Cumberland Plain, Sydney Basin Bioregion, (HN556)	Cumberland - Hawkesbury/Nepean and any IBRA subregion that adjoins the IBRA subregion in which the development occurs

7. Forest Red Gum - Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney Basin Bioregion, (HN526)

Number of ecosystem credits created	107
IBRA sub-region	Cumberland - Hawkesbury/Nepean

Offset options - Plant Community types	Offset options - IBRA sub-regions
Forest Red Gum - Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney Basin Bioregion, (HN526)	Cumberland - Hawkesbury/Nepean and any IBRA subregion that adjoins the IBRA subregion in which the development occurs

8. Swamp Oak open forest on riverflats of the Cumberland Plain and Hunter valley, (HN674)

Number of ecosystem credits created	67
IBRA sub-region	Cumberland - Hawkesbury/Nepean

Offset options - Plant Community types	Offset options - IBRA sub-regions
Swamp Oak open forest on riverflats of the Cumberland Plain and Hunter valley, (HN674)	Cumberland - Hawkesbury/Nepean and any IBRA subregion that adjoins the IBRA subregion in which the development occurs

Summary of species credits required

Common name	Scientific name	Extent of impact Ha or individuals	Number of species credits created
Dillwynia tenuifolia	Dillwynia tenuifolia	244.00	4,392
Pultenaea parviflora	Pultenaea parviflora	90.00	1,350
Southern Myotis	Myotis macropus	0.92	20
Cumberland Plain Land Snail	Meridolum corneovirens	1.86	24

Biodiversity credit report

This report identifies the number and type of biodiversity credits required for a major project.

Date of report: 29/04/2019 Time: 2:07:01PM Calculator version: v4.0

Major Project details

Proposal ID:	0023/2019/4989MP
Proposal name:	M12 Motorway indirect impacts
Proposal address:	Elizabeth Drive Kemps Creek NSW
Proponent name:	Roads and Maritime Services
Proponent address:	27 Argyle Street Parramatta NSW 2150
Proponent phone:	131782
Assessor name:	Jane Rodd
Assessor address:	Level 5, 141 Walker Street NORTH SYDNEY NSW 2060
Assessor phone:	8907 8266
Assessor accreditation:	0023

Summary of ecosystem credits required

Plant Community type	Area (ha)	Credits created
Broad-leaved Ironbark - Grey Box - Melaleuca decora grassy open forest on clay/gravel soils of the Cumberland Plain, Sydney Basin Bioregion	0.52	7.00
Forest Red Gum - Grey Box shrubby woodland on shale of the southern Cumberland Plain, Sydney Basin Bioregion	0.54	5.00
Grey Box - Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin Bioregion	0.24	3.00
Grey Box - Forest Red Gum grassy woodland on shale of the southern Cumberland Plain, Sydney Basin Bioregion	11.43	139.85
Total	12.73	155

Credit profiles

1. Forest Red Gum - Grey Box shrubby woodland on shale of the southern Cumberland Plain, Sydney Basin Bioregion, (HN524)

Number of ecosystem credits created	5
IBRA sub-region	Cumberland - Hawkesbury/Nepean

Offset options - Plant Community types	Offset options - IBRA sub-regions
Forest Red Gum - Grey Box shrubby woodland on shale of the southern Cumberland Plain, Sydney Basin Bioregion, (HN524) Grey Box - Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin Bioregion, (HN528) Grey Box - Forest Red Gum grassy woodland on shale of the southern Cumberland Plain, Sydney Basin Bioregion, (HN529)	Cumberland - Hawkesbury/Nepean and any IBRA subregion that adjoins the IBRA subregion in which the development occurs

2. Grey Box - Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin Bioregion, (HN528)

Number of ecosystem credits created	3
IBRA sub-region	Cumberland - Hawkesbury/Nepean

Offset options - Plant Community types	Offset options - IBRA sub-regions
Grey Box - Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin Bioregion, (HN528)	Cumberland - Hawkesbury/Nepean and any IBRA subregion that adjoins the IBRA subregion in which the development occurs

3. Grey Box - Forest Red Gum grassy woodland on shale of the southern Cumberland Plain, Sydney Basin Bioregion, (HN529)

Number of ecosystem credits created	140
IBRA sub-region	Cumberland - Hawkesbury/Nepean

Offset options - Plant Community types	Offset options - IBRA sub-regions
Grey Box - Forest Red Gum grassy woodland on shale of the southern Cumberland Plain, Sydney Basin Bioregion, (HN529) Grey Box - Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin Bioregion, (HN528)	Cumberland - Hawkesbury/Nepean and any IBRA subregion that adjoins the IBRA subregion in which the development occurs

4. Broad-leaved Ironbark - Grey Box - Melaleuca decora grassy open forest on clay/gravel soils of the Cumberland Plain, Sydney Basin Bioregion, (HN512)

Number of ecosystem credits created	7
IBRA sub-region	Cumberland - Hawkesbury/Nepean

Offset options - Plant Community types	Offset options - IBRA sub-regions
Broad-leaved Ironbark - Grey Box - Melaleuca decora grassy open forest on clay/gravel soils of the Cumberland Plain, Sydney Basin Bioregion, (HN512) Broad-leaved Ironbark - Melaleuca decora shrubby open forest on clay soils of the Cumberland Plain, Sydney Basin Bioregion, (HN513) Turpentine - Grey Ironbark open forest on shale in the lower Blue Mountains, Sydney Basin Bioregion, (HN604) Narrow-leaved Ironbark - Broad-leaved Ironbark - Grey Gum open forest of the edges of the Cumberland Plain, Sydney Basin Bioregion, (HN556)	Cumberland - Hawkesbury/Nepean and any IBRA subregion that adjoins the IBRA subregion in which the development occurs

Annexure D – Biodiversity offset strategy (BOS)

Australian Government

BUILDING OUR FUTURE

NSW GOVERNMENT

M12 Motorway Environmental Impact Statement

Biodiversity offset strategy

Roads and Maritime Services | October 2019

Executive summary

Roads and Maritime Services (Roads and Maritime) is seeking approval under Part 5, Division 5.2 of the *Environmental Planning and Assessment Act 1979* (EP&A Act) to construct and operate the M12 Motorway project to provide direct access between the Western Sydney Airport at Badgerys Creek and Sydney's motorway network (the project). The project has been determined to be a controlled action under Section 75 of the *Environment Protection and Biodiversity Conservation Act 1999* (Commonwealth) (EPBC Act) (EPBC 2018/8286) for significant impact to threatened species and communities (Section 18 and Section 18A of the EPBC Act). As such, the project requires assessment and approval from the Commonwealth Government.

The M12 Motorway would run between the M7 Motorway at Cecil Hills and The Northern Road at Luddenham for a distance of about 16 kilometres and would be opened to traffic prior to opening of the Western Sydney Airport.

The Department of Planning, Industry and Environment (DPIE) (Planning and Assessment) has determined that the project is saved under the Biodiversity Conservation (Savings and Transitional) Regulation 2017 (and therefore assessed under the now repealed *Threatened Species Conservation Act 1995* (TSC Act)). The project is also subject to the Commonwealth and NSW Bilateral Agreement under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act), allowing Matters of National Environmental Significance (MNES) to be assessed and offset under appropriate NSW (State) legislation.

A Biodiversity Assessment Report (BAR) has been prepared for the project in accordance with the *Framework of Biodiversity Assessment 2014* (FBA); the key biodiversity assessment document under the Biodiversity Offsets Policy for Major Projects. This Biodiversity Offset Strategy (BOS) builds on the information in the Biodiversity Assessment Report by detailing the residual biodiversity impacts of the project that must be offset, with offset requirements quantified as biodiversity credits. Primarily, this report has been developed to provide the framework for an offsets package for the project.

Ecosystem credits have been calculated for six Plant Community Types (PCTs), all of which correspond with Threatened Ecological Communities (TECs) under the *Threatened Species Conservation Act 1995* and/or *Environment Protection and Biodiversity Conservation Act 1999*. A total of 2,568 ecosystem credits have been identified as being required to offset the direct and indirect impacts of the project. **Table B**, overleaf, lists the number of biodiversity credits calculated for each Plant Community Type and identifies the area of each that meets condition criteria for the *Environment Protection and Biodiversity Conservation Act 1999* listed Threatened Ecological Community, and the related portion of ecosystem credits.
Species credits have been calculated for two threatened flora species and two threatened fauna species listed under the *Threatened Species Conservation Act 1995* and/or *Environment Protection and Biodiversity Conservation Act 1999* (summarised below in **Table A**).

Table A Species impacts and credit requirements

Species credits	Status (TSC Act)	Status (EPBC Act)	Impact (number of individuals/ area)	Species credits required
Dillwynia tenuifolia	Vulnerable	Not listed	244 individuals	4,392
Pultenaea parviflora (Sydney Bush Pea)	Endangered	Vulnerable	90 individuals	1,350
Myotis macropus (Southern Myotis)	Vulnerable	Not listed	0.92 ha	20
Meridolum corneovirens (Cumberland Plain Land Snail)	Endangered	Not listed	1.86 ha	24
Total species credits				**5,786**

Table B Areas of Plant Community Types (PCTs) in the construction footprint meeting *Threatened Species Conservation Act 1995* (TSC Act) and/or *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) criteria and credits required to offset impacts

PCT No.	PCT Name	Equivalent TECs	Total area of impacts		Total credits required	Area meeting EPBC TEC criteria (ha)		Credits required to offset EPBC TEC impacts
			Direct impacts	Indirect impacts		Direct impacts	Indirect impacts	
724	Broad-leaved Ironbark - Grey Box - Melaleuca decora grassy open forest on clay/gravel soils of the Cumberland Plain, Sydney Basin Bioregion	Shale Gravel Transition Forest in the Sydney Basin Bioregion (Endangered, TSC Act) Cumberland Plain Shale Woodlands and Shale-Gravel Transition Forest (Critically Endangered, EPBC Act)	6.91	0.52	379	4.86	0.52	283
830	Forest Red Gum - Grey Box shrubby woodland on shale of the southern Cumberland Plain, Sydney Basin Bioregion	Moist Shale Woodland in the Sydney Basin Bioregion (Endangered, TSC Act; Critically Endangered, EPBC Act)	0.44	0.54	20	0.44	0.54	20
835	Forest Red Gum - Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney Basin Bioregion	River-Flat Eucalypt Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions (Endangered, TSC Act)	3.23	0	107	N/A	N/A	N/A
849	Grey Box - Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin Bioregion	Cumberland Plain Woodland in the Sydney Basin Bioregion (Critically Endangered, TSC Act) Cumberland Plain Shale Woodlands and Shale-Gravel Transition Forest (Critically Endangered, EPBC Act)	6.09	0.24	206	1.61	0.24	68

PCT No.	PCT Name	Equivalent TECs	Total area of impacts		Total credits required	Area meeting EPBC TEC criteria (ha)		Credits required to offset EPBC TEC impacts
			Direct impacts	Indirect impacts		Direct impacts	Indirect impacts	
850	Grey Box - Forest Red Gum grassy woodland on shale of the southern Cumberland Plain, Sydney Basin Bioregion	Cumberland Plain Woodland in the Sydney Basin Bioregion (Critically Endangered, TSC Act) Cumberland Plain Shale Woodlands and Shale-Gravel Transition Forest (Critically Endangered, EPBC Act)	54.07 (includes 18.07 ha in Low condition)	11.43	1,789	32.01	11.33	1,607
1800	Swamp Oak open forest on riverflats of the Cumberland Plain and Hunter valley	Swamp oak floodplain forest of the NSW North Coast, Sydney Basin and South East Corner bioregions (Endangered, TSC Act and EPBC Act)	2.53	0	67	0	0	0
Total			**73.27**	**12.73**	**2,568**	**38.92**	**12.63**	**1,978**

Offsets for Matters of National Environmental Significance are covered under the NSW and Commonwealth *Bilateral Assessment Agreement (2015)* and are therefore subject to the *Framework of Biodiversity Assessment 2014*. The project would result in residual significant impacts to two Matters of National Environmental Significance: the Threatened Ecological Community Cumberland Plain Shale Woodlands and Shale-Gravel Transition Forest, listed as critically endangered, and the threatened flora species *Pultenaea parviflora* (Sydney Bush Pea), listed as vulnerable. To offset these impacts, 1,958 and 1,350 credits are required respectively.

The Grey-headed Flying-fox (*Pteropus poliocephalus*), listed as vulnerable under both the *Threatened Species Conservation Act 1995* and *Environment Protection and Biodiversity Conservation Act 1999*, was the only fauna species listed under the *Environment Protection and Biodiversity Conservation Act 1999* to be recorded or assumed present within the study area. This species is listed as a dual-credit species under the *Framework of Biodiversity Assessment 2014*. Grey-headed Flying-fox breeding habitat is not present within the construction footprint and therefore no species credits are required to offset impacts to this species. About 55.20 hectares of Grey-headed Flying-fox foraging habitat would be removed; however, all foraging habitat would be offset by provision of ecosystem credits required for removal of vegetation.

The project intersects the north-eastern corner of the South West Growth Centre as defined under the State Environmental Planning Policy (Sydney Region Growth Centres 2006) (Growth Centres SEPP). These areas are subject to the conditions of Biodiversity Certification under this policy, and in accordance with the *Environment Protection and Biodiversity Conservation Act 1999* Strategic Assessment of the Sydney Growth Centres Program. Given that no areas of existing native vegetation as defined under the Biodiversity Certification Order are mapped within the non-certified area in the construction footprint, this area is therefore not subject to the specific offsetting requirements listed in the Biodiversity Certification Order. The impacts of the project on native vegetation identified within non-certified areas within the south-west growth centre will, however, be offset under the *Framework of Biodiversity Assessment 2014*.

The construction footprint overlaps the eastern boundary of the M7 biobank site (ID number 119), located within the Western Sydney Parklands. The project would require the removal of about 1.85 hectares of native vegetation mapped within this biobank site. All areas to be impacted within the biobank site are Plant Community Type 850 Grey Box - Forest Red Gum grassy woodland on shale of the southern Cumberland Plain, Sydney Basin Bioregion, meeting both *Threatened Species Conservation Act 1995* and *Environment Protection and Biodiversity Conservation Act 1999* condition criteria for Cumberland Plain Woodland Threatened Ecological Community. The 82 credits required for impacts to native vegetation within the biobank site is included within the total number of credits required for the project.

The impacts to the biobank site have been assessed in accordance with the *Framework for Biodiversity Assessment 2014* and offsets will be sought to compensate for the impacts to identified biodiversity values. Determining appropriate compensation for the loss of part of the biobank site is outside the *Framework for Biodiversity Assessment 2014* and therefore separate to this Biodiversity Offset Strategy and will be subject to negotiation between Roads and Maritime and the Western Sydney Parklands Trust.

The aquatic assessment within the Biodiversity Assessment Report was used to determine that impacts to threatened species listed under the *Fisheries Management Act 1994* (FM Act) were unlikely, and therefore do not require offsets. Riparian vegetation would be offset via relevant ecosystem credits (PCT 835 Forest Red Gum – Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney Basin Bioregion and PCT 1800 Swamp Oak open forest on riverflats of the Cumberland Plain and Hunter valley).

The offsets for aquatic habitat are limited to the area of key fish habitat impacted and are considered separately from impacts offset under the *Framework of Biodiversity Assessment 2014.* The Regions, Industry, Agriculture and Resources Group (RIAR) of the DPIE (DPI, 2013) Policy and guidelines for fish habitat conservation and management specify that significant environmental impacts (direct and indirect) are to be offset by compensatory works to ensure no net loss. The DPIE (2013) calculates habitat compensation on a minimum 2:1 basis for all key fish habitat lost; a greater compensation ratio may be considered if offsets cannot be sourced in the vicinity of the impact or are not of the same habitat type as that impacted.

The project crosses four waterways (Badgerys Creek, Cosgroves Creek, Kemps Creek and South Creek) that are considered to meet the definition of key fish habitat. Bridges are proposed at all four creeks. A fifth bridge is proposed at Ropes Creek, in the north-eastern extent of the study area, which does not meet the definition of key fish habitat. Badgerys Creek, South Creek and Kemps Creek would be permanently adjusted over distances of 64 metres, 200 metres and 84 metres respectively. The adjustments would replace around 6,366 square metres of key fish habitat in the channels with about 7,452 square metres of newly created channels, partially compensating for the loss. Based on a 2:1 offset ratio, about 5,281 square metres of key fish habitat is still required to be offset following creek adjustments, which would cost approximately $290,455 assuming an offset cost of $55 per square metre. This will be finalised following further detailed design of the adjusted channel. The cost per square metre would be confirmed with NSW Department of Planning, Industry and Environment, and the required amount would be paid into the Department of Planning, Industry and Environment Fish Conservation Trust Fund.

Roads and Maritime have purchased 2,112 suitable ecosystem credits to be retired as offsets for the project, representing over three quarters of the ecosystem credits expected to be required. Searches of the public biodiversity credits register revealed more than 2,000 credits potentially suitable for two species impacted by the project: Cumberland Plain Land Snail and Southern Myotis. These credits require further investigation to confirm availability and proceed with purchase. This is currently being undertaken by the Roads and Maritime project team.

Roads and Maritime are currently investigating other avenues for securing the outstanding offset requirements, including:

- Advertising in newspapers circulating in the Cumberland - Hawkesbury/Nepean IBRA subregion for expressions of interest from landholders interested in establishing a biodiversity stewardship site that will protect these offsets in perpetuity
- Listing the required credit types on the Environment, Energy and Science Group (EESG) of DPIE (former NSW Office of Environment and Heritage) ‘Credits Wanted’ register
- Contacting landholders with potential suitable credits listed on the biobank EOI register
- Engaging with existing biodiversity credit holders who may have suitable habitat for *Dillwynia tenuifolia* and *Pultenaea parviflora* to discuss undertaking additional species credit surveys
- Undertaking desktop assessment of potential offset sites and, where feasible, conduct surveys of potential offset sites for species credits. Progress stewardship site agreements on suitable sites.

If credits cannot be sourced for species not listed under the *Environment Protection and Biodiversity Conservation Act 1999*, such as *Dillwynia tenuifolia* and Cumberland Plain Land Snail, it may be possible to satisfy the offset obligation for these species through a payment into the Biodiversity Conservation Fund, managed by the Biodiversity Conservation Trust.

Contents

Glossary of terms and abbreviations for this report

Abbreviations

BAR	Biodiversity assessment report
BBCC	BioBanking credit calculator
BC Act	Biodiversity Conservation Act 2016 (NSW)
BVT	Biometric vegetation type
CAMBA	China-Australia Migratory Bird Agreement
CEMP	Construction environmental management plan
DECCW	Department of Environment, Climate Change and Water NSW
DoE	Department of the Environment
DoEE	Department of the Environment and Energy
DPE	Department of Planning and Environment
DPI	Department of Primary Industries
DPIE	Department of Planning, Industry and Environment
EEC	Endangered ecological community
EESG	Environment, Energy and Science Group of the DPIE (former NSW Office of Environment and Heritage)
EIS	Environmental impact statement
EP&A Act	Environmental Planning and Assessment Act 1979 (NSW)
EPBC Act	Environmental Protection and Biodiversity Conservation Act 1999 (Commonwealth)
FBA	Framework for Biodiversity Assessment
FM Act	Fisheries Management Act 1994 (NSW)
GDE	Groundwater dependent ecosystems
IBRA	Interim Biogeographically Regionalisation of Australia
JAMBA	Japan-Australia Migratory Bird Agreement
LEP	Local environmental plan
LGA	Local government area
MNES	Matters of national environmental significance
NPW Act	National Parks and Wildlife Act 1974 (NSW)
NSW	New South Wales
OEH	Office of Environment and Heritage
PCT	Plant community type
RIAR	Regions, Industry, Agriculture and Resources Group of the Department of Planning, Industry and Environment
ROKAMBA	Republic of Korea-Australia Migratory Bird Agreement
SEARs	Secretary's environmental assessment requirements
SEPP	State environmental planning policy
SSI	State significant infrastructure
TECs	Threatened ecological community
TSPD	Threatened species profile database
TSC Act	Threatened Species Conservation Act 1995 (NSW)
VIS	Vegetation information system

Definitions

Assessment circles	Two circles (the inner and outer assessment circle) in which the per cent of native vegetation cover in the landscape is assessed, taking into account both cover and condition of vegetation (OEH, 2014b).
Bilateral agreement	The bilateral agreement made under Section 45 of the Environment Protection and Biodiversity Conservation Act 1999 (Commonwealth) relating to environmental assessment.
Biodiversity credit report	The report produced by the Credit Calculator that sets out the number and type of biodiversity credits required to offset the remaining adverse impacts on biodiversity values at a development site or sets out the number and type of biodiversity credits that are created at an offset site (OEH, 2014b).
Construction footprint	The construction footprint is the area required to build the project. This includes the area required for temporary work such as sedimentation basins, drainage channels, access roads and construction ancillary facilities.
Credit Calculator	Spreadsheet developed as part of Biobanking scheme to calculate offset requirements for impact assessment.
Cumulative impact	The impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions. Cumulative impacts can result from individually minor but collectively significant

	actions taking place over a period of time. Refer to the project SEARs for cumulative impact assessment requirements.
Direct impact	Where a primary action is a substantial cause of a secondary event or circumstance which has an impact on a protected matter (CoA, 2012).
Ecosystem credit	Ecosystem or species credits (OEH, 2014b).
Ecosystem credit species	A measurement of the value of EECs, CEECs and threatened species habitat for species that can be reliably predicted to occur with a PCT. Ecosystem credits measure the loss in biodiversity values at a development site and the gain in biodiversity values at an offset site (OEH, 2014b).
Habitat	An area or areas occupied, or periodically or occasionally occupied, by a species, population or ecological community, including any biotic or abiotic component (OEH, 2014).
Indirect impact	Where an event or circumstance is a direct consequence of the action (CoA, 2012).
Matters for further consideration	Impacts that are considered to be complicated or severe that would require further consideration by the consent authority (OEH, 2014b). The assessment is based on thresholds detailed in Section 9 of the FBA. These can also be included as part of the project SEARs.
MNES	A matter of national environmental significance protected by a provision of Part 3 of the EPBC Act.
Mitchell landscape	Landscapes with relatively homogeneous geomorphology, soils and broad vegetation types, mapped at a scale of 1: 250,000 (OEH, 2014b).
Mitigation	Action to reduce the severity of an impact (OEH, 2014b).
Mitigation measure	Any measure that facilitates the safe movement of wildlife and/or prevents wildlife mortality.
M12 Motorway	The proposed M12 Motorway which is the subject of this document (also known as 'the project').
M7 Motorway	A major connecting road on Sydney's orbital motorway network. It runs for 40 kilometres and links the M5 Motorway with the M4 Motorway, and the M2 Motorway.
Operational footprint	Generally includes the M12 Motorway and additional areas required for operation and maintenance of the project.
Population	All the individuals that interbreed within a given area.
Project area/ Project site	The area of land that is directly impacted on by a proposed Major Project that is under the EP&A Act, including access roads, and areas used to store construction materials (OEH, 2014b).
Species credit species	Threatened species and populations that are assessed according to Section 6.4 of the FBA (OEH, 2014b).
Study area	The study area for biodiversity investigations is about 300 metres wide and 16 kilometres long and is shown on Figure 2-2 in BAR.
Target species	A species that is the focus of a study or intended beneficiary of a conservation action or connectivity measure.
The project	M12 Motorway.
Western Sydney Aerotropolis	As defined in the Western Sydney Aerotropolis Stage 1 Plan, the Aerotropolis surrounds the Western Sydney Airport site at Badgerys Creek and will comprise industrial, commercial and residential development.
Western Sydney Airport	The future Western Sydney International Airport at Badgerys Creek.
Western Sydney Parklands Biobank Site	Biobanking Agreement Site ID 199.

1 Introduction

1.1 Project background

Roads and Maritime Services (Roads and Maritime) is seeking approval under Part 5, Division 5.2 of the *Environmental Planning and Assessment Act 1979* (EP&A Act) to construct and operate the M12 Motorway project to provide direct access between the Western Sydney Airport at Badgerys Creek and Sydney's motorway network (the project). In addition, the project has been determined to be a controlled action under Section 75 of the *Environment Protection and Biodiversity Conservation Act 1999* (Commonwealth) (EPBC Act) (EPBC 2018/8286) for significant impact to threatened species and communities (Section 18 and Section 18A of the EPBC Act). As such, the project requires assessment and approval from the Commonwealth Government.

The M12 Motorway would run between the M7 Motorway at Cecil Hills and The Northern Road at Luddenham for a distance of about 16 kilometres and would be opened to traffic prior to opening of the Western Sydney Airport. The project would commence about 30 kilometres west of the Sydney central business district, at its connection with the M7 Motorway. The project traverses the local government areas of Fairfield, Liverpool and Penrith. The suburbs of Cecil Park and Cecil Hills are found to the east of the M12 Motorway, with Luddenham to the west.

The project is predominately located in greenfield areas. The topography in and around the project comprises rolling hills and small valleys between generally north–south ridge lines. The existing land uses are semi-rural residential, recreational, agricultural, commercial and industrial. The main residential areas are Kemps Creek, Mount Vernon and Cecil Hills.

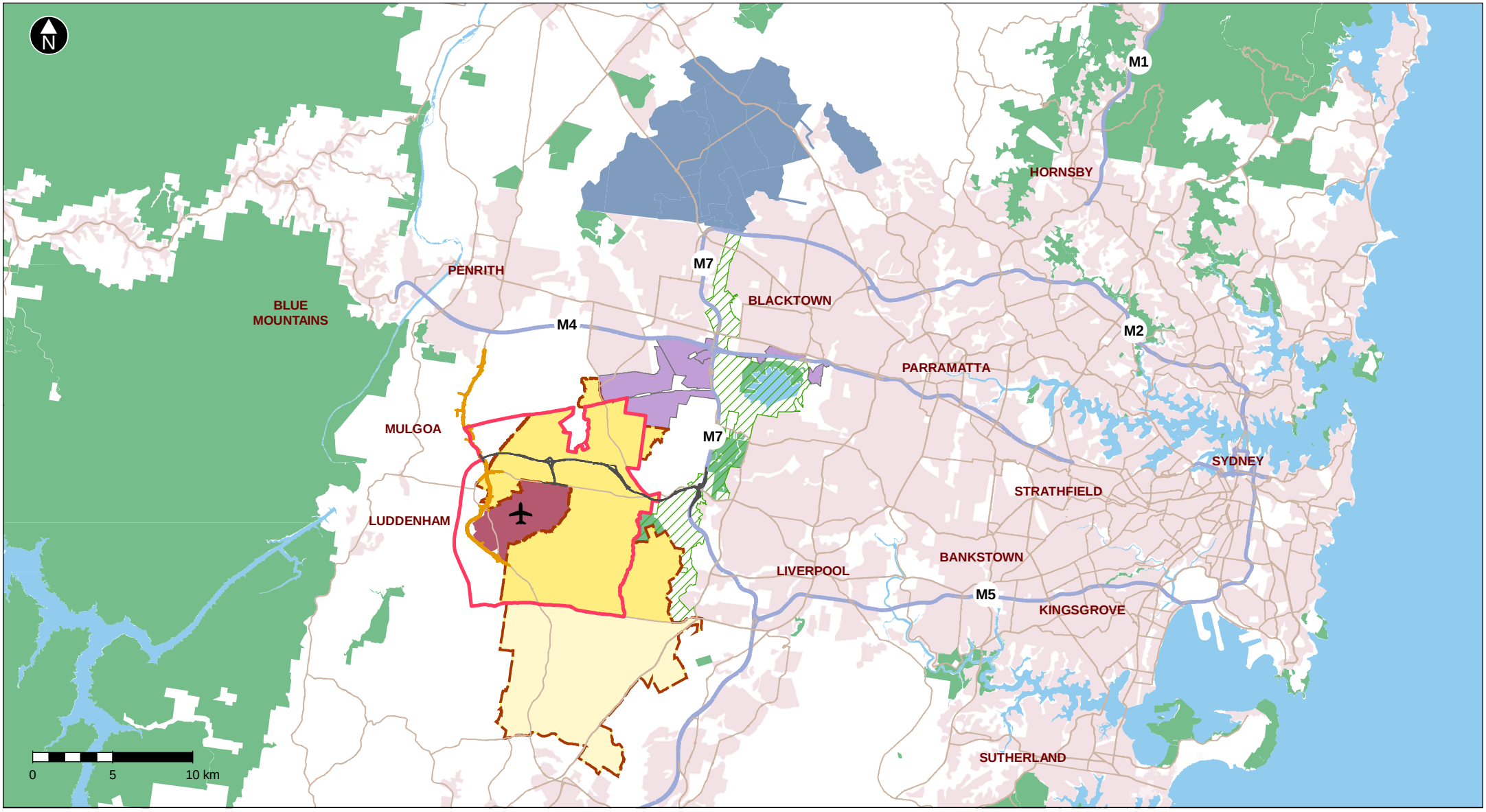
The project is required to support the opening of the Western Sydney Airport by connecting Sydney's motorway network to the airport. The project would also serve and facilitate the growth and development of the Western Sydney which is expected to undergo significant development and land use change over the coming decades. The motorway would provide increased road capacity and reduce congestion and travel times in the future and would also improve the movement of freight in and through western Sydney.

The project location is shown in **Figure 1-1** in relation to its regional context.

1.2 Project overview

The project would include the following key features:

- A new dual-carriageway motorway between the M7 Motorway and The Northern Road with two lanes in each direction with a central median allowing future expansion to six lanes
- Motorway access via three interchanges/intersections:
  - A motorway-to-motorway interchange at the M7 Motorway and associated works (extending about four kilometres within the existing M7 Motorway corridor)
  - A grade–separated interchange referred to as the Western Sydney Airport interchange, including a dual-carriageway four–lane airport access road (two lanes in each direction for about 1.5 kilometres) connecting with the Western Sydney Airport Main Access Road
  - A signalised intersection at The Northern Road with provision for grade separation in the future
- Bridge structures across Ropes Creek, Kemps Creek, South Creek, Badgerys Creek and Cosgroves Creek
- Bridge structure across the M12 Motorway into Western Sydney Parklands to maintain access to the existing water tower and mobile telephone/other service towers on the ridgeline in the vicinity of Cecil Hills, to the west of the M7 Motorway
- Bridge structures at interchanges and at Clifton Avenue, Elizabeth Drive, Luddenham Road and other local roads to maintain local access and connectivity



The project
Motorways
Existing main roads
The Northern Road upgrade (currently under construction)

Western Sydney Parklands
NPWS estate / reserve
Urban areas
Main waterbodies

Growth areas

Western Sydney Priority Growth Area
South West Priority Growth Area
South West Growth Area
Western Sydney Airport
Western Sydney Aerotropolis
Western Sydney Employment Area
North West Growth Area

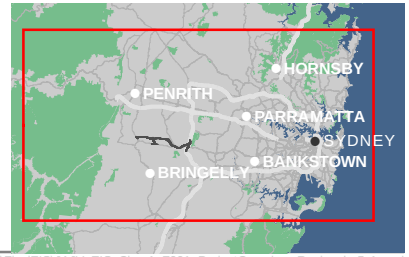


Figure 1-1 Project location (regional context)

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- Inclusion of active transport (pedestrian and cyclist) facilities through provision of pedestrian bridges and an off-road shared user path including connections to existing and future shared user path networks
- Modifications to the local road network, as required, to facilitate connections across and around the M12 Motorway including:
  - Realignment of Elizabeth Drive at the Western Sydney Airport, with Elizabeth Drive bridging over the airport access road and future passenger rail line to the airport
  - A realignment of Clifton Avenue over the M12 Motorway, with associated adjustments to nearby property access
  - Relocation of Salisbury Avenue cul-de-sac, on the southern side of the M12 Motorway
  - Realignment of Wallgrove Road north of its intersection with Elizabeth Drive to accommodate the M7 Motorway northbound entry ramp
- Adjustment, protection or relocation of existing utilities
- Ancillary facilities to support motorway operations, smart motorways operation in the future and the existing M7 Motorway operation, including gantries, electronic signage and ramp metering
- Other roadside furniture including safety barriers, signage and street lighting
- Adjustments of waterways, where required, including Kemps Creek, South Creek and Badgerys Creek
- Permanent water quality management measures including swales and basins
- Establishment and use of temporary ancillary facilities, temporary construction sedimentation basins, access tracks and haul roads during construction
- Permanent and temporary property adjustments and property access refinements as required.

The project overview presented in this document represents the design outlined in the M12 Motorway EIS. If the project is approved, a further detailed design process would follow, which may include variations to the design. Flexibility has been provided in the design to allow for refinement of the project during detailed design, in response to any submissions received following the exhibition of the environmental impact statement (EIS), or if opportunities arise to further minimise potential environmental impacts.

The key features of the project are shown on **Figure 1-2**.

1.3 Purpose and scope of this report

This report has been prepared to support the EIS for the project. The EIS has been prepared to address the Secretary's Environmental Assessment Requirements (SEARs) for the project (SSI 9364) and to enable the Minister for Planning and Public Spaces to make a determination on whether the project can proceed. The Biodiversity Assessment Report (BAR) presents an assessment of the construction and operational activities for the project that have the potential to impact biodiversity. This report (Biodiversity Offset Strategy; BOS) subsequently identifies the offset requirements for the project.

Policy and planning including NSW and Commonwealth legislative requirements are discussed in detail in the sub-sections below.

1.3.1 Policy and planning setting

On 26 February 2015, the NSW and Commonwealth Governments entered into a Bilateral Agreement for environmental assessment under Section 45 of the EPBC Act. This agreement establishes a "One-stop Shop" for environmental approvals, removing duplication of assessment and approval processes while maintaining appropriate environmental standards. This project is subject to this agreement. Further information can be found in Section 1.8 of the BAR (Appendix E of the EIS).

On 25 August 2017, the *Biodiversity Conservation Act 2016* (BC Act) (NSW) came into effect, repealing the former *Threatened Species Conservation Act 1995* (TSC Act) (NSW). The Biodiversity Conservation (Savings and Transitional) Regulation 2017 (BC (Savings and Transitional) Reg) provides the criteria under which a project would be saved, meaning the former planning provisions would continue to apply.

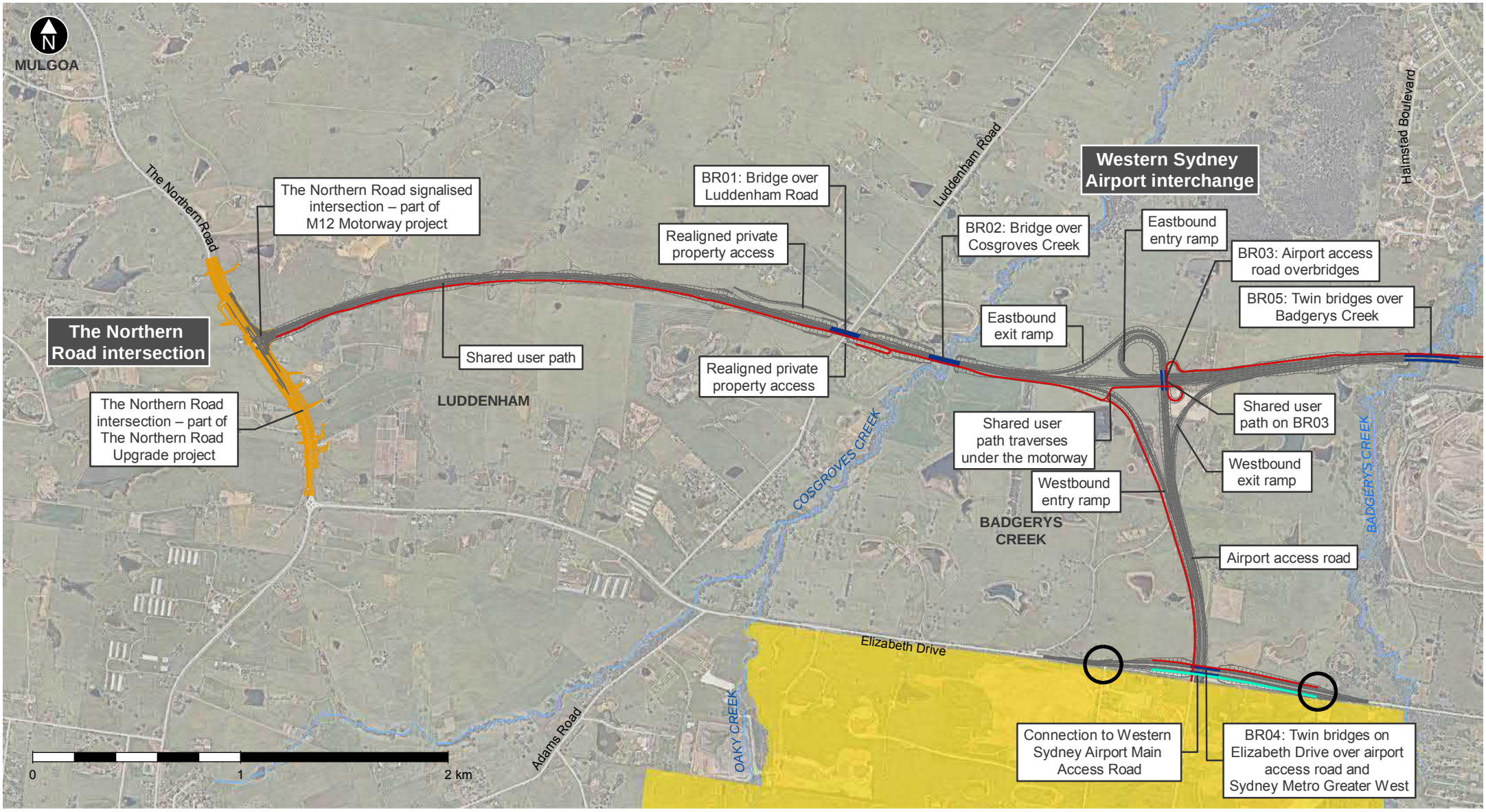

Figure 1-2 Key features of the project

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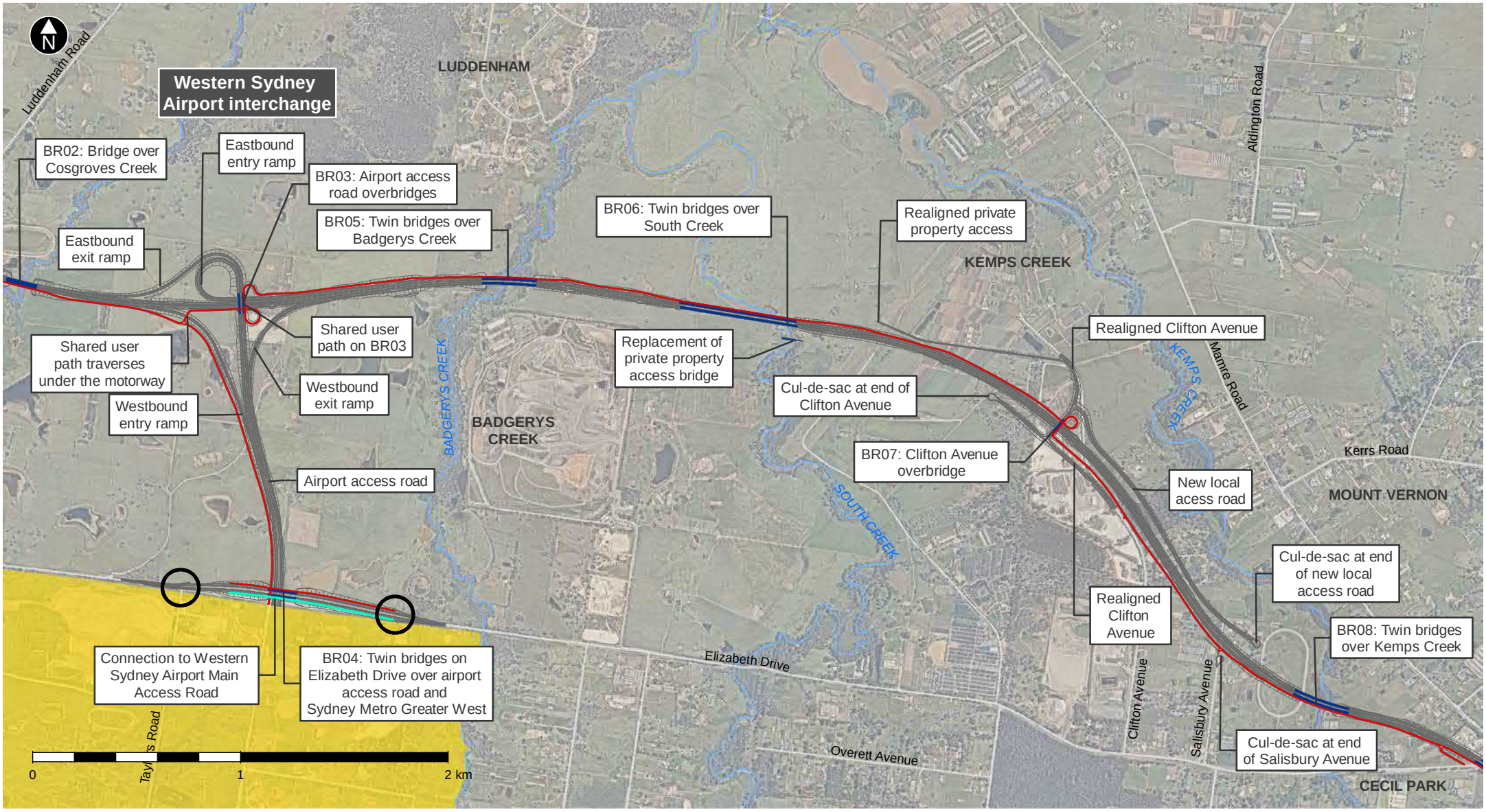


The project

Part of The Northern Road upgrade project

Shared user path

Future shared user path (by others)

Existing roads

Waterways

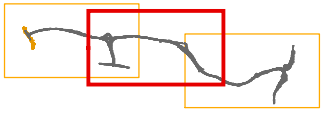
Bridges

Western Sydney Airport

Note. The roads within this zone are being removed as part of airport construction.

Potential future intersections (by others)

Note: Locations to be confirmed



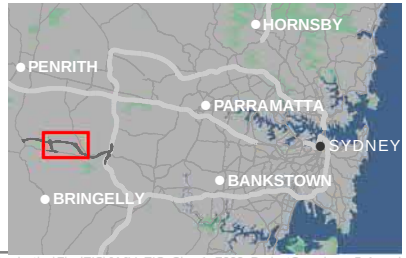


Figure 1-2 Key features of the project

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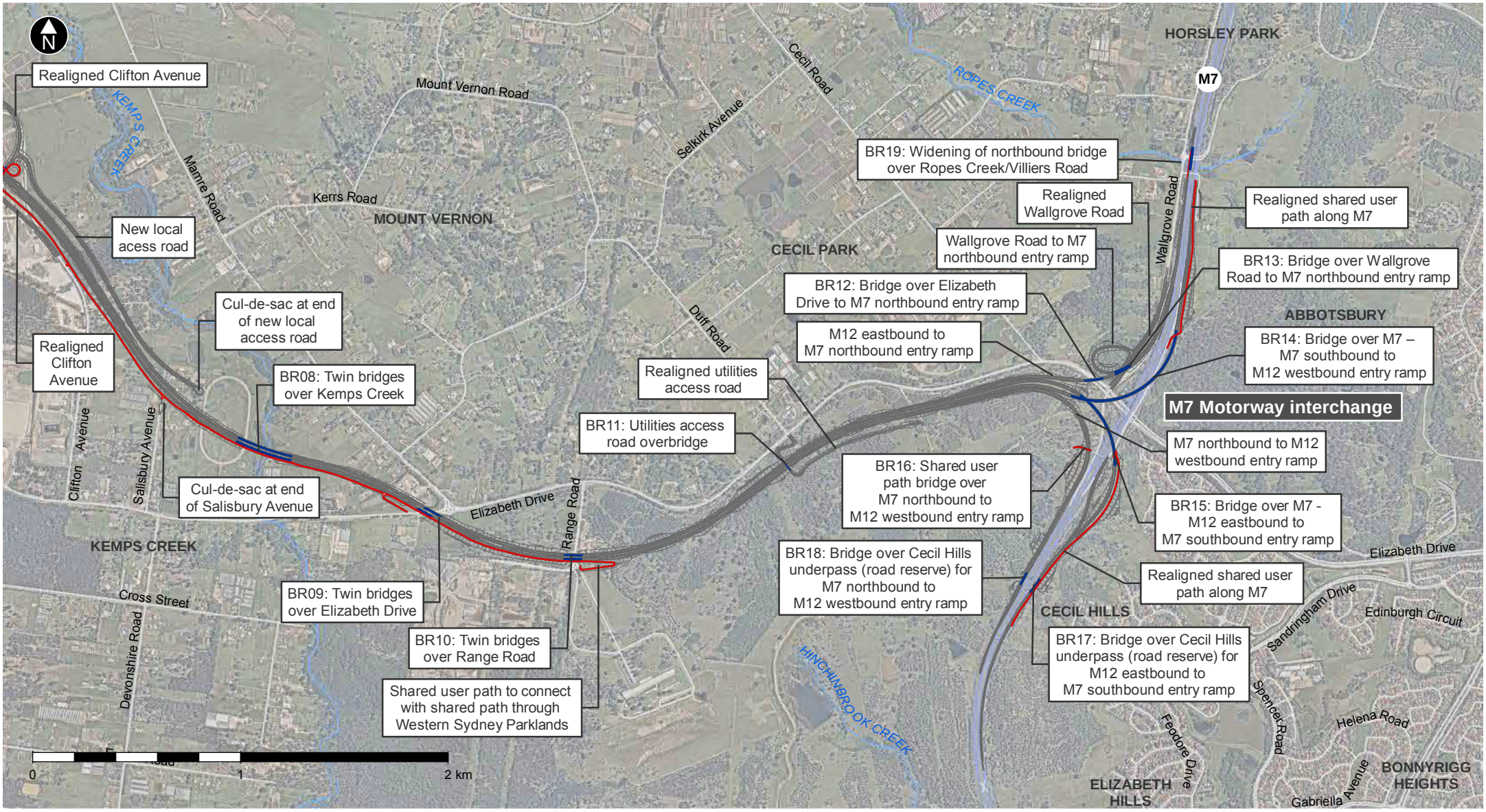
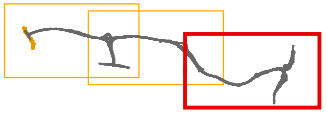


The project
Part of The Northern Road upgrade project
Shared user path
Future shared user path (by others)
Existing roads
Waterways
Bridges



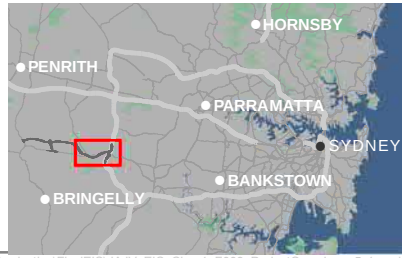


Figure 1-2 Key features of the project

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An application was made to the Secretary of the Department of Planning, Industry and Environment (Planning and Assessment) (DPIE (Planning and Assessment)) to consider whether substantial environmental assessment had been undertaken by Roads and Maritime. This application was granted on 5 April 2018. Accordingly, the project can be assessed under the TSC Act and in accordance with the NSW Biodiversity Offsets Policy for Major Projects (2014) which is underpinned by the *Framework for Biodiversity Assessment 2014* (FBA).

The Secretary of DPIE (Planning and Assessment) has issued SEARs to Roads and Maritime for the assessment of the project (12 July 2018). The SEARs were then revised on 30 October 2018 to reflect the decision by the Commonwealth Department of Environment and Energy (DoEE) that the project is a controlled action under the EPBC Act and would be assessed under the Bilateral Agreement between Commonwealth and NSW Governments. DoEE added Guidelines for preparing Assessment Documentation relevant to the project (EPBC 2018/8286 (SSI 9634)) to the SEARs. These guidelines and SEARs relevant to the BOS are listed in **Table 1-1** below.

The NSW Biodiversity Offsets Policy for Major Projects clarifies and standardises biodiversity impact assessment and offsetting for major project approvals in NSW subject to assessment under the FBA. This BOS has been prepared in accordance with the requirements of this policy. The assessment Bilateral Agreement between the NSW and Commonwealth governments endorses the NSW Biodiversity Offsets Policy for Major Projects and the FBA as the basis for offsetting of the biodiversity impacts on both state and nationally listed threatened species for major projects. Further detail on the policy and planning instruments relevant to the assessment of biodiversity can be found in Section 1.4 of the BAR.

Table 1-1 SEARs and Commonwealth assessment requirements for the project

Secretary's requirement	Where addressed in this report
SEARs	
3. Assessment of Key Issues	
2. For each key issue the Proponent must: (g) detail how any residual impacts will be managed or offset, and the approach and effectiveness of these measures.	Throughout BOS report
16. Protected and sensitive lands	
The Proponent must assess the impacts of the project on environmentally sensitive land and processes (and the impact of processes on the project) including, but not limited to: d) biobank sites, private conservation lands and other lands identified as offsets.	**Section 1.3.2.4**
Attachment A: Guidelines for preparing Assessment Documentation relevant to the EPBC Act (Commonwealth)	
Avoidance, mitigation and offsetting	
9. For each of the relevant matters protected that are likely to be significantly impacted by the development, the EIS must provide information on proposed avoidance and mitigation measures to deal with the relevant impacts of the action, including: • a description of the offsets proposed to address the residual adverse significant impacts and how these offsets will be established.	**Chapter 2**
10. Where a significant residual adverse impact to a threatened species or community is considered likely, the EIS must provide information on the proposed offset strategy, including discussion of the conservation benefit associated with the proposed offset strategy. Paragraphs 13 & 14 provide further requirements in relation to offsets.	**Chapter 2**

Secretary's requirement	Where addressed in this report
Key issues – biodiversity	
13. For each of the relevant EPBC Act listed threatened species and communities likely to be significantly impacted by the development the EIS must provide a separate: • details of how the current published NSW Framework for Biodiversity Assessment (FBA) has been applied in accordance with the objects of the EPBC Act to offset significant residual adverse impacts;	**Throughout BOS report**
• details of the offset package to compensate for significant residual impacts including details of the credit profiles required to offset the development in accordance with the FBA and/or mapping and descriptions of the extent and condition of the relevant habitat and/or threatened communities occurring on proposed offset sites.	**Chapter 2**
Note: For the purposes of approval under the EPBC Act, it is a requirement that offsets directly contribute to the ongoing viability of the specific protected matter impacted by a proposed action i.e. 'like for like'. In applying the FBA, residual impacts on EPBC Act listed threatened ecological communities must be offset with Plant Community Type(s) (PCT) that are ascribed to the specific EPBC listed ecological community. PCTs from a different vegetation class will not generally be acceptable as offsets for EPBC listed communities.	**Chapter 2**
14. Any significant residual impacts not addressed by the FBA may need to be addressed in accordance with the Environment Protection and *Biodiversity Conservation Act 1999* Environmental Offset Policy. *[Note if the EPBC Act Environmental Offset Policy is used to calculate proposed offsets for a threatened species or community you may wish to seek further advice from the DPIE (Planning and Assessment).]*	**Chapter 2**

1.3.2 Offset requirements

1.3.2.1 Biodiversity credits

The offset requirements for the project were calculated using the Biobanking Credit Calculator in accordance with the FBA (OEH, 2014). The biodiversity credit requirements to offset the direct and indirect impacts of the project are listed in **Table 1-2** and **Table 1-3**. As stated in the credit report, offsets for ecosystem credits must be located within the Cumberland – Hawkesbury/Nepean IBRA subregion, or any adjoining IBRA subregion. Offsets for species credits may be located anywhere in NSW. Commonwealth (EPBC) offset requirements are summarised below in **Section 2.7.**

Table 1-2 Ecosystem credits required

PCT	Equivalent TEC/status	Like-for-like offsets (PCT/BVT)	Area of impact requiring offsets (ha)		Credits required		
			Direct impacts	Indirect impacts	Direct impacts	Indirect impacts	Total credits
PCT 724: Broad-leaved Ironbark - Grey Box - Melaleuca decora grassy open forest on clay/gravel soils of the Cumberland Plain, Sydney Basin Bioregion	Shale Gravel Transition Forest in the Sydney Basin Bioregion (Endangered, TSC Act) Cumberland Plain Shale Woodlands and Shale-Gravel Transition Forest (Critically Endangered, EPBC Act)	PCT 724 (HN512)* PCT 725 (HN513) PCT 1281 (HN604) PCT 1395 (HN556)	6.91	0.52	372	7	379

PCT	Equivalent TEC/status	Like-for-like offsets (PCT/BVT)	Area of impact requiring offsets (ha)		Credits required		
			Direct impacts	Indirect impacts	Direct impacts	Indirect impacts	Total credits
PCT 830: Forest Red Gum - Grey Box shrubby woodland on shale of the southern Cumberland Plain, Sydney Basin Bioregion	Moist Shale Woodland in the Sydney Basin Bioregion (Endangered, TSC Act; Critically Endangered, EPBC Act)	PCT 830 (HN524)* PCT 849 (HN528) PCT 850 (HN529)	0.44	0.54	15	5	20
PCT 835: Forest Red Gum - Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney Basin Bioregion	River-Flat Eucalypt Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions (Endangered, TSC Act)	PCT 835 (HN526)	3.23	0	107	0	107
PCT 849: Grey Box - Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin Bioregion	Cumberland Plain Woodland in the Sydney Basin Bioregion (Critically Endangered, TSC Act) Cumberland Plain Shale Woodlands and Shale-Gravel Transition Forest (Critically Endangered, EPBC Act)	PCT 849 (HN528)	6.09	0.24	203	3	206
PCT 850: Grey Box - Forest Red Gum grassy woodland on shale of the southern Cumberland Plain, Sydney Basin Bioregion	Cumberland Plain Woodland in the Sydney Basin Bioregion (Critically Endangered, TSC Act) Cumberland Plain Shale Woodlands and Shale-Gravel Transition Forest (Critically Endangered, EPBC Act)	PCT 849 (HN528) PCT 850 (HN529)	36.00	11.43	1,650	139	1,789
PCT 1800: Swamp Oak open forest on riverflats of the Cumberland Plain and Hunter valley	Swamp oak floodplain forest of the NSW North Coast, Sydney Basin and South East Corner bioregions (Endangered, TSC Act and EPBC Act)	PCT 1800 (HN674)	2.53	0	67	0	67
Total			**55.20**	**12.73**	**2,414**	**154**	**2,568**

*Only this PCT meets the criteria for like-for-like offsets under EPBC Act assessment requirements.

Table 1-3 Species credits required

Species	Conservation status	Like-for-like offsets	Impact (number of individuals/ area)	Credits required
Dillwynia tenuifolia	Vulnerable (TSC Act)	*Dillwynia tenuifolia*	244 individuals	4,392
Pultenaea parviflora (Sydney Bush Pea)	Endangered (TSC Act) Vulnerable (EPBC Act)	*Pultenaea parviflora* (Sydney Bush Pea)	90 individuals	1,350
Myotis macropus (Southern Myotis)	Vulnerable (TSC Act)	*Myotis macropus* (Southern Myotis)	0.92 ha	20
Meridolum corneovirens (Cumberland Plain Land Snail)	Endangered (TSC Act)	*Meridolum corneovirens* (Cumberland Plain Land Snail)	1.86 ha	24
Total species credits				**5,786**

Offset credit requirements for the threatened flora species *Dillwynia tenuifolia* and *Pultenaea parviflora* have been calculated based on a count of the number of individuals located within the construction footprint, as required by the FBA credit calculator which does not allow for input of area values for threatened flora species. However, the current unit of measure for offsetting both these species is area in hectares, as listed in the Threatened Biodiversity Data Collection (OEH, 2019). As such, the area of occupancy for each species and resultant credit value has also been calculated, in the event any credits available for these species have been calculated based on area (**Table 1-4**). The area of occupancy for each species has been determined by applying a 30 metre buffer around each record of the species to generate a species polygon. The species credit values were calculated using Equation 6 of the FBA (OEH, 2014):

Number of species credits required at development site	=	Area of species habitat	x	Threatened species offset multiplier	x	Species credit scaling factor of 10

Table 1-4 Species credits required for threatened flora species using area-based calculation

Species	**Conservation status**	**Like-for-like offsets**	**Impact (area of occupancy)**	**Threatened species offset multiplier**	**Credits required using area-based calculation**
Dillwynia tenuifolia	Vulnerable (TSC Act)	*Dillwynia tenuifolia*	3.63 ha	1.8	65
Pultenaea parviflora (Sydney Bush Pea)	Endangered (TSC Act) Vulnerable (EPBC Act)	*Pultenaea parviflora* (Sydney Bush Pea)	1.65 ha	1.5	25
Total species credits					**90**

The species credits calculated using the area unit of survey are far lower in number than those calculated using the individual unit of survey. It is therefore important to stipulate that the species credit requirements calculated using the area unit of survey could only be offset using species credits that have also been calculated based on the area unit of survey, to ensure that like for like offsets are being provided. Offsets would be secured for these two threatened flora species credit species based on either individuals or area, not both.

Offset calculations based on impacts to individuals have been used throughout this BOS when assessing threatened flora species; this may be amended with the above values, should area-based calculations be required due to availability of offsets.

1.3.2.2 Sydney growth centres SEPP and biodiversity certification

The State Environment Planning Policy (Sydney Region Growth Centres 2006) (Growth Centres SEPP) aims to co-ordinate the release of land for residential, employment and other urban development in the North West and South West Growth Centres of the Sydney region. The project intersects the north-eastern corner of the South West Growth Centre as defined under the Growth Centres SEPP.

On 11 December 2007, an order conferring biodiversity certification on the Sydney Growth Centres SEPP was made by the Commonwealth Minister for the Environment under Section 126G of the TSC Act. The Biodiversity Certification Order consists of 41 Relevant Biodiversity Measures (RBMs), which together form the conditions of certification.

Under the terms of the Biodiversity Certification Order, any developments or activities proposed to be undertaken within certified areas do not need to undertake assessment of impacts on threatened species, populations and ecological communities, or their habitats, that would normally be required by Parts 3, 4 or 5 of the EP&A Act. Development within non-certified land within the Growth Centres requires assessment under normal legislative requirements. Non-certified areas in the Growth Centres are identified on the maps in Schedule 2 of the Biodiversity Certification Order.

RBM 8 specifies the offset requirements for non-certified areas:

> *…the clearing of any existing native vegetation in the non-certified areas will be offset by:*
>
> > *(a) the protection of an equal or greater area of existing native vegetation elsewhere in the Growth Centres; and/or*
> >
> > *(b) the revegetation and/or restoration of an area of land elsewhere in the Growth Centres…* [subject to conditions].

RBM 11 of the Biodiversity Certification Order states:

> *Where there are essential infrastructure proposals, including but not limited to proposals under Part 3A of the Environmental Planning and Assessment Act 1979, that involve clearing of existing native vegetation in the non-certified areas and that do not require development consent under the SEPP, such clearing must be offset by applying the same requirements specified in condition 8 above.*
>
> *In this case the offsets may be located outside of the Growth Centres (but within the Cumberland Plain of Western Sydney) if the GCC is satisfied that there are no practicable offset options within the Growth Centres and all other requirements of condition 8 will be met.*

According to the definitions in schedule 1 of the biodiversity certification order:

> *"existing native vegetation" means areas of indigenous trees (including any sapling) that:*
>
> > *(a) had 10% or greater over-storey canopy cover present;*
> >
> > *(b) were equal to or greater than 0.5 ha in area; and*
> >
> > *(c) were identified as "vegetation" on maps 4 and 5 of the draft Growth Centres Conservation Plan.*

The native vegetation identified in the BAR (Appendix E of the EIS) in the non-certified areas of the South West Growth Centre meets criteria (a) and (b) for Existing Native Vegetation (ENV), however no areas within the construction footprint were identified as 'vegetation' on maps 4 and 5 of the draft Growth Centres Conservation Plan (ELA 2007).

Given that no areas of ENV, as defined under the Biodiversity Certification Order, are mapped within the non-certified area in the construction footprint, this area is therefore not subject to the specific offsetting requirements listed in the Biodiversity Certification Order. The impacts of the project on native vegetation identified within non-certified areas within the South West Growth Centre will however be offset under the FBA, as detailed in **Section 1.3.2.1**.

We have calculated that 1.43 hectares of ENV, as defined under the Biodiversity Certification Order, is mapped within the certified area and within the construction footprint. Impacts to areas of ENV within certified areas are offset using funds from special infrastructure contributions that apply within the Growth Centres, as determined during precinct planning.

1.3.2.3 EPBC strategic assessment

The DPIE (Planning and Assessment), in consultation with the DoEE, undertook a Strategic Assessment under the EPBC Act of the *Sydney Growth Centres Program* (the Program) (DoP, 2010). The Commonwealth Minister endorsed the Program document in December 2011, and subsequently approved all actions associated with the development of the Western Sydney Growth Centres as described in the Strategic Assessment Program Report on 28 February 2012.

The Program builds upon the Biodiversity Certification and specifies a range of additional measures that specifically target MNES listed under the EPBC Act. In particular, the program requires the NSW Government to ensure that:

- A minimum of 998 hectares of Cumberland Plain Shale Woodlands and Shale Gravel Transition Forest (CPW) will be retained and protected within the Growth Centres, including a minimum of 363 hectares of High Management Viability (HMV) CPW
- At least 2,400 hectares of either CPW, or other grassy woodland communities which are similar to CPW in floristic structure, will be protected outside of the Growth Centres. As part of this commitment at least 205 hectares of additional HMV CPW will be protected outside of the Growth Centre.

HMV is defined in the Growth Centres Draft Conservation Plan as areas that are Endangered Ecological Community (EEC), in good condition based on existing regional mapping, greater than four hectares in size, with good landscape connectivity and less likely to be impacted by surrounding land use threats.

The Strategic Assessment relies on the information in the Growth Centres Draft Conservation Plan to evaluate the impacts to native vegetation in the Growth Centres. The Strategic Assessment endorses the offset mechanisms in the Biodiversity Certification Order, provided that they deliver the program commitments. Given that there is no native vegetation within the non-certified area in the construction footprint subject to the specific offsetting requirements listed in the Biodiversity Certification Order, there are also no specific offset requirements for the project under the Strategic Assessment.

1.3.2.4 M7 biobank site

A portion of Western Sydney Parklands located to the south-west of the M7 Motorway and Elizabeth Drive intersection is the subject of a biobanking agreement under Part 7A Division 2 of the TSC Act. This biobank site (ID number 119) is about 32.2 hectares in area and forms part of the offset for the M7 Motorway.

The construction footprint overlaps the eastern boundary of the biobank site, directly impacting a strip of about 2.89 hectares in area and ranging from about 10 metres to 80 metres wide. Of the areas of native vegetation mapped within the construction footprint, about 1.85 hectares are located within the biobank site. Another 1.52 hectares of native vegetation within the biobank site have been determined as subject to indirect impacts due to potential edge effects. The areas of each PCT within and adjoining the biobank site that would be directly impacted, and the corresponding ecosystem credit requirements, are listed in **Table** 1-5.

The 99 credits required for impacts to native vegetation within the biobank site are included within the total number of credits required for the project (as presented in **Table 1-2**). There are no species credit polygons mapped within the biobank site.

The impacts to the biobank site have been assessed in accordance with the FBA and offsets will be sought to compensate for the impacts to identified biodiversity values. Determining appropriate compensation for the loss of part of the biobank site is outside the FBA and therefore separate to this BOS and will be subject to negotiation between Roads and Maritime and the Western Sydney Parklands Trust.

Table 1-5 Ecosystems credits required for impacts in the M7 biobank site

PCT	Equivalent TEC/status	Like-for-like offsets (PCT/BVT)	Area of direct impact within biobank site (ha)	Area of indirect impact within biobank site (ha)	Credits required under FBA for biobank site impacts
PCT 850: Grey Box - Forest Red Gum grassy woodland on shale of the southern Cumberland Plain, Sydney Basin Bioregion	Cumberland Plain Woodland in the Sydney Basin Bioregion (Critically Endangered, TSC Act) Cumberland Plain Shale Woodlands and Shale-Gravel Transition Forest (Critically Endangered, EPBC Act)	PCT 849 (HN528) PCT 850 (HN529)	1.85	1.52	99

1.3.2.5 Other biodiversity impacts requiring offsets

The BAR included assessments of aquatic impacts, including impacts to Key Fish Habitat (KFH), riparian vegetation and threatened species listed under the FM Act.

The aquatic assessment determined impacts to threatened species listed under the FM Act were unlikely and therefore do not require offsets. Riparian vegetation would be offset via relevant ecosystem credits (PCTs 835 and 1800) (see **Table 1-2**).

Under the RIAR (DPI, 2013) Policy and guidelines for fish habitat conservation and management impacts to KFH are to be offset by compensatory works to ensure no net loss. RIAR (DPI, 2013) calculates habitat compensation on a minimum 2:1 basis for all KFH lost; a greater compensation ratio may be considered if offsets cannot be sourced in the vicinity of the impact or are not of the same habitat type as that impacted.

RIAR (DPI, 2013) uses a rate of $52 per square metre for offset payments. This rate is consistent with aquatic ecosystem services rates calculated by Costanza *et al.* (1997, cited in DPI 2013), and is subject to annual inflation from 1 July each financial year. The rate above is from the 2013–2014 financial year. The cost per square metre would be confirmed with RIAR but for the purposes of this assessment the current rate has been estimated (from annual rates of CPI of 1.5 per cent in 2014-2015, 1.0 per cent in 2015-2016, 1.9 per cent 2016-2017 and 2.1 per cent in 2017-2018) to be $55 per square metre.

The project crosses four waterways (Badgerys Creek, Cosgroves Creek, Kemps Creek and South Creek) that are considered to meet the definition of KFH. An additional creek, Ropes Creek, has been assessed as unlikely fish habitat, and does not meet the definition of key fish habitat in accordance with the Policy and Guidelines for Fish Habitat Conservation and Management (DPI 2013).

Bridges are proposed at all four creeks meeting KFH. Badgerys Creek, South Creek and Kemps Creek would be permanently adjusted over distances of 64 metres, 200 metres and 84 metres respectively. A creek adjustment is not proposed at Cosgroves Creek and no instream habitat removal would occur as the bridge piers would be located outside the waterway. The proposed creek alignments would have a similar capacity to the existing creek channels and where possible would be designed and constructed in a way that mimics natural flow conditions as illustrated in **Figure 1-3** to **Figure 1-5**. The creek corridors would be revegetated with locally native riparian vegetation, in accordance with the requirements of the Policy and guidelines for fish habitat conservation and management (DPI, 2013) and *Guidelines for instream works on waterfront land* (DPI, 2012). The creek channels would be rehabilitated to preconstruction conditions or better.

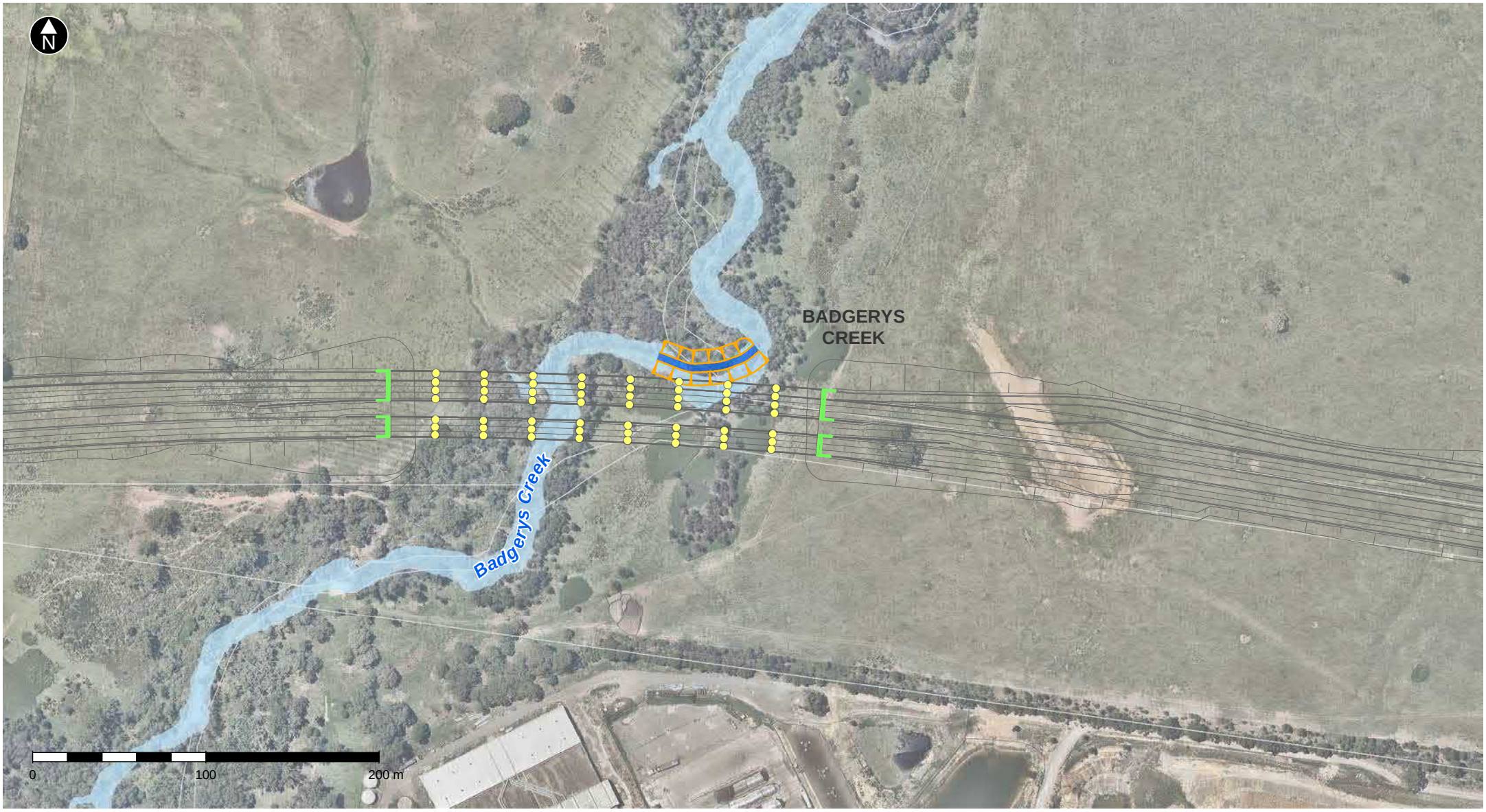
The adjustments would replace around 6,366 square metres of KFH in the channels with about 7,452 square metres of newly created channels, partially compensating for the loss. Area calculations are provided in **Table 1-6**. Based on a 2:1 offset ratio, about 5,281 square metres of KFH is still required to be

offset following creek adjustments, which would cost approximately $290,455 assuming an offset cost of $55/square metre. This will be finalised following further detailed design of the adjusted channel. The cost per square metre would be confirmed with RIAR, and the required amount would be paid into the RIAR Fish Conservation Trust Fund.

The offsets for aquatic habitat are limited to the area of KFH impacted and are considered separately from impacts offset under the FBA.

Table 1-6 Creek adjustment areas and offset requirement

Waterway	Area impacted (sq m)	Offset requirement (2:1) (m^2)	Adjusted area (m^2)	Difference (m^2)	Cost
Badgerys Creek	1,127	2,254	1,222	1,032	$56,760
South Creek	3,339	6,678	4,567	2,111	$116,105
Kemps Creek	1,900	3,800	1,662	2,138	$117,590
Total	**6,366**	**12,732**	**7,451**	**5,281**	**$290,455**



The project
Cadastre
Existing creek alignment
Proposed creek adjustment

Proposed creek realignment
Bridge piers
Bridge abutments
Earthworks associated with proposed creek realignment

Data sources
Existing creek alignment, cadastre
- DFSI Spatial Services, NSW

Figure 1-3 Proposed adjustment at Badgerys Creek

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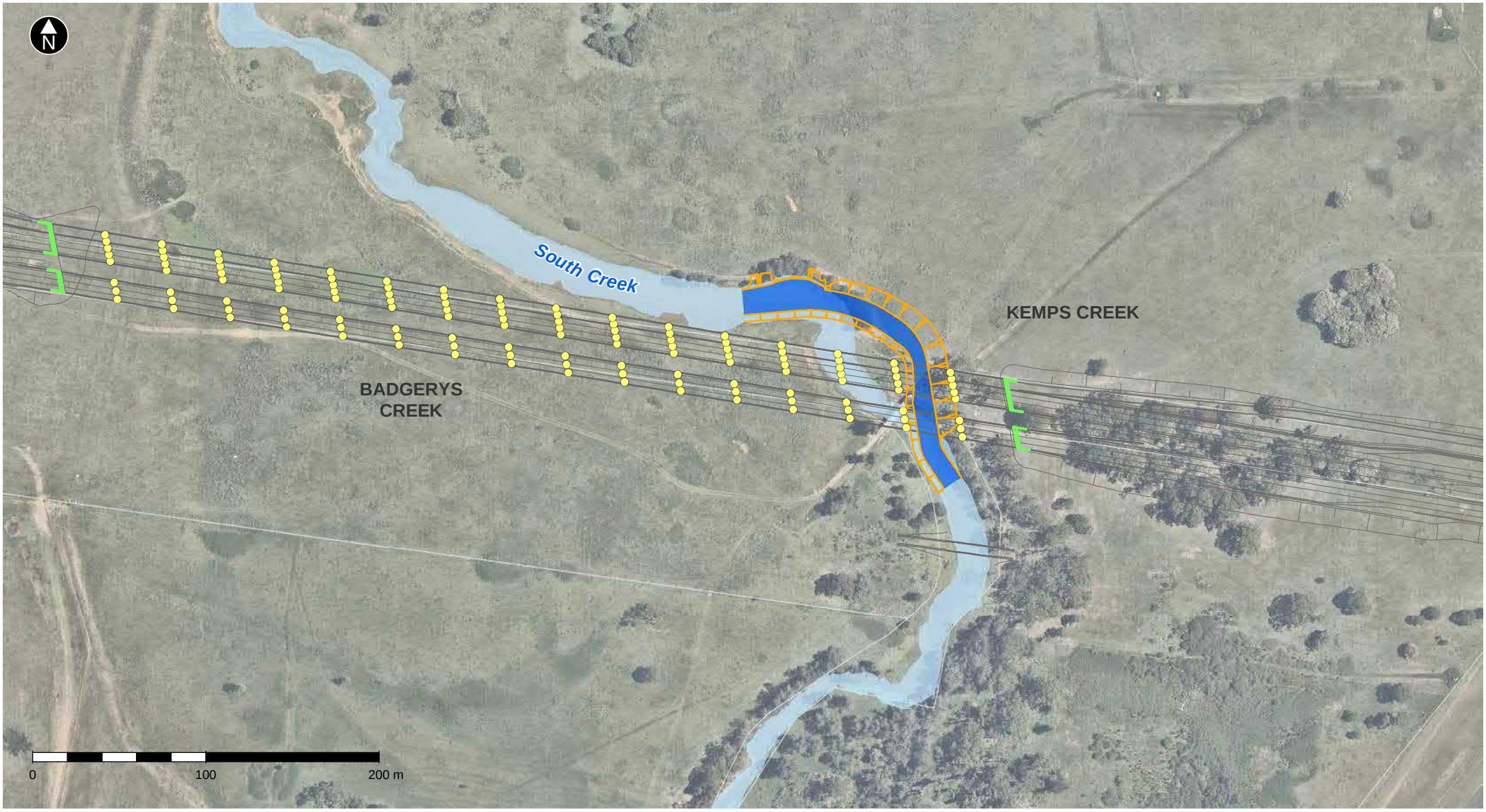

The project
Cadastre
Existing creek alignment
Proposed creek adjustment

Proposed creek realignment
Bridge piers
Bridge abutments
Earthworks associated with proposed creek realignment

Data sources
Existing creek alignment, cadastre
- DFSI Spatial Services, NSW

Figure 1-4 Proposed adjustment at South Creek

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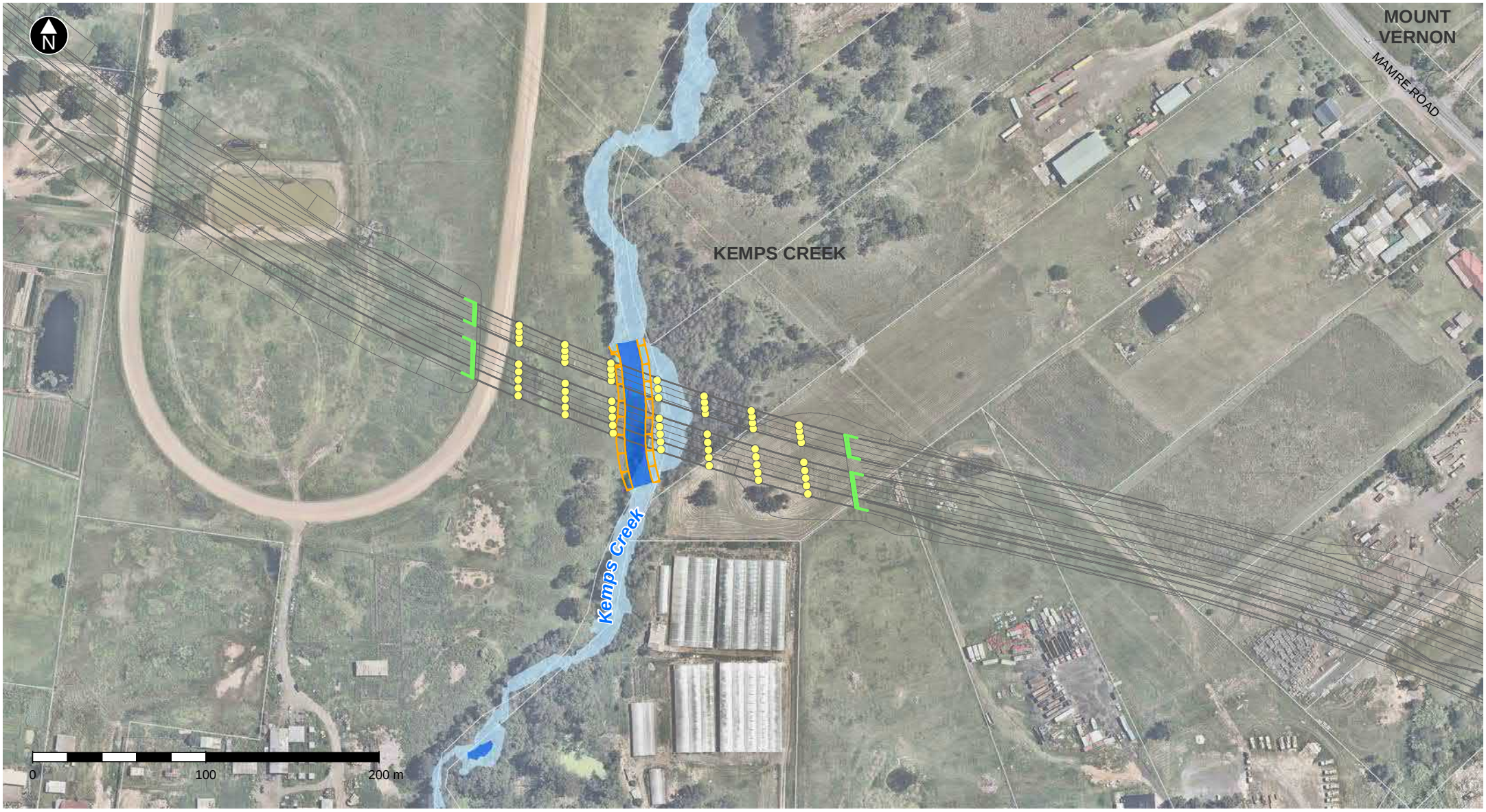

The project
Cadastre
Existing creek alignment
Proposed creek adjustment

Proposed creek realignment
Bridge piers
Bridge abutments
Earthworks associated with proposed creek realignment

Data sources
Existing creek alignment, cadastre
- DFSI Spatial Services, NSW

Figure 1-5 Proposed adjustment at Kemps Creek

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2 Biodiversity offset strategy

2.1 Offset identification

The NSW Biodiversity Offset Policy for Major Projects (2014) specifies that the primary mechanism for offsetting biodiversity impacts is through the retirement of biobanking credits established under the TSC Act (now repealed and replaced by the BC Act).

In accordance with the available options for offsetting under the Biodiversity Offset Policy for Major Projects (2014), the measures proposed to address the offset obligation for this project are as follows:

- An appropriate number and class of like-for-like biodiversity credits would be purchased and retired
- If all the required like-for-like biodiversity credits cannot be sourced from the market, suitable properties that contain potential like-for-like credit requirements would be investigated and, if suitable, Biodiversity Stewardship Agreements would be established and/or progressed on these
- If like-for-like biodiversity credits cannot be sourced following reasonable steps to locate them, it may be possible to apply variation rules to locate appropriate offsets. Variation credits would only be applied to offset impacts that are not residual significant impacts to Matters of National Environmental Significance under the EPBC Act
- If neither like-for-like biodiversity credits or variation biodiversity credits can be sourced, supplementary measures may be considered in consultation with the Department of Planning, Industry and Environment (Environment, Energy and Science) (EESG) and DoEE.

For impacts that are residual significant impacts to MNES under the EPBC Act, a maximum of 10 per cent of the offset requirement may be fulfilled with supplementary measures. Supplementary measures are detailed in **Section 2.4** below.

2.2 Available credits

2.2.1 Current purchase of credits

Based on preliminary offset estimations, Roads and Maritime have investigated and secured a number of biodiversity credits to be retired as offsets for the project. For some credit classes, the credits purchased exceed the project requirements as they were purchased early in the project planning phase and a “worst case scenario” was used to determine required credits prior to detailed assessment of the project. If credits become surplus to the requirements of the project, Roads and Maritime will consider whether to allocate them to another project.

Additional offsets are currently in the process of being negotiated. The offsets that are secured to date and those under negotiation are detailed in **Table 2-1**.

Table 2-1 Credits purchased

Biodiversity credit	Number of credits required to offset impacts	Number of like-for-like credits purchased	Credits still required
HN512 (PCT 724) Broad-leaved Ironbark - Grey Box - Melaleuca decora grassy open forest on clay/gravel soils of the Cumberland Plain, Sydney Basin Bioregion	379	0	379
HN524 (PCT 830) Forest Red Gum - Grey Box shrubby woodland on shale of the southern Cumberland Plain, Sydney Basin Bioregion	20	30	0

Biodiversity credit	Number of credits required to offset impacts	Number of like-for-like credits purchased	Credits still required
HN526 (PCT 835) Forest Red Gum - Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney Basin Bioregion	107	203	0
HN528 (PCT 849) Grey Box - Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin Bioregion	206	213	0
HN529 (PCT 850) Grey Box - Forest Red Gum grassy woodland on shale of the southern Cumberland Plain, Sydney Basin Bioregion	1,789	1,666	123
HN674 (PCT 1800) Swamp Oak open forest on riverflats of the Cumberland Plain and Hunter valley	67	0	67
Total	**2,568**	**2,112**	**569**

2.2.2 Credit searches

A search of the public biodiversity credits register (https://www.environment.nsw.gov.au/bimsprapp/SearchBiodiversityCredit.aspx) was conducted on 5 November 2018 and updated on 12 April 2019 to determine whether any of the required credits are currently for sale. The search was undertaken for all ecosystem and species credit types for which credits are still required once those already secured by Roads and Maritime are considered. The results of this search are summarised below in **Table 2-2**.

No suitable corresponding credits were identified for the two impacted PCTs for which credits have not been sourced (PCTs 724 and 1800), but available credits are listed for PCT 850, for which some credits are still required. Suitable corresponding credits were identified for three threatened fauna species (**Table 2-1**). Details of the relevant credits listed on the register are included in **Annexure A**.

Table 2-2 Results of searches of the biodiversity credits register

Biodiversity credit	Credits still required	Search results
HN512 (PCT 724) Broad-leaved Ironbark - Grey Box - Melaleuca decora grassy open forest on clay/gravel soils of the Cumberland Plain, Sydney Basin Bioregion	379	No credits listed
HN529 (PCT 850) Grey Box - Forest Red Gum grassy woodland on shale of the southern Cumberland Plain, Sydney Basin Bioregion	123	5,930 credits listed in 17 biobanking agreements* Of these credits, 4,315 are listed as available An additional agreement with 1,660 credits is pending
HN674 (PCT 1800) Swamp Oak open forest on riverflats of the Cumberland Plain and Hunter valley	67	No credits listed

Biodiversity credit	Credits still required	Search results
Dillwynia tenuifolia	4,392	No credits listed
Pultenaea parviflora Sydney Bush Pea	1,350	No credits listed
Cumberland Plain Land Snail *Meridolum corneovirens*	24	1,782 credits listed in 12 biobanking agreements*
Southern Myotis *Myotis macropus*	20	329 credits listed in two biobanking agreements

*Excludes credits owned by Roads and Maritime.

2.3 Potential offset sites

An alternative to purchasing credits (as per **Table 1-2**) is to establish one or more offset sites. Given that the BC Act is now in force, any offset site established in the future would be secured under a Biodiversity Stewardship Site Agreement under the BC Act, with credits calculated using the Biodiversity Assessment Method (BAM). As such, an assessment of reasonable equivalence may need to be applied to the offset credit obligation for the project to determine the number of biodiversity credits as calculated under the BAM that would be needed to be retired against any outstanding offsets calculated under the FBA.

2.3.1 Biobanking EOI register

A search of the public biobank site expressions of interest (EOI) register https://www.environment.nsw.gov.au/bimsprapp/SearchBiobankingEOI.aspx) was conducted on 2 November 2018 and updated on 5 April 2019 to determine whether any potential offset sites listed on the EOI register include any of the required credits. A search was undertaken for all ecological communities and species for which credits are not currently held by Roads and Maritime or listed on the Biodiversity Credits register.

Two EOI notices listed one or more of the ecological communities and species for which offsets are required as potentially occurring on the offset site (**Table 2-3**). Potential credit values for these entities are not listed. Furthermore, the EOIs have not been verified by EESG, and the information in the register should be only an estimation of the type of credits that could be generated at the site if a biodiversity stewardship site was established. The EOIs have been given arbitrary, unique identifiers ‘Site 1’ and ‘Site 2’.

Table 2-3 Potential offset sites listed on biobank site EOI register

Biodiversity credit	Credits still required	Search results
HN512 (PCT 724) Broad-leaved Ironbark - Grey Box - Melaleuca decora grassy open forest on clay/gravel soils of the Cumberland Plain, Sydney Basin Bioregion	379	One potential site (EOI ‘Site 1’)
HN674 (PCT 1800) Swamp Oak open forest on riverflats of the Cumberland Plain and Hunter valley	67	No potential sites
Dillwynia tenuifolia	4,392	Two potential sites (EOIs ‘Site 1’ and ‘Site 2’).

Biodiversity credit	Credits still required	Search results
Pultenaea parviflora Sydney Bush Pea	1,350	One potential site (EOI 'Site 1').

2.4 Variation criteria and supplementary measures

2.4.1 Overview

Variation rules may be applied to offset credit requirements for impacts to TECs and threatened species where like-for-like credits cannot be sourced (OEH, 2014). The variation rules allow greater flexibility in offsetting:

- Impacts on vegetation may be offset with vegetation from the same vegetation formation, that has undergone an equal or greater amount of clearing since European habitation
- Impacts on fauna species not associated with a PCT may be offset in the same taxonomic order that uses similar habitat impacted in the same locality and under the same level of threat as that impacted
- Impacts on flora species may be offset in the same family and with the same life form impacted in the same locality and under the same level of threat as that impacted.

Supplementary measures may also be proposed where like-for-like credits cannot be sourced. Supplementary measures involve sponsoring (funding) the following types of activities:

- Relevant research and biological survey activities in partnership with a university or recognised conservation organisation
- Targeted conservation management activities as part of EESG's Saving our Species program
- Vegetation rehabilitation and restoration activities in partnership with a local land care groups and/or public land managers (including local government, Local Land Services and NPWS).

Variation criteria and/or supplementary measures may only be considered when it can be demonstrated that suitable offsets cannot be sourced after undertaking reasonable steps. Reasonable steps to locate like-for-like offsets are defined in the NSW Biodiversity Offsets Policy for Major Projects as:

- Consideration of any feasible sites known to the proponent including:
  - Checking the biobanking public register and having an expression of interest for credits on it for at least six months
  - Liaising with a EESG office (or fisheries NSW office for aquatic biodiversity) and relevant local councils to obtain a list of potential sites that meet the requirements for offsetting
  - Considering properties for sale in the required area.
- Providing evidence of why offset sites are not feasible – suitable evidence may include:
  - The unwillingness of a landowner to sell or establish a biobank site
  - The cost of an offset site itself should not be a factor unless it can be demonstrated the landowner is charging significantly above market rates.

Variation from direct, like-for-like offsets must be consistent with Commonwealth offsetting requirements for MNES as specified in the EPBC Environmental Offsets Policy (Commonwealth of Australia, 2012). This includes the provision of like-for-like offsets for MNES that are subject to residual significant impacts, and a maximum of 10 per cent of the offset requirements for MNES subject to residual significant impacts being fulfilled with the use of supplementary measures. The variation rules would generally not be used for offsets for MNES, unless it could be demonstrated that the offsets were consistent with the EPBC Environmental Offsets Policy.

Offset requirements which may be difficult to satisfy, based on existing information, are listed in **Table 2-4**.

Table 2-4 Potential outstanding offset requirements

Biodiversity credit	Credits still required	Comments
HN512 (PCT 724) Broad-leaved Ironbark - Grey Box - Melaleuca decora grassy open forest on clay/gravel soils of the Cumberland Plain, Sydney Basin Bioregion	379	No like-for-like credits listed in biodiversity credit register (that would satisfy EPBC Act assessment requirements). One potential biobank site listed on biobank EOI register (EOI 'Site 1'). Requires like-for-like offsets, of which 90% must be direct offsets (Commonwealth listed).
HN674 (PCT 1800) Swamp Oak open forest on riverflats of the Cumberland Plain and Hunter valley	67	No like-for-like credits or potential offsets sites listed in biodiversity credit register or biobank EOI register.
Dillwynia tenuifolia	4,392	No like-for-like credits listed in biodiversity credit register. Two potential biobank sites listed on biobank EOI register (EOIs 'Site 1' and 'Site 2').
Pultenaea parviflora Sydney Bush Pea	1,350	No like-for-like credits listed in biodiversity credit register. One potential biobank site listed on biobank EOI register (EOI 'Site 1'). Requires like-for-like offsets, of which 90% must be direct offsets (Commonwealth listed).

2.4.2 Strategy for obtaining outstanding offset requirements

Roads and Maritime began sourcing credits in Western Sydney in early 2016 and has attempted to source credits from the EESG Biobanking register and EOIs in the local community (see above **Table 2-3**). This has resulted in obtaining 2,112 credits, however there are still both ecosystem and species credits outstanding. **Table 2-5** below details the process that has already been completed, tasks that are on-going, and those that are planned for this year.

Table 2-5 Summary of process for obtaining offsets

Task	Timing	Summary/notes	Status
Biodiversity offset requirements were estimated from the strategic footprint of project	February 2016	Based on the most likely shortlisted options determined as part of the strategic route assessment (RMS 2016), likely offset requirements were determined using a "worst case" scenario.	Completed
Search of the Biobanking Public Registers on the EESG Biobanking webpage	Mid 2016-April 2019	Searches for required credits have occurred at regular intervals during the development of project. Additional searches will be undertaken in case further credits become available.	Ongoing
Communication with: • interested and potential credit holders • accredited Biobanking assessors • local Councils who are pursuing options to	Mid 2016 - ongoing	Roads and Maritime began contacting owners of suitable properties after shortlisted options for the M12 route were announced. Roads and Maritime produced a factsheet *Selling Biodiversity Credits to Roads and Maritime Services* (2017) which outlines the process Roads and Maritime uses to purchase credits from landholders.	Ongoing

Task	Timing	Summary/notes	Status
establish Biobank sites on their own Council land, or who were known to be interested			
Roads and Maritime listed credits required for M12 on EESG "Credits Wanted" register	Feb- Nov 2017	The following entities were listed: *Pultenaea parviflora* Cumberland Plain Land Snail HN529 HN526 HN528 HN630 HN512	Completed
Purchase of credits	May 2017 – Ongoing	Purchase of relevant credits listed on EESG Bio-banking Public register.	Ongoing
Expression of interest (EOI) for Ecosystem credits launched	December 2017	Due to a shortfall in required credits, Roads and Maritime put out EOIs for ecosystem credits for the M12 and other Western Sydney projects. Advertisements were placed in the following local papers: Macarthur Chronicle, Camden Haven Courier, Campbelltown Camden Wollondilly Advertiser, Hawkesbury Gazette, Hawkesbury courier, Penrith City Gazette, Penrith Press EOI webpage and email address was set up.	Completed
EOIs received and secured	February 2018	Four EOIs were received and additional ecosystem credits were secured through the EOI submission	Completed
Proposed EOI for species credits	Mid 2019	A similar process to the EOI for ecosystem credits will be used to source species credits that remain for this project (Table 2-1)	In planning stage
Contact existing biodiversity credit holders	Mid 2019	Landholders who have offset agreements with Roads and Maritime or other entity may have suitable habitat for species credit species (eg for *Pultenaea parviflora* or *Dillwynia tenuifolia).* Discuss potential to undertake additional species credit surveys	In planning stage
Desktop assessment of potential offset sites	TBA	If suitable sites are identified, contact landholders to carry our surveys of potential offset sites for species credits. If appropriate, progress stewardship site agreements.	In planning stage
Contribution to the Biodiversity Conservation Trust for non-EPBC listed species	TBA	For species such as *Dillwynia tenuifolia* and Cumberland Plain Land Snail, a contribution to the Biodiversity Conservation Trust Fund might be the only option if all the above methods for obtaining species credits are unsuccessful.	If required

2.5 Other biodiversity impacts requiring offsets

Based on a 2:1 offset ratio, about 5,281 square metres of key fish habitat would be required to be offset following creek adjustments, which would cost approximately $290,455 assuming an offset cost of $55 per square metre. The area of impact would be finalised following further detailed design of the adjusted channel. The cost per square metre would be confirmed with RIAR, and the required amount would be paid into the RIAR Fish Conservation Trust Fund.

2.6 Summary of offset measures

More than half of the ecosystem credits required have been purchased (**Table 2-5**) Credits are still required for four PCTs, two threatened flora species, and two threatened fauna species. Offset measures that are secured, being negotiated or still required are summarised in **Table 2-6**.

Table 2-6 Summary of offset measures under the FBA

Biodiversity value	Equivalent TEC / Status	Credits required	Credits purchased	Credits to be negotiated	Remaining credits required
Ecosystem credits					
PCT 724: Broad-leaved Ironbark - Grey Box - Melaleuca decora grassy open forest on clay/gravel soils of the Cumberland Plain, Sydney Basin Bioregion	Shale Gravel Transition Forest in the Sydney Basin Bioregion Endangered (TSC Act) Critically Endangered (EPBC Act)	379	0	0	379 (One potential biobank site listed on the public register)
PCT 830: Forest Red Gum - Grey Box shrubby woodland on shale of the southern Cumberland Plain, Sydney Basin Bioregion	Moist Shale Woodland in the Sydney Basin Bioregion Endangered (TSC Act) Critically Endangered (EPBC Act)	20	30	0	0
PCT 835: Forest Red Gum - Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney Basin Bioregion	River-Flat Eucalypt Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions Endangered (TSC Act)	107	203	0	0
PCT 849: Grey Box - Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin Bioregion	Cumberland Plain Woodland in the Sydney Basin Bioregion Critically Endangered (TSC Act, EPBC Act)	206	213	0	0

Biodiversity value	Equivalent TEC / Status	Credits required	Credits purchased	Credits to be negotiated	Remaining credits required
PCT 850: Grey Box - Forest Red Gum grassy woodland on shale of the southern Cumberland Plain, Sydney Basin Bioregion	Cumberland Plain Woodland in the Sydney Basin Bioregion Critically Endangered (TSC Act, EPBC Act)	1,789	1,666	0	123
PCT 1800: Swamp Oak open forest on riverflats of the Cumberland Plain and Hunter valley	Swamp oak floodplain forest of the NSW North Coast, Sydney Basin and South East Corner bioregions Endangered (TSC Act, EPBC Act)	67	0	0	67 (No like-for-like credits or potential offsets sites listed in biodiversity credit register or biobank EOI register)
Total ecosystem credits		**2,568**	**2,112**	**0**	**569**
Species credits					
Dillwynia tenuifolia	Vulnerable (TSC Act)	4,392	0	0	4,392 (Two potential biobank sites listed on the public register)
Pultenaea parviflora (Sydney Bush Pea)	Endangered (TSC Act) Vulnerable (EPBC Act)	1,350	0	0	1,350 (One potential biobank site listed on the public register)
Myotis macropus (Southern Myotis)	Vulnerable (TSC Act)	20	0	20	20 (329 credits listed in two biobanking agreements)
Meridolum corneovirens (Cumberland Plain Land Snail)	Endangered (TSC Act)	24	0	0	24 (1782 credits listed in 12 biobanking agreements)
Total species credits		**5,786**	**0**	**0**	**5,786**

2.7 Matters of national environmental significance

There are nine different categories of MNES as listed under the EPBC Act. Only MNES with the potential to occur and be impacted, as discussed in Chapter 5 of the BAR, are examined in this section. They are:

- Threatened species
- TECs
- Migratory specie
- Commonwealth land.

2.7.1 Threatened ecological communities

Two TECs identified in the study area meet the criteria for listing under the EPBC Act. The project requires the removal of 38.48 hectares of Cumberland Plain Shale Woodlands and Shale-Gravel Transition Forest and 0.44 hectares of Western Sydney Dry Rainforest and Moist Woodland on Shale (**Table 2-7**) that meet the condition criteria to be included in the EPBC Act definitions of these TECs.

The removal of 38.48 hectares of the critically endangered Cumberland Plain Shale Woodlands and Shale-Gravel Transition Forest represents a significant impact to this TEC and has been determined to be a controlled action by DoEE (see **Section 1.3** for background). Under the Bilateral Agreement between the Commonwealth and NSW, impacts to MNES can be assessed and if required, offset under the FBA.

In contrast, the small area of Western Sydney Dry Rainforest and Moist Woodland on Shale to be cleared comprises the fragmented and disturbed edge of a larger patch. This TEC would not be significantly impacted by the project, and therefore offsets under the EPBC Act are not required. This TEC would however still be offset under the FBA.

Table 2-7 Direct impacts to EPBC Act listed TECs and offset requirements

PCT	Equivalent EPBC TEC/status	Like-for-like offsets (PCT/BVT)	Area of impact (ha)		Credits required		
			Direct impacts	Indirect impacts	Direct impacts	Indirect impacts	Total credits
PCT 724: Broad-leaved Ironbark - Grey Box - Melaleuca decora grassy open forest on clay/gravel soils of the Cumberland Plain, Sydney Basin Bioregion	Cumberland Plain Shale Woodlands and Shale-Gravel Transition Forest (CPSW SGTF) Critically Endangered (EPBC Act)	PCT 724 (HN512)	4.86	0.52	276	7	283
PCT 849: Grey Box - Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin Bioregion		PCT 849 (HN528)	1.61	0.24	65	3	68
PCT 850: Grey Box - Forest Red Gum grassy woodland on shale of the southern Cumberland Plain, Sydney Basin Bioregion		PCT 849 (HN528) PCT 850 (HN529)	32.01	11.33	1,469	138	1,607

PCT	Equivalent EPBC TEC/status	Like-for-like offsets (PCT/BVT)	Area of impact (ha)		Credits required		
			Direct impacts	Indirect impacts	Direct impacts	Indirect impacts	Total credits
Total CPSW SGTF			**38.48**	**12.09**	**1,810**	**148**	**1,958**
PCT 830: Forest Red Gum - Grey Box shrubby woodland on shale of the southern Cumberland Plain, Sydney Basin Bioregion	Western Sydney Dry Rainforest and Moist Woodland on Shale Critically Endangered (EPBC Act)	PCT 830 (HN524)	0.44	0.54	15	5	20
Total all TECs			**38.92**	**12.63**	**1,825**	**153**	**1,978**

As discussed in **Section 2.2**, Roads and Maritime have secured some biodiversity credits to be retired as offsets for the project and are negotiating further offset credits. A comparison of the offsets secured to date and those under negotiation with the credit requirements for EPBC Act listed TECs is provided in **Table 2-8**.

Table 2-8 Credits purchased and under negotiation (EPBC Act TECs)

EPBC Act listed TEC	Biodiversity credit	Number of credits required for EPBC Act listed TEC	Number of like-for-like credits purchased	Remaining credits required
Cumberland Plain Shale Woodlands and Shale-Gravel Transition Forest Critically Endangered (EPBC Act)	HN512 (PCT 724) Broad-leaved Ironbark - Grey Box - Melaleuca decora grassy open forest on clay/gravel soils of the Cumberland Plain, Sydney Basin Bioregion	283	0	283
	HN528 (PCT 849) Grey Box - Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin Bioregion	68	213	0
	HN529 PCT 850) Grey Box - Forest Red Gum grassy woodland on shale of the southern Cumberland Plain, Sydney Basin Bioregion	1,607	1,666	0
Total CPSW SGTF		**1,958**	**1,879**	**283**
Western Sydney Dry Rainforest and Moist Woodland on Shale Critically Endangered (EPBC Act)	HN524 (PCT 830) Forest Red Gum - Grey Box shrubby woodland on shale of the southern Cumberland Plain, Sydney Basin Bioregion	20	30	0

Given that all credits required for EPBC listed TECs would be offset with ecosystem credits representing the same TEC, the like for like offset requirements of the EPBC Act Environmental Offsets Policy would be satisfied.

2.7.2 Threatened flora

Desktop assessment of EPBC Act listed threatened flora identified 26 species with the potential to occur within the study area (Annexure E of the BAR). This list was narrowed down during desktop research based on available information on the PCTs on the site and other microhabitat information (see Section 5.3.1 and Section 8.4.1 of the BAR for further information).

One threatened flora species listed under the EPBC Act, *Pultenaea parviflora* (Sydney bush-pea), requires offsetting due to a portion of the population being within the construction footprint (**Table 2-9**).

Table 2-9 Summary of EPBC listed threatened flora within the study area

Scientific name	Common name	Status under the EPBC Act	Number of individuals to be removed	Number of credits required
Pultenaea parviflora	Sydney bush-pea	Vulnerable	90	1,350

There are currently no credits available on the market for *Pultenaea parviflora*. One potential offset site containing the species is listed on the biobank site EOI register (see **Section 2.3**). A notice has been placed on the Biobanking Credits Wanted register for *Pultenaea parviflora* credits (ID 182, listed 1 April 2019).

2.7.3 Threatened fauna

Desktop assessment identified 24 EPBC listed fauna species that have been recorded or that have potential habitat occurring within 10 kilometres of the study area (Annexure B of the BAR). Further desktop assessment of vegetation communities and microhabitat occurrence was carried out to provide a likelihood of occurrence for each of these 24 species. Only those species with a moderate or high likelihood of occurrence (six species out of the 24) were the subject of further assessment, including field surveys, which are discussed in detail in Section 4.2 of the BAR. In total, one EPBC listed fauna species, the Grey-headed Flying-fox (*Pteropus poliocephalus*; vulnerable), was present or assumed present within the study area (**Table 2-10**). Further information on how the EPBC listed fauna species were determined to be present or assumed present can be found in Sections 4.1.2, 4.2.2 and 8.42 of the BAR.

The outcome of impact assessment (detailed in Section 5.3.2 and Section 8.4.2 of the BAR) for the Grey-headed Flying-fox was that impacts to this species would not be significant. As such, no offsets are required. It should be noted however that all Cumberland Plain Shale Woodland and Shale-Gravel Transition Forest that would be offset for the project would be potential foraging habitat for the Grey-headed Flying-fox, so foraging resources for this species are likely to be maintained with the purchase of credits for Cumberland Plain Woodland.

Table 2-10 EPBC listed fauna species present or assumed present within the study area

Scientific name	Common name	Status under the EPBC Act	Area of habitat to be removed (ha)	Significance?	Number of credits required
Pteropus poliocephalus	Grey-headed Flying-fox	Vulnerable	55.20 (foraging only)	Not significant	0

2.7.4 Migratory species

Desktop assessment identified 16 EPBC listed migratory fauna species that have been recorded or that have potential habitat occurring within 10 kilometres of the study area (Annexure B of the BAR). Of these species, eight were considered to have a moderate likelihood of occurrence, and no migratory species were considered to have a high likelihood of occurrence in the study area. While the White-bellied Sea-Eagle (*Haliaeetus leucogaster*) is a listed marine species under the EPBC Act, it is not considered a migratory species and therefore was not assessed as a migratory species. No migratory species were recorded in the study area during surveys and no 'important habitat' as defined in DoE (2013) was considered likely to be impacted by the project. Therefore, while the project is likely to result in the loss of

occasional habitat for migratory species, it does not impact on important habitat, and is unlikely to result in a significant impact on migratory species listed under the EPBC Act. Further information is provided in Section 5.4 and Section 8.4.4 of the BAR.

2.7.5 Commonwealth land

No direct impacts are proposed on any areas of Commonwealth land. The project is adjacent to areas of Commonwealth land within the proposed Western Sydney Airport site. The indirect impacts associated with the project are unlikely to have a significant impact on the environment of Commonwealth land as defined in the *Significant Impact Guidelines*, *Section 1.2* (Actions on, or impacting upon, Commonwealth land, and actions by Commonwealth agencies) (Commonwealth of Australia, 2013). As such no offsets are required for impacts on Commonwealth land.

3 Conclusion

The project has been developed to minimise impacts to biodiversity values, however, residual impacts to vegetation and threatened flora and fauna habitat remains. Under Commonwealth and State legislative requirements these residual impacts must be offset. The offset requirements for the project are:

- Ecosystem credits for six PCTs (724, 830, 835, 849, 850 and 1800) corresponding with TECs under the TSC Act, totalling 2,568 credits
- Species credits for two threatened flora species: *Pultenaea parviflora* and *Dillwynia tenuifolia* (1,350 and 4,392 credits respectively)
- Species credits for two threatened fauna species: listed under the TSC Act (Southern Myotis (20 credits), and Cumberland Plain Land Snail (24 credits).

Offsets for MNES are considered under the NSW and Commonwealth bilateral assessment agreement and are therefore subject to the FBA. The project would result in residual significant impacts to two MNES:

- TEC Cumberland Plain Shale Woodlands and Shale-Gravel Transition Forest, listed as critically endangered
- Threatened flora species *Pultenaea parviflora* (Sydney Bush Pea), listed as vulnerable.

No significant impacts are predicted for EPBC Act listed fauna species.

Significant impacts for biodiversity matters outside of the FBA are not anticipated, this includes threatened fish species listed under the FM Act, migratory species under the EPBC Act, Commonwealth land or groundwater dependent ecosystems. As such, no offsets are required for these entities.

Roads and Maritime began sourcing credits in Western Sydney in early 2016 and has attempted to source credits from the EESG Biobanking register and EOIs in the local community. Through this process, Roads and Maritime have purchased 2,112 suitable ecosystem credits to be retired as offsets for the project, representing over three quarters of the ecosystem credits expected to be required. Searches of the public biodiversity credits register revealed more than 2,000 suitable species credits for two species impacted by the project: Cumberland Plain Land Snail and Southern Myotis. These credits require further investigation to confirm and secure.

The priorities for finalising the offset package for the project are to determine the outcome of the negotiations for the credits still required for the offset of the EPBC listed Cumberland Plain Shale Woodlands and Shale-Gravel Transition Forest, which is composed of three threatened PCTs under the TSC Act.

Further investigation of two EOI sites ('Site 1' and 'Site 2'), or alternative potential offset sites, would also be required to finalise the package, including confirmation of like-for-like offsetting under both the EPBC and TSC Acts, once the offset package is secured.

Alongside negotiations and investigations of the two EOI sites, Roads and Maritime are investigating other avenues for securing the outstanding offset requirements, including:

- An EOI in local newspapers circulating in the Cumberland - Hawkesbury/Nepean IBRA subregion for expressions of interest from landholders interested in establishing a biodiversity stewardship site that will protect species credits in perpetuity
- Engaging with existing biodiversity credit holders who may have suitable habitat for *Dillwynia tenuifolia* and *Pultenaea parviflora* to discuss undertaking additional species credit surveys
- Undertaking desktop assessment of potential offset sites and, where feasible, conduct surveys of potential offset sites for species credits. Progress stewardship site agreements on suitable sites.

If credits cannot be sourced for non-EPBC listed species such as *Dillwynia tenuifolia* and Cumberland Plain Land Snail, it may be possible to satisfy the offset obligation for these species through a payment into the Biodiversity Conservation Fund, managed by the Biodiversity Conservation Trust.

4 References

Commonwealth of Australia 2012, *Environment Protection and Biodiversity Conservation Act 1999 Environmental Offsets Policy.* http://www.environment.gov.au/epbc/publications/epbc-act-environmental-offsets-policy

Department of Primary Industries (DPI) 2013, *Policy and Guidelines for Fish Habitat Conservation and Management (Update 2013)*, http://www.dpi.nsw.gov.au/__data/assets/pdf_file/0009/468927/Policy-and-guidelines-for-fish-habitat.pdf

Office of Environment and Heritage (OEH) 2014. *Framework for Biodiversity Assessment: NSW Biodiversity Offsets for Major Projects*, http://www.environment.nsw.gov.au/resources/biodiversity/140675fba.pdf

Office of Environment and Heritage (OEH) 2014, *NSW Biodiversity Offset Policy for Major Projects*, http://www.environment.nsw.gov.au/resources/biodiversity/140672biopolicy.pdf

Office of Environment and Heritage (OEH) 2019, *Threatened Biodiversity Data Collection.* https://www.environment.nsw.gov.au/AtlasApp/UI_Modules/TSM_/Default.aspx?a=1

Annexure A – Results of Biobanking public register searches

Biodiversity credit register search results

Biodiversity credit type	IBRA subregion	Agreement ID	Date credits issued	Credits	Credits available
Ecosystem credits					
HN528 Grey Box - Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin Bioregion	Cumberland - Hawkesbury/Nepean	100	2/10/2013	6	0
HN528	Cumberland - Hawkesbury/Nepean	120	30/09/2014	5	0
HN528	Cumberland - Hawkesbury/Nepean	137	18/11/2014	21	0
HN528	Cumberland - Hawkesbury/Nepean	215	01/02/2017	4	4
HN528	Cumberland - Hawkesbury/Nepean	217	4/05/2016	536	0
HN528	Cumberland - Hawkesbury/Nepean	239	2/02/2018	100	100
HN528	Cumberland - Hawkesbury/Nepean			47	0
HN528	Cumberland - Hawkesbury/Nepean	250	12/03/2018	205	205
HN528	Cumberland - Hawkesbury/Nepean			25	0
HN528	Cumberland - Hawkesbury/Nepean	256	22/02/2018	103	103
HN528	Cumberland - Hawkesbury/Nepean	274	23/01/2018	65	0
HN528	Cumberland - Hawkesbury/Nepean			5	0
HN528	Cumberland - Hawkesbury/Nepean	321	2/07/2018	23	23
HN528	Cumberland - Hawkesbury/Nepean	336	1/02/2018	13	0
HN528	Cumberland - Hawkesbury/Nepean	339	23/05/2018	45	0

Biodiversity credit type	IBRA subregion	Agreement ID	Date credits issued	Credits	Credits available
HN528	Cumberland - Hawkesbury/Nepean			17	17
HN528	Cumberland - Hawkesbury/Nepean	382	8/05/2018	53	53
HN528	Cumberland - Hawkesbury/Nepean			243	0
HN528	Cumberland - Hawkesbury/Nepean	395	09/04/2018	6	6
HN528	Cumberland - Hawkesbury/Nepean			124	0
HN528	Cumberland - Hawkesbury/Nepean	N/A - pending	N/A - pending	493	N/A - pending
HN529 Grey Box - Forest Red Gum grassy woodland on shale of the southern Cumberland Plain, Sydney Basin Bioregion	Cumberland - Hawkesbury/Nepean	3	28/01/2011	3	0
HN529	Cumberland - Hawkesbury/Nepean	143	12/06/2014	20	0
HN529	Cumberland - Hawkesbury/Nepean			2	0
HN529	Cumberland - Hawkesbury/Nepean			84	0
HN529	Cumberland - Hawkesbury/Nepean			118	118
HN529	Cumberland - Hawkesbury/Nepean	147	31/08/2015	488	488
HN529	Cumberland - Hawkesbury/Nepean			364	0
HN529	Cumberland - Hawkesbury/Nepean	156	30/10/2017	162	162
HN529	Cumberland - Hawkesbury/Nepean	168	15/02/2017	321	0
HN529	Cumberland - Hawkesbury/Nepean	217	04/05/2016	12	0
HN529	Cumberland - Hawkesbury/Nepean	235	14/09/2017	444	444
HN529	Cumberland - Hawkesbury/Nepean	239	02/02/2018	63	63

Biodiversity credit type	IBRA subregion	Agreement ID	Date credits issued	Credits	Credits available
HN529	Cumberland - Hawkesbury/Nepean	250	12/03/2018	589	589
HN529	Cumberland - Hawkesbury/Nepean			250	0
HN529	Cumberland - Hawkesbury/Nepean	274	23/01/2018	7	7
HN529	Cumberland - Hawkesbury/Nepean	284	26/07/2018	1464	1,464
HN529	Cumberland - Hawkesbury/Nepean	321	02/07/2018	362	329
HN529	Cumberland - Hawkesbury/Nepean	336	01/02/2018	25	25
HN529	Cumberland - Hawkesbury/Nepean	354	12/07/2018	339	339
HN529	Cumberland - Hawkesbury/Nepean	358	23/05/2018	148	0
HN529	Cumberland - Hawkesbury/Nepean			97	97
HN529	Cumberland - Hawkesbury/Nepean	395	09/04/2018	27	27
HN529	Cumberland - Hawkesbury/Nepean			193	0
HN529	Cumberland - Hawkesbury/Nepean	399	23/05/2018	185	0
HN529	Cumberland - Hawkesbury/Nepean			163	163
HN529	Cumberland - Hawkesbury/Nepean	N/A - pending	N/A - pending	1660	N/A - pending
Species credits					
Southern Myotis *Myotis macropus*	Upper Hunter	383	23/11/2017	94	94
Southern Myotis	Upper Hunter	331	25/06/2018	235	235
Cumberland Plain Land Snail *Meridolum corneovirens*	Not available	Not available	Not available	465	Unknown
Cumberland Plain Land Snail	Not available	Not available	Not available	292	Unknown
Cumberland Plain Land Snail	Not available	Not available	Not available	270	Unknown
Cumberland Plain Land Snail	Not available	Not available	Not available	251	Unknown

Biodiversity credit type	IBRA subregion	Agreement ID	Date credits issued	Credits	Credits available
Cumberland Plain Land Snail	Not available	Not available	Not available	145	Unknown
Cumberland Plain Land Snail	Not available	Not available	Not available	137	Unknown
Cumberland Plain Land Snail	Not available	Not available	Not available	98	Unknown
Cumberland Plain Land Snail	Not available	Not available	Not available	55	Unknown
Cumberland Plain Land Snail	Not available	Not available	Not available	23	Unknown
Cumberland Plain Land Snail	Not available	Not available	Not available	20	Unknown
Cumberland Plain Land Snail	Not available	Not available	Not available	16	Unknown
Cumberland Plain Land Snail	Not available	Not available	Not available	10	Unknown

Biobank site EOI register search results

Biodiversity credit	IBRA subregion	Date of EOI	ID	Site area (ha)	Date of search
Ecosystem credits					
HN512 Broad-leaved Ironbark - Grey Box - Melaleuca decora grassy open forest on clay/gravel soils of the Cumberland Plain, Sydney Basin Bioregion	Cumberland – Hawkesbury/Nepean	20/11/2014	'Site 1'	1,424	05/04/2019 (updated)
Species credits					
Dillwynia tenuifolia	Cumberland – Hawkesbury/Nepean	20/11/2014	'Site 1'	1,424	05/04/2019 (updated)
	Cumberland – Hawkesbury/Nepean	2/09/2016	'Site 2'	8	05/04/2019 (updated)
Pultenaea parviflora	Cumberland – Hawkesbury/Nepean	20/11/2014	'Site 1'	1,424	05/04/2019 (updated)

Annexure E – Protected matters search tool (PMST)

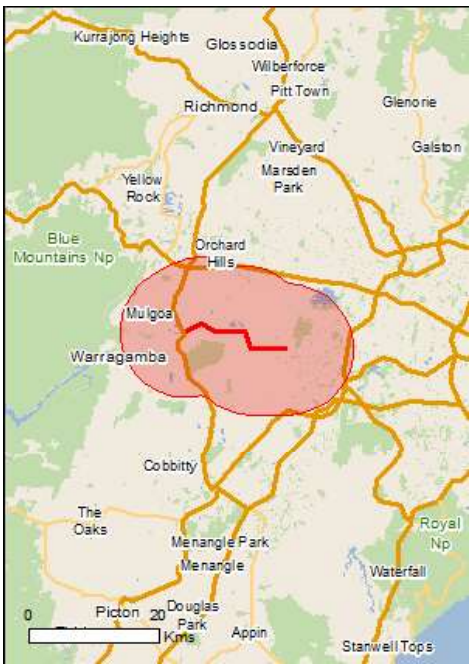
EPBC Act Protected Matters Report

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

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

Information is available about Environment Assessments and the EPBC Act including significance guidelines, forms and application process details.

Report created: 05/04/19 11:53:02



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

Coordinates
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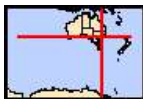


Summary

Matters of National Environmental Significance

This part of the report summarises the matters of national environmental significance that may occur in, or may relate to, the area you nominated. Further information is available in the detail part of the report, which can be accessed by scrolling or following the links below. If you are proposing to undertake an activity that may have a significant impact on one or more matters of national environmental significance then you should consider the Administrative Guidelines on Significance.

World Heritage Properties:	1
National Heritage Places:	1
Wetlands of International Importance:	None
Great Barrier Reef Marine Park:	None
Commonwealth Marine Area:	None
Listed Threatened Ecological Communities:	8
Listed Threatened Species:	50
Listed Migratory Species:	16

Other Matters Protected by the EPBC Act

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

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

A permit may be required for activities in or on a Commonwealth area that may affect a member of a listed threatened species or ecological community, a member of a listed migratory species, whales and other cetaceans, or a member of a listed marine species.

Commonwealth Land:	17
Commonwealth Heritage Places:	1
Listed Marine Species:	22
Whales and Other Cetaceans:	None
Critical Habitats:	None
Commonwealth Reserves Terrestrial:	None
Australian Marine Parks:	None

Extra Information

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

State and Territory Reserves:	5
Regional Forest Agreements:	None
Invasive Species:	50
Nationally Important Wetlands:	None
Key Ecological Features (Marine)	None

Details

Matters of National Environmental Significance

World Heritage Properties [Resource Information]

Name	State	Status
The Greater Blue Mountains Area	NSW	Declared property

National Heritage Properties [Resource Information]

Name	State	Status
Natural		
The Greater Blue Mountains Area	NSW	Listed place

Listed Threatened Ecological Communities [Resource Information]

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

Name	Status	Type of Presence
Castlereagh Scribbly Gum and Agnes Banks Woodlands of the Sydney Basin Bioregion	Endangered	Community likely to occur within area
Coastal Swamp Oak (Casuarina glauca) Forest of New South Wales and South East Queensland ecological community	Endangered	Community likely to occur within area
Cooks River/Castlereagh Ironbark Forest of the Sydney Basin Bioregion	Critically Endangered	Community likely to occur within area
Cumberland Plain Shale Woodlands and Shale-Gravel Transition Forest	Critically Endangered	Community likely to occur within area
Shale Sandstone Transition Forest of the Sydney Basin Bioregion	Critically Endangered	Community likely to occur within area
Turpentine-Ironbark Forest of the Sydney Basin Bioregion	Critically Endangered	Community likely to occur within area
Upland Basalt Eucalypt Forests of the Sydney Basin Bioregion	Endangered	Community likely to occur within area
Western Sydney Dry Rainforest and Moist Woodland on Shale	Critically Endangered	Community likely to occur within area

Listed Threatened Species [Resource Information]

Name	Status	Type of Presence
Birds		
Anthochaera phrygia Regent Honeyeater [82338]	Critically Endangered	Species or species habitat known to occur within area
Botaurus poiciloptilus Australasian Bittern [1001]	Endangered	Species or species habitat known to occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area
Dasyornis brachypterus Eastern Bristlebird [533]	Endangered	Species or species habitat may occur within area
Grantiella picta Painted Honeyeater [470]	Vulnerable	Species or species habitat likely to occur within area
Lathamus discolor Swift Parrot [744]	Critically Endangered	Species or species habitat known to occur

Name	Status	Type of Presence within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat may occur within area
Rostratula australis Australian Painted-snipe, Australian Painted Snipe [77037]	Endangered	Species or species habitat likely to occur within area
Fish		
Maccullochella peelii Murray Cod [66633]	Vulnerable	Species or species habitat may occur within area
Macquaria australasica Macquarie Perch [66632]	Endangered	Species or species habitat may occur within area
Prototroctes maraena Australian Grayling [26179]	Vulnerable	Species or species habitat likely to occur within area
Frogs		
Heleioporus australiacus Giant Burrowing Frog [1973]	Vulnerable	Species or species habitat likely to occur within area
Litoria aurea Green and Golden Bell Frog [1870]	Vulnerable	Species or species habitat known to occur within area
Litoria littlejohni Littlejohn's Tree Frog, Heath Frog [64733]	Vulnerable	Species or species habitat may occur within area
Litoria raniformis Growling Grass Frog, Southern Bell Frog, Green and Golden Frog, Warty Swamp Frog [1828]	Vulnerable	Species or species habitat may occur within area
Mixophyes balbus Stuttering Frog, Southern Barred Frog (in Victoria) [1942]	Vulnerable	Species or species habitat likely to occur within area
Mammals		
Chalinolobus dwyeri Large-eared Pied Bat, Large Pied Bat [183]	Vulnerable	Species or species habitat known to occur within area
Dasyurus maculatus maculatus (SE mainland population) Spot-tailed Quoll, Spotted-tail Quoll, Tiger Quoll (southeastern mainland population) [75184]	Endangered	Species or species habitat known to occur within area
Petauroides volans Greater Glider [254]	Vulnerable	Species or species habitat known to occur within area
Petrogale penicillata Brush-tailed Rock-wallaby [225]	Vulnerable	Species or species habitat likely to occur within area
Phascolarctos cinereus (combined populations of Qld, NSW and the ACT) Koala (combined populations of Queensland, New South Wales and the Australian Capital Territory) [85104]	Vulnerable	Species or species habitat known to occur within area
Pseudomys novaehollandiae New Holland Mouse, Pookila [96]	Vulnerable	Species or species habitat may occur within area
Pteropus poliocephalus Grey-headed Flying-fox [186]	Vulnerable	Roosting known to occur within area
Other		

Name	Status	Type of Presence
Pommerhelix duralensis Dural Land Snail [85268]	Endangered	Species or species habitat known to occur within area
Plants		
Acacia bynoeana Bynoe's Wattle, Tiny Wattle [8575]	Vulnerable	Species or species habitat may occur within area
Acacia pubescens Downy Wattle, Hairy Stemmed Wattle [18800]	Vulnerable	Species or species habitat known to occur within area
Allocasuarina glareicola [21932]	Endangered	Species or species habitat likely to occur within area
Cryptostylis hunteriana Leafless Tongue-orchid [19533]	Vulnerable	Species or species habitat may occur within area
Cynanchum elegans White-flowered Wax Plant [12533]	Endangered	Species or species habitat known to occur within area
Eucalyptus aggregata Black Gum [20890]	Vulnerable	Species or species habitat may occur within area
Eucalyptus benthamii Camden White Gum, Nepean River Gum [2821]	Vulnerable	Species or species habitat known to occur within area
Genoplesium baueri Yellow Gnat-orchid [7528]	Endangered	Species or species habitat may occur within area
Grevillea parviflora subsp. parviflora Small-flower Grevillea [64910]	Vulnerable	Species or species habitat known to occur within area
Haloragis exalata subsp. exalata Wingless Raspwort, Square Raspwort [24636]	Vulnerable	Species or species habitat may occur within area
Leucopogon exolasius Woronora Beard-heath [14251]	Vulnerable	Species or species habitat likely to occur within area
Melaleuca deanei Deane's Melaleuca [5818]	Vulnerable	Species or species habitat may occur within area
Persoonia acerosa Needle Geebung [7232]	Vulnerable	Species or species habitat likely to occur within area
Persoonia hirsuta Hairy Geebung, Hairy Persoonia [19006]	Endangered	Species or species habitat likely to occur within area
Persoonia nutans Nodding Geebung [18119]	Endangered	Species or species habitat known to occur within area
Pimelea curviflora var. curviflora [4182]	Vulnerable	Species or species habitat may occur within area
Pimelea spicata Spiked Rice-flower [20834]	Endangered	Species or species habitat known to occur within area

Name	Status	Type of Presence
Pomaderris brunnea Rufous Pomaderris [16845]	Vulnerable	Species or species habitat likely to occur within area
Pterostylis gibbosa Illawarra Greenhood, Rufa Greenhood, Pouched Greenhood [4562]	Endangered	Species or species habitat may occur within area
Pterostylis saxicola Sydney Plains Greenhood [64537]	Endangered	Species or species habitat likely to occur within area
Pultenaea glabra Smooth Bush-pea, Swamp Bush-pea [11887]	Vulnerable	Species or species habitat likely to occur within area
Pultenaea parviflora [19380]	Vulnerable	Species or species habitat known to occur within area
Syzygium paniculatum Magenta Lilly Pilly, Magenta Cherry, Daguba, Scrub Cherry, Creek Lilly Pilly, Brush Cherry [20307]	Vulnerable	Species or species habitat likely to occur within area
Thelymitra kangaloonica Kangaloon Sun Orchid [81861]	Critically Endangered	Species or species habitat may occur within area
Thesium australe Austral Toadflax, Toadflax [15202]	Vulnerable	Species or species habitat may occur within area
Reptiles		
Hoplocephalus bungaroides Broad-headed Snake [1182]	Vulnerable	Species or species habitat may occur within area

Listed Migratory Species [Resource Information]

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

Name	Threatened	Type of Presence
Migratory Marine Birds		
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Migratory Terrestrial Species		
Cuculus optatus Oriental Cuckoo, Horsfield's Cuckoo [86651]		Species or species habitat known to occur within area
Hirundapus caudacutus White-throated Needletail [682]		Species or species habitat known to occur within area
Monarcha melanopsis Black-faced Monarch [609]		Species or species habitat known to occur within area
Monarcha trivirgatus Spectacled Monarch [610]		Species or species habitat known to occur within area
Motacilla flava Yellow Wagtail [644]		Species or species habitat likely to occur within area
Myiagra cyanoleuca Satin Flycatcher [612]		Species or species habitat known to occur within area

Name	Threatened	Type of Presence
Rhipidura rufifrons Rufous Fantail [592]		Species or species habitat known to occur within area
Migratory Wetlands Species		
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat likely to occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]		Species or species habitat likely to occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat may occur within area
Gallinago hardwickii Latham's Snipe, Japanese Snipe [863]		Species or species habitat may occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat may occur within area
Pandion haliaetus Osprey [952]		Species or species habitat known to occur within area
Tringa nebularia Common Greenshank, Greenshank [832]		Species or species habitat likely to occur within area

Other Matters Protected by the EPBC Act

Commonwealth Land [Resource Information]

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

Name
Commonwealth Land -
Commonwealth Land - Australian Postal Commission
Commonwealth Land - Australian Postal Corporation
Commonwealth Land - Australian Telecommunications Commission
Commonwealth Land - Australian Telecommunications Corporation
Commonwealth Land - Commonwealth Trading Bank of Australia
Commonwealth Land - Defence Housing Authority
Commonwealth Land - Defence Service Homes Corporation
Commonwealth Land - Deputy Director of War Service Homes
Commonwealth Land - Director of War Service Homes
Commonwealth Land - Overseas Telecommunications Commission (Australia)
Commonwealth Land - Telstra Corporation Limited
Defence - 1CAD ORCHARD HILLS KINGSWOOD
Defence - BRINGELLY RADIO RECEIVING STATION
Defence - INGLEBURN AREA (Bardia Barracks)
Defence - RANMME (DEOH)
Defence - SIGNAL STRS DEPOT-KINGSWOOD

Commonwealth Heritage Places [Resource Information]

Name	State	Status
Natural		
Orchard Hills Cumberland Plain Woodland	NSW	Listed place

Listed Marine Species		[Resource Information]
* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.		
Name	Threatened	Type of Presence
Birds		
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat likely to occur within area
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Ardea alba Great Egret, White Egret [59541]		Species or species habitat known to occur within area
Ardea ibis Cattle Egret [59542]		Species or species habitat may occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]		Species or species habitat likely to occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat may occur within area
Chrysococcyx osculans Black-eared Cuckoo [705]		Species or species habitat likely to occur within area
Gallinago hardwickii Latham's Snipe, Japanese Snipe [863]		Species or species habitat may occur within area
Haliaeetus leucogaster White-bellied Sea-Eagle [943]		Species or species habitat known to occur within area
Hirundapus caudacutus White-throated Needletail [682]		Species or species habitat known to occur within area
Lathamus discolor Swift Parrot [744]	Critically Endangered	Species or species habitat known to occur within area
Merops ornatus Rainbow Bee-eater [670]		Species or species habitat may occur within area
Monarcha melanopsis Black-faced Monarch [609]		Species or species habitat known to occur within area
Monarcha trivirgatus Spectacled Monarch [610]		Species or species habitat known to occur within area
Motacilla flava Yellow Wagtail [644]		Species or species habitat likely to occur within area
Myiagra cyanoleuca Satin Flycatcher [612]		Species or species habitat known to occur within area

Name	Threatened	Type of Presence
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat may occur within area
Pandion haliaetus Osprey [952]		Species or species habitat known to occur within area
Rhipidura rufifrons Rufous Fantail [592]		Species or species habitat known to occur within area
Rostratula benghalensis (sensu lato) Painted Snipe [889]	Endangered*	Species or species habitat likely to occur within area
Tringa nebularia Common Greenshank, Greenshank [832]		Species or species habitat likely to occur within area

Extra Information

State and Territory Reserves [Resource Information]

Name	State
Bents Basin	NSW
Blue Mountains	NSW
Kemps Creek	NSW
Mulgoa	NSW
Prospect	NSW

Invasive Species [Resource Information]

Weeds reported here are the 20 species of national significance (WoNS), along with other introduced plants that are considered by the States and Territories to pose a particularly significant threat to biodiversity. The following feral animals are reported: Goat, Red Fox, Cat, Rabbit, Pig, Water Buffalo and Cane Toad. Maps from Landscape Health Project, National Land and Water Resouces Audit, 2001.

Name	Status	Type of Presence
Birds		
Acridotheres tristis Common Myna, Indian Myna [387]		Species or species habitat likely to occur within area
Alauda arvensis Skylark [656]		Species or species habitat likely to occur within area
Anas platyrhynchos Mallard [974]		Species or species habitat likely to occur within area
Carduelis carduelis European Goldfinch [403]		Species or species habitat likely to occur within area
Carduelis chloris European Greenfinch [404]		Species or species habitat likely to occur within area
Columba livia Rock Pigeon, Rock Dove, Domestic Pigeon [803]		Species or species habitat likely to occur within area
Lonchura punctulata Nutmeg Mannikin [399]		Species or species habitat likely to occur within area
Passer domesticus House Sparrow [405]		Species or species

Name	Status	Type of Presence
		habitat likely to occur within area
Passer montanus Eurasian Tree Sparrow [406]		Species or species habitat likely to occur within area
Pycnonotus jocosus Red-whiskered Bulbul [631]		Species or species habitat likely to occur within area
Streptopelia chinensis Spotted Turtle-Dove [780]		Species or species habitat likely to occur within area
Sturnus vulgaris Common Starling [389]		Species or species habitat likely to occur within area
Turdus merula Common Blackbird, Eurasian Blackbird [596]		Species or species habitat likely to occur within area
Frogs		
Rhinella marina Cane Toad [83218]		Species or species habitat known to occur within area
Mammals		
Bos taurus Domestic Cattle [16]		Species or species habitat likely to occur within area
Canis lupus familiaris Domestic Dog [82654]		Species or species habitat likely to occur within area
Felis catus Cat, House Cat, Domestic Cat [19]		Species or species habitat likely to occur within area
Feral deer Feral deer species in Australia [85733]		Species or species habitat likely to occur within area
Lepus capensis Brown Hare [127]		Species or species habitat likely to occur within area
Mus musculus House Mouse [120]		Species or species habitat likely to occur within area
Oryctolagus cuniculus Rabbit, European Rabbit [128]		Species or species habitat likely to occur within area
Rattus norvegicus Brown Rat, Norway Rat [83]		Species or species habitat likely to occur within area
Rattus rattus Black Rat, Ship Rat [84]		Species or species habitat likely to occur within area
Vulpes vulpes Red Fox, Fox [18]		Species or species habitat likely to occur within area
Plants		
Alternanthera philoxeroides Alligator Weed [11620]		Species or species habitat likely to occur within area

Name	Status	Type of Presence
Anredera cordifolia Madeira Vine, Jalap, Lamb's-tail, Mignonette Vine, Anredera, Gulf Madeiravine, Heartleaf Madeiravine, Potato Vine [2643]		Species or species habitat likely to occur within area
Asparagus aethiopicus Asparagus Fern, Ground Asparagus, Basket Fern, Sprengi's Fern, Bushy Asparagus, Emerald Asparagus [62425]		Species or species habitat likely to occur within area
Asparagus asparagoides Bridal Creeper, Bridal Veil Creeper, Smilax, Florist's Smilax, Smilax Asparagus [22473]		Species or species habitat likely to occur within area
Asparagus plumosus Climbing Asparagus-fern [48993]		Species or species habitat likely to occur within area
Cabomba caroliniana Cabomba, Fanwort, Carolina Watershield, Fish Grass, Washington Grass, Watershield, Carolina Fanwort, Common Cabomba [5171]		Species or species habitat likely to occur within area
Chrysanthemoides monilifera Bitou Bush, Boneseed [18983]		Species or species habitat may occur within area
Chrysanthemoides monilifera subsp. monilifera Boneseed [16905]		Species or species habitat likely to occur within area
Cytisus scoparius Broom, English Broom, Scotch Broom, Common Broom, Scottish Broom, Spanish Broom [5934]		Species or species habitat likely to occur within area
Dolichandra unguis-cati Cat's Claw Vine, Yellow Trumpet Vine, Cat's Claw Creeper, Funnel Creeper [85119]		Species or species habitat likely to occur within area
Eichhornia crassipes Water Hyacinth, Water Orchid, Nile Lily [13466]		Species or species habitat likely to occur within area
Genista monspessulana Montpellier Broom, Cape Broom, Canary Broom, Common Broom, French Broom, Soft Broom [20126]		Species or species habitat likely to occur within area
Genista sp. X Genista monspessulana Broom [67538]		Species or species habitat may occur within area
Lantana camara Lantana, Common Lantana, Kamara Lantana, Large-leaf Lantana, Pink Flowered Lantana, Red Flowered Lantana, Red-Flowered Sage, White Sage, Wild Sage [10892]		Species or species habitat likely to occur within area
Lycium ferocissimum African Boxthorn, Boxthorn [19235]		Species or species habitat likely to occur within area
Nassella neesiana Chilean Needle grass [67699]		Species or species habitat likely to occur within area
Nassella trichotoma Serrated Tussock, Yass River Tussock, Yass Tussock, Nassella Tussock (NZ) [18884]		Species or species habitat likely to occur within area
Opuntia spp. Prickly Pears [82753]		Species or species habitat likely to occur within area
Pinus radiata Radiata Pine Monterey Pine, Insignis Pine, Wilding Pine [20780]		Species or species habitat may occur within area

Name	Status	Type of Presence
Rubus fruticosus aggregate		
Blackberry, European Blackberry [68406]		Species or species habitat likely to occur within area
Sagittaria platyphylla		
Delta Arrowhead, Arrowhead, Slender Arrowhead [68483]		Species or species habitat likely to occur within area
Salix spp. except S.babylonica, S.x calodendron & S.x reichardtii		
Willows except Weeping Willow, Pussy Willow and Sterile Pussy Willow [68497]		Species or species habitat likely to occur within area
Salvinia molesta		
Salvinia, Giant Salvinia, Aquarium Watermoss, Kariba Weed [13665]		Species or species habitat likely to occur within area
Senecio madagascariensis		
Fireweed, Madagascar Ragwort, Madagascar Groundsel [2624]		Species or species habitat likely to occur within area
Ulex europaeus		
Gorse, Furze [7693]		Species or species habitat likely to occur within area
Reptiles		
Hemidactylus frenatus		
Asian House Gecko [1708]		Species or species habitat likely to occur within area

Caveat

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

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

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

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

Threatened, migratory and marine species distributions have been derived through a variety of methods. Where distributions are well known and if time permits, maps are derived using either thematic spatial data (i.e. vegetation, soils, geology, elevation, aspect, terrain, etc) together with point locations and described habitat; or environmental modelling (MAXENT or BIOCLIM habitat modelling) using point locations and environmental data layers.

Where very little information is available for species or large number of maps are required in a short time-frame, maps are derived either from 0.04 or 0.02 decimal degree cells; by an automated process using polygon capture techniques (static two kilometre grid cells, alpha-hull and convex hull); or captured manually or by using topographic features (national park boundaries, islands, etc). In the early stages of the distribution mapping process (1999-early 2000s) distributions were defined by degree blocks, 100K or 250K map sheets to rapidly create distribution maps. More reliable distribution mapping methods are used to update these distributions as time permits.

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

- migratory and
- marine

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

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

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

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

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

Coordinates

-33.86 150.7,-33.85 150.72,-33.86 150.74,-33.86 150.77,-33.86 150.78,-33.88 150.79,-33.88 150.81,-33.88 150.83,-33.88 150.84

Acknowledgements

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

-Office of Environment and Heritage, New South Wales
-Department of Environment and Primary Industries, Victoria
-Department of Primary Industries, Parks, Water and Environment, Tasmania
-Department of Environment, Water and Natural Resources, South Australia
-Department of Land and Resource Management, Northern Territory
-Department of Environmental and Heritage Protection, Queensland
-Department of Parks and Wildlife, Western Australia
-Environment and Planning Directorate, ACT
-Birdlife Australia
-Australian Bird and Bat Banding Scheme
-Australian National Wildlife Collection
-Natural history museums of Australia
-Museum Victoria
-Australian Museum
-South Australian Museum
-Queensland Museum
-Online Zoological Collections of Australian Museums
-Queensland Herbarium
-National Herbarium of NSW
-Royal Botanic Gardens and National Herbarium of Victoria
-Tasmanian Herbarium
-State Herbarium of South Australia
-Northern Territory Herbarium
-Western Australian Herbarium
-Australian National Herbarium, Canberra
-University of New England
-Ocean Biogeographic Information System
-Australian Government, Department of Defence
Forestry Corporation, NSW
-Geoscience Australia
-CSIRO
-Australian Tropical Herbarium, Cairns
-eBird Australia
-Australian Government – Australian Antarctic Data Centre
-Museum and Art Gallery of the Northern Territory
-Australian Government National Environmental Science Program
-Australian Institute of Marine Science
-Reef Life Survey Australia
-American Museum of Natural History
-Queen Victoria Museum and Art Gallery, Inveresk, Tasmania
-Tasmanian Museum and Art Gallery, Hobart, Tasmania
-Other groups and individuals

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

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

Department of the Environment
GPO Box 787
Canberra ACT 2601 Australia
+61 2 6274 1111

Annexure F – Microbat echolocation call analysis

Introduction

This memo outlines the methods and results of microbat echolocation call analysis undertaken for the M12 biodiversity assessment. Desktop assessment identified the potential occurrence of eight microbat species listed as threatened under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) and/or the NSW *Threatened Species Conservation Act 1995* (TSC Act). Threatened species considered from the desktop assessment as potential to occur within the study area are listed below:

- Eastern Bentwing-bat (*Miniopterus schreibersii oceanensis*) (V – TSC Act)
- Eastern False Pipistrelle (*Falsistrellus tasmaniensis*) (V – TSC Act)
- Eastern Freetail-bat (*Mormopterus norfolkensis*) (V – TSC Act)
- Greater Broad-nosed Bat (*Scoteanax rueppellii*) (V – TSC Act)
- Large-eared Pied Bat (*Chalinolobus dwyeri*) (V – EPBC Act and TSC Act)
- Little Bentwing-bat (*Miniopterus australis*) (V – TSC Act)
- Southern Myotis (*Myotis macropus*) (V – TSC Act)
- Yellow-bellied Sheathtail-bat (*Saccolaimus flaviventris*) (V – TSC Act)

Methods

Field surveys

Two microbat echolocation call recording devices ‘Anabat SD1’ (Titley Pty Ltd) were deployed at six sites within the study area during the survey. Call recording sites were selected to sample the diversity of potential microbat habitats within the study area (Figure 4-1 of the Biodiversity Assessment Report (BAR)). Each device was moved after a period of three or four nights, and each device was used at a total of three recording sites.

Analysis of data collected during surveys indicated that data was not recorded for every night of survey. Only one night of data was recorded at each of five of the survey locations. One survey location did not record any bat call data.

A summary of survey effort is outlined in **Table 1** below.

Table 1 A summary of microbat echolocation survey effort

Anabat Site	Site Description	Device Serial No.	Set – Collect Dates (intended survey effort)	Data time and date stamps of first and last bat calls (actual survey effort)
1	Woodland habitat adjacent to dam on the west side of M7 in Western Sydney Parklands	SN80224	9 – 13 November 2017 (4 nights)	No data recorded (0 nights)
2	Woodland habitat adjacent to track leading to water reservoir on the south side of Elizabeth Drive in Western Sydney Parklands	SN81287	9 – 13 November 2017 (4 nights)	8.40pm – 9/11/17 to 2.55am – 10/11/17 (1 night)
3	Riparian Forest habitat adjacent to Kemps Creek to the north of Elizabeth Drive	SN80224	16 – 20 November 2017 (4 nights)	8.07pm – 16/11/17 to 5.24am – 17/11/17 (1 night)
4	Riparian Forest habitat adjacent to South Creek to the north of Elizabeth Drive	SN80224	13 – 16 November 2017 (3 nights)	8.06pm – 13/11/17 to 5.18am – 14/11/17 (1 night)
5	Riparian Forest habitat adjacent to Badgerys Creek to the north of Elizabeth Drive	SN81287	13 – 16 November 2017 (3 nights)	8.01pm – 13/11/17 to 5.21am – 14/11/17 (1 night)

Anabat Site	Site Description	Device Serial No.	Set – Collect Dates (intended survey effort)	Data time and date stamps of first and last bat calls (actual survey effort)
6	Grassland habitat adjacent to large dam between Badgerys and Cosgroves Creeks to the north of Elizabeth Drive	SN81287	16 – 20 November 2017 (4 nights)	8.14pm – 16/11/17 to 5.12am – 17/11/17 (1 night)

Weather conditions during the study period were consistently warm and clear throughout the survey period. Variations in weather conditions during the survey period are therefore considered unlikely to contribute to the lack of data collected on some nights. The weather records from the Horsley Park weather station (station 067119) for the surveyed dates, and total rainfall for the week before surveys, are detailed below in **Table 2.**

Table 2 Summary of weather conditions during microbat surveys

Date	Temperature		Rain	Maximum wind gust	
	Min (°C)	Max (°C)	mm	Direction	Speed (km/h)
2-8 November 2017 (1 week before surveys)	-	-	17.2 (total over 1 week)	-	-
9 November 2017	9.4	23.9	0	E	28
10 November 2017	10.3	25	0	E	31
11 November 2017	11.7	25.7	0	E	33
12 November 2017	12.4	24.6	0	E	33
13 November 2017	14	23.9	0	E	35
14 November 2017	11.4	24.7	0	E	37

Date	Temperature		Rain	Maximum wind gust	
	Min (°C)	Max (°C)	mm	Direction	Speed (km/h)
15 November 2017	12.7	27.9	0	ENE	35
16 November 2017	13.9	26.1	0	E	28
17 November 2017	16.1	26.6	0	ENE	41
18 November 2017	19.1	24.6	0	ESE	44
19 November 2017	15.6	25.8	0	SE	43
20 November 2017	13.4	24.3	0	ESE	35

Echolocation call analysis

Echolocation calls recorded during surveys were analysed by Arcadis ecologist Carl Corden. Carl has over 16 years' experience as a consultant ecologist and has undertaken microbat echolocation call analysis for a large number of projects across eastern Australia.

Calls were extracted, viewed and analysed using 'AnalookW for bat call analysis using ZCA - Version 4.2n 16 March 2017' software (Chris Corben, Copyright © 2017). Calls were identified with reference to 'Bat Calls of NSW' (Pennay et al., 2004). The report has been prepared in accordance with the 'Standards for reporting bat detector surveys' (Australasian Bat Society Inc. n.d)

Where possible, calls were identified to species or genus based on the presence/absence of determinate features such as frequency, shape, pulse intervals and other indicative features (e.g. alternations in frequency within call sequences). Details of identification features used are provided for calls of each species identified in Appendix 1.

Results

Eleven species from nine genera were identified as 'probable' or 'definite' from echolocation calls recorded across the study area (**Table 3**). This level of confidence is considered adequate to assume presence of these taxa within the study area.

Three additional microbat species were identified as 'possible' from calls recorded during the survey. These call records did not show the characteristics required to adequately distinguish them from other species with calls at similar frequencies. Identification of 'possible' calls is not considered adequate to confirm occurrence of these species; however threatened species should be 'assumed present' when assessing potential impacts.

Species identified from analysis of the call data and levels of confidence are provided in **Table 3**. Example calls recorded, and characteristics used to determine species/genus identity are provided as Appendix 1.

Table 3 A summary of microbat species/genus identified from the M12 study area

Scientific Name*	Common Name	TSC Act	Confidence
MOLISSIDAE			
Austronomus (Tadarida) australis	White-striped Freetail Bat	-	Definite
Mormopterus (Micronomus) norfolkensis	Eastern Freetail-bat	V	Probable
Mormopterus (Ozimops) ridei	Eastern Free-tailed Bat	-	Definite

Scientific Name*	Common Name	TSC Act	Confidence
EMBALLONURIDAE			
Saccolaimus flaviventris	Yellow-bellied Sheathtail-bat	V	Probable
VESPERTILIONIDAE			
Nyctophilinae			
Nyctophilus sp.	Unidentified Long-eared Bat	-	Definite
Vespertilioninae			
Chalinolobus gouldii	Gould's Wattled Bat	-	Definite
Chalinolobus morio	Chocolate Wattled Bat	-	Definite
Falsistrellus tasmaniensis	Eastern False Pipistrelle	V	Possible
Myotis macropus	Southern Myotis	V	Possible
Scoteanax rueppellii	Greater Broad-nosed Bat	V	Probable
Scotorepens orion	Eastern Broad-nosed Bat	-	Possible
Vespadelus vulturnus	Little Forest Bat	-	Definite
MINIOPTERIDAE			
Miniopterus australis	Little Bentwing-bat	V	Probable
Miniopterus schreibersii oceanensis	Eastern Bentwing-bat	V	Definite

* ABRS 2009. *Australian Faunal Directory.* Australian Biological Resources Study, Canberra. Viewed 5 October 2018.

Conclusion

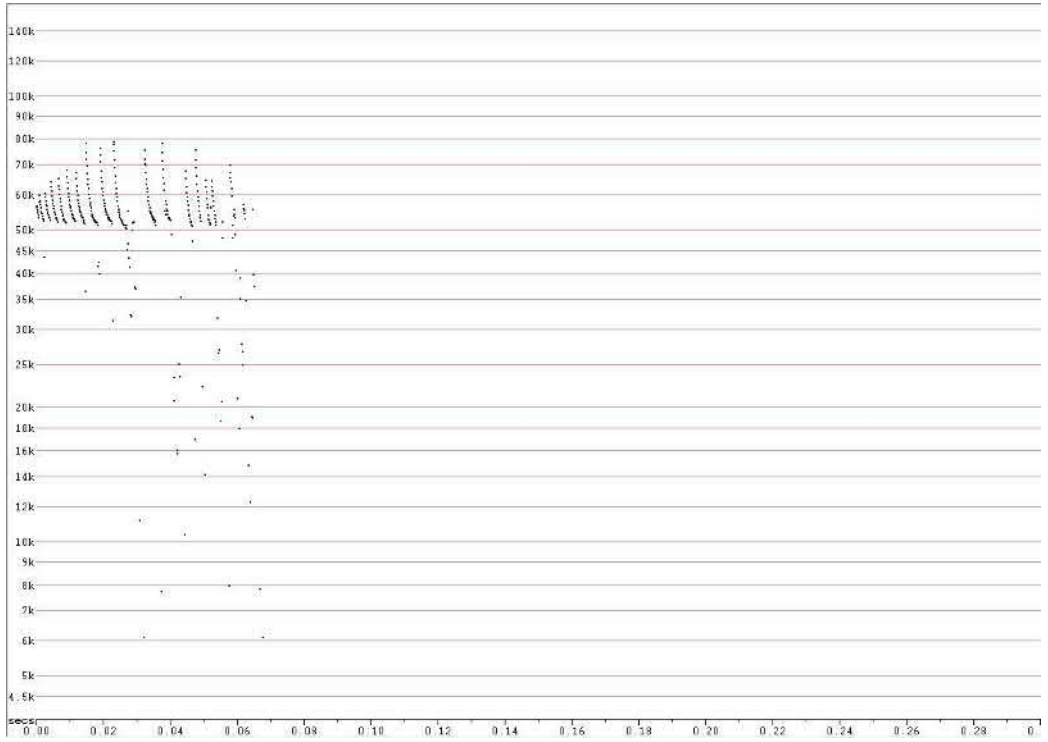
Eleven species of microbat were identified as ‘definite’ or ‘probable’ across five different locations within the study area (Appendix 1). This included five species listed as Vulnerable under the TSC Act. None of these species are listed as threatened under the EPBC Act.

Given the limitations of the survey it is recommended that a precautionary approach should be taken, and those species recorded as ‘possible’ (*F. tasmaniensis* and *M. macropus*) are assumed to occur where suitable habitat is present within the study area.

Appendix 1 – Example call sequences

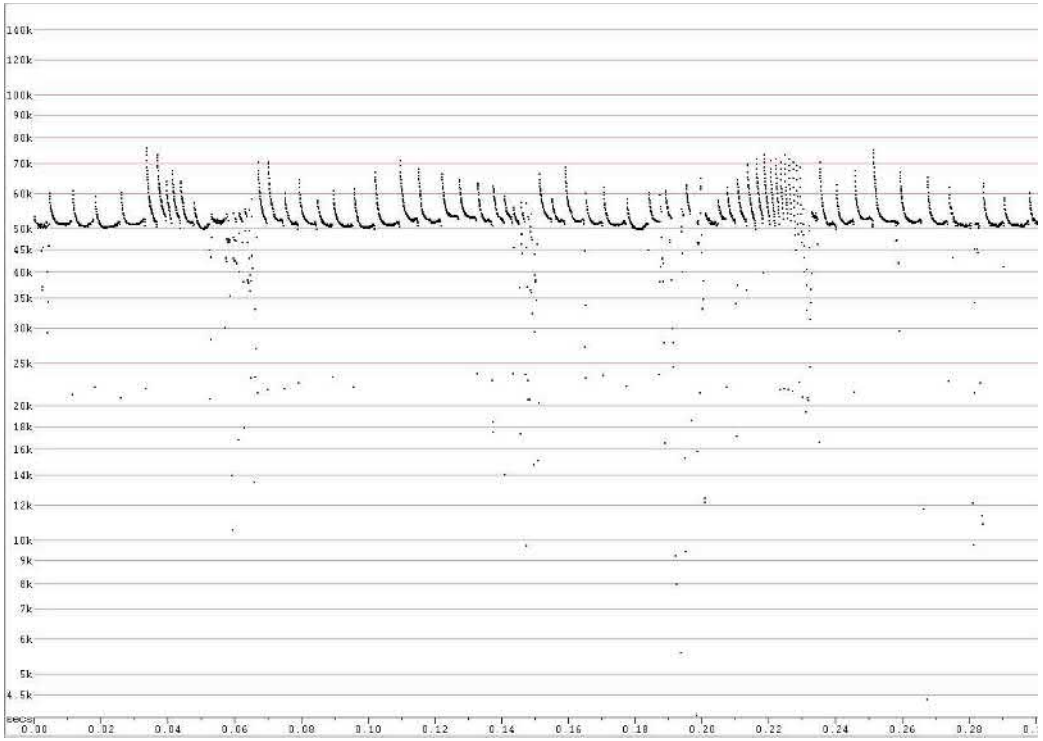
Chocolate Wattled-bat *Chalinolobus morio*

Calls overlap in frequency with Little Forest Bat *Vespadelus vulturnus*. Calls identified as Chocolate Wattled-bat based on call shape (down-sweeping tail), slight alternation between pulses and characteristic frequency (52kHz).



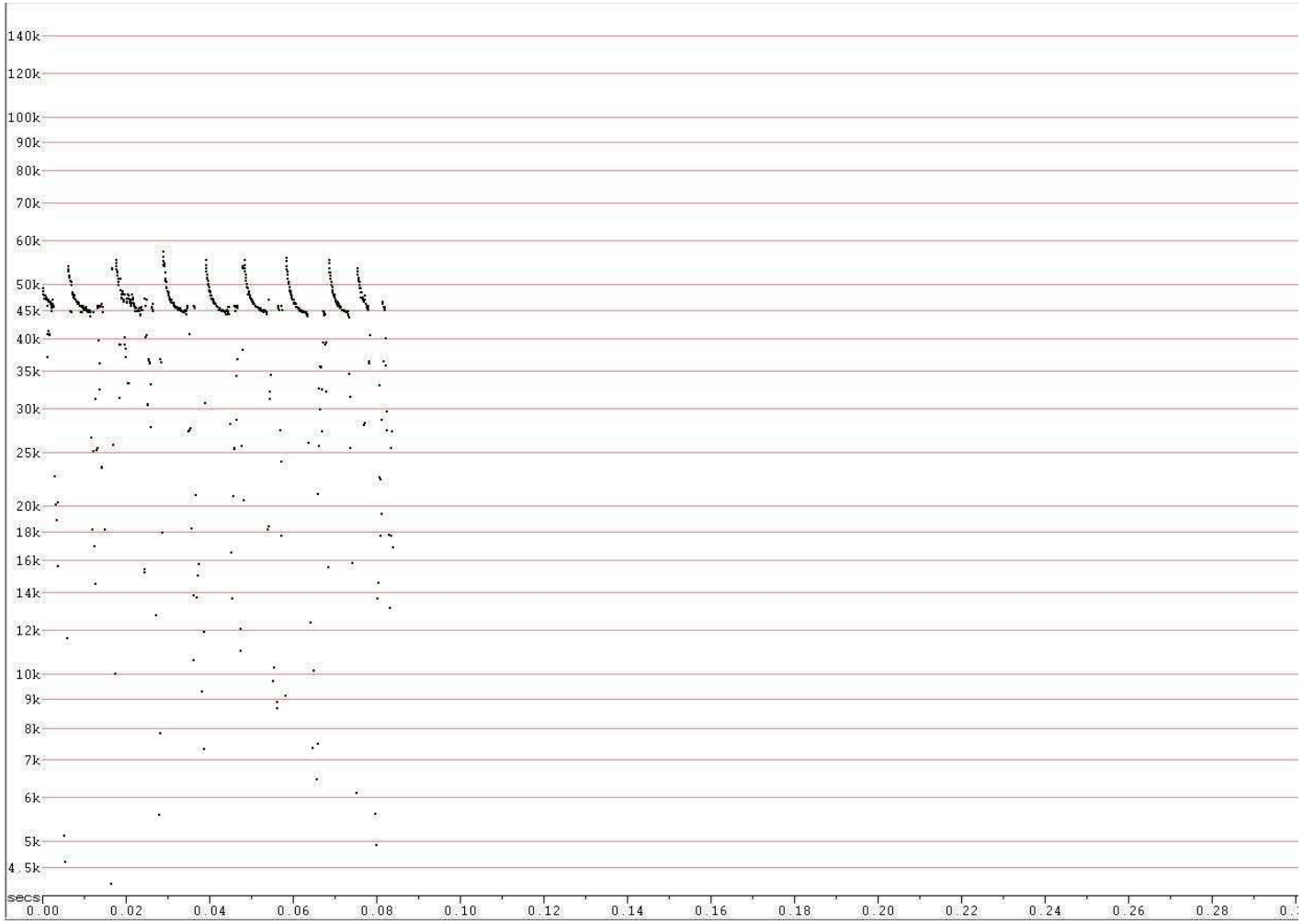
Little Forest Bat *Vespadelus vulturnus*

Calls overlap in frequency with Chocolate Wattled-bat *Chalinolobus morio*. Calls identified as Little Forest Bat based on call shape (up-sweeping tail), high frequency variation within sequence (probably due to Doppler effect resulting from tight circling behaviour) and characteristic frequency (52kHz).



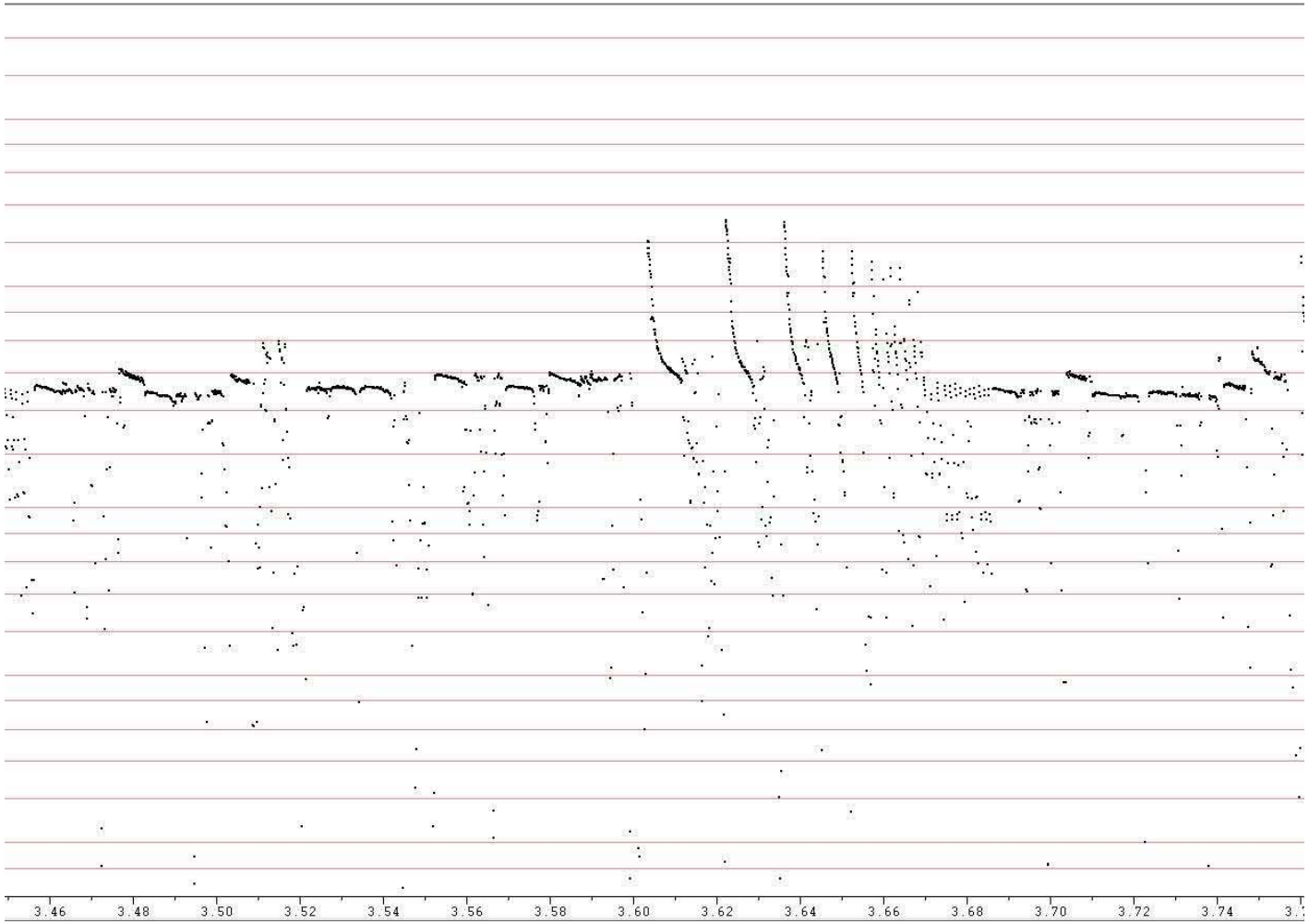
Eastern Bentwing-bat *Miniopterus schreibersii oceanensis*

Calls identified based on call shape (down-sweeping tail), variations in pulse shapes within the sequence and characteristic frequency (45kHz).



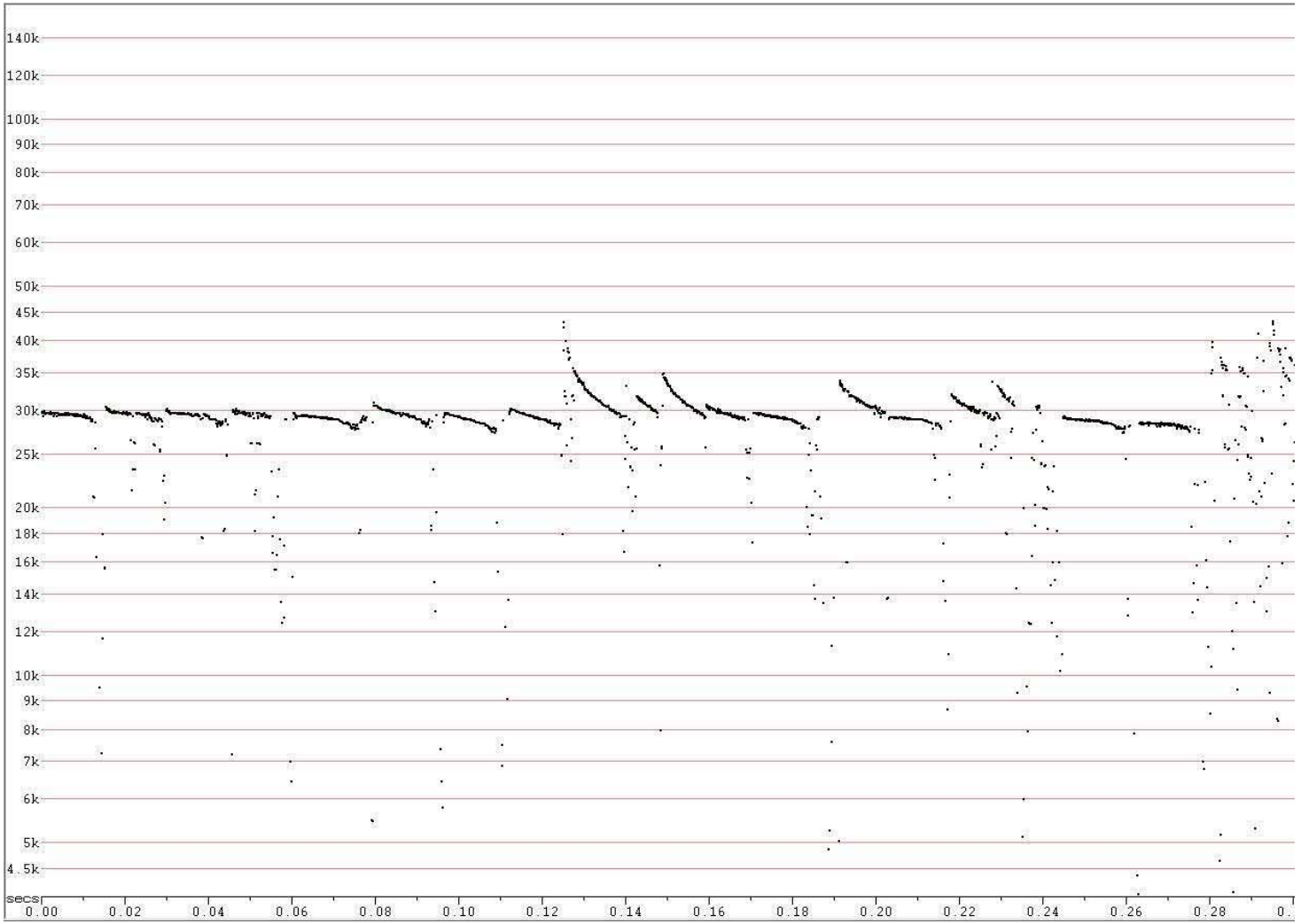
Eastern Freetail-bat *Mormopterus norfolkensis*

Calls identified based on call shape (flat with down-sweeping tail), occasional variations in pulse shapes within the sequence and characteristic frequency (33kHz lower frequency, 35kHz occasional higher frequency).



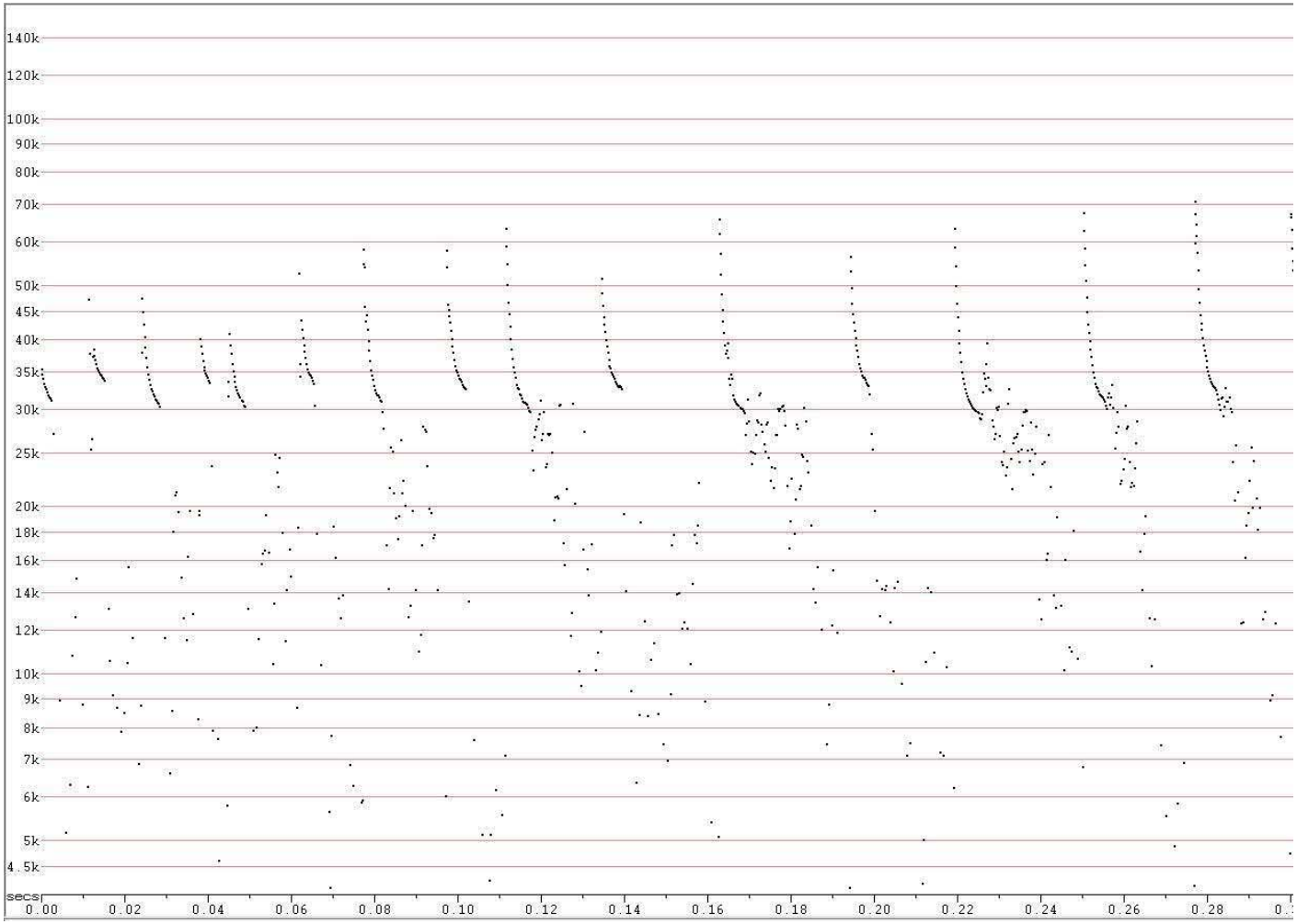
Eastern Free-tailed Bat *Mormopterus ridei*

Calls identified based on call shape (flat), characteristic frequency (30 kHz) and lack of regular alternating pulses.



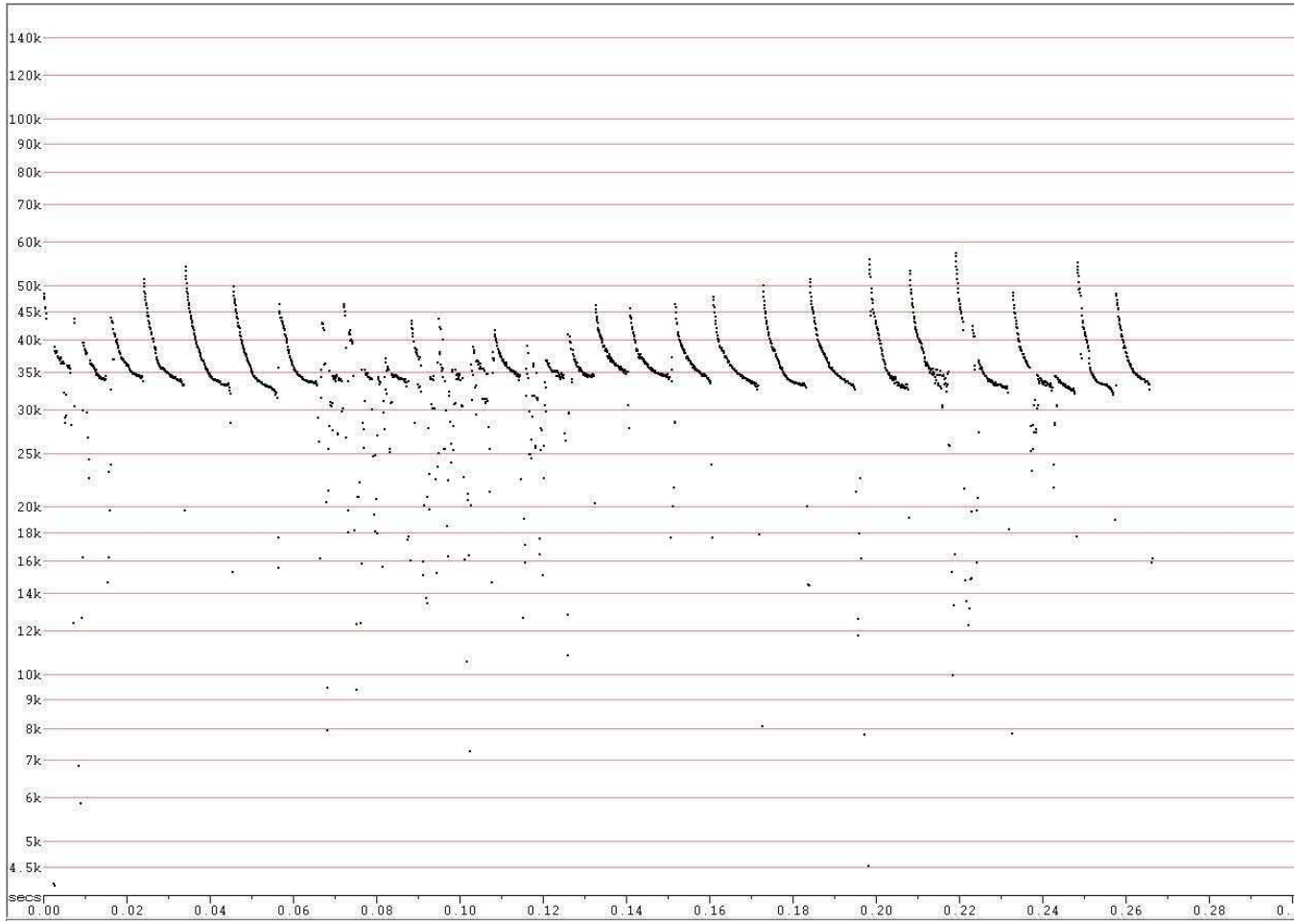
Gould's Wattled Bat *Chalinolobus gouldii*

Calls identified based on call shape (down-sweeping tail), regular alternating pulses and characteristic frequencies (31kHz for lower pulses, 33kHz for alternating higher pulses).



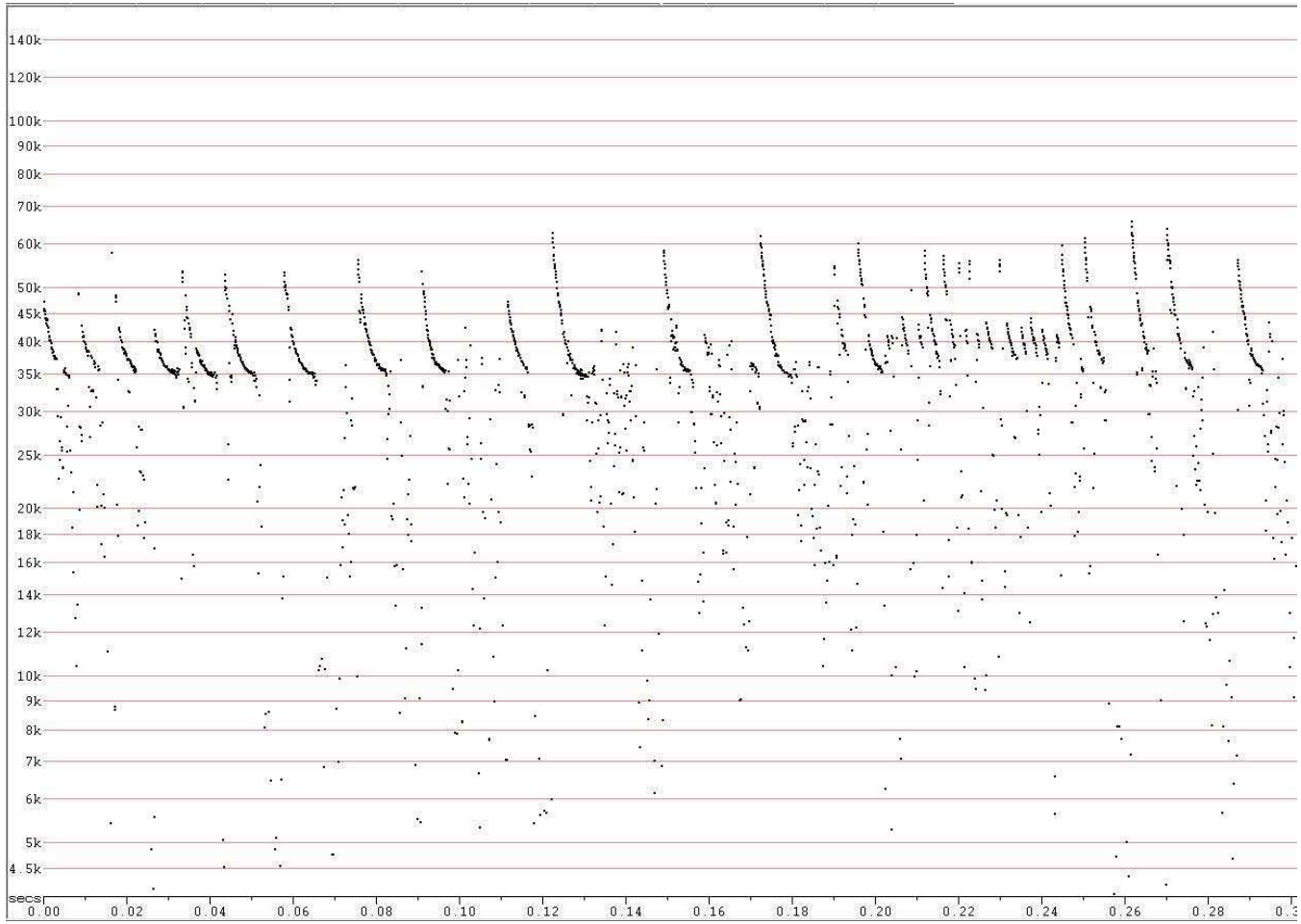
Greater Broad-nosed Bat *Scoteanax rueppellii*

Calls overlap in frequency with Eastern False Pipistrelle *Falsistrellus tasmaniensis* and Eastern Broad-nosed Bat *Scotorepens orion*. Calls above 35kHz are ‘possible’ records for any of these three species. Some calls identified as ‘probable’ Greater Broad-nosed Bat based on call shape (down-sweeping tail) and characteristic frequency of some calls (34kHz) which is below range of other similar species.



Eastern False Pipistrelle *Falsistrellus tasmaniensis*

Calls considered ‘possible’ for Eastern False Pipistrelle *Falistrellus tasmaniensis*, Greater Broad-nosed Bat *Scoteanax rueppellii* or Eastern Broad-nosed Bat *Scotorepens orion*. Calls are ‘possible’ records for any of these three species given overlapping frequency (35kHz) and similar call shape.

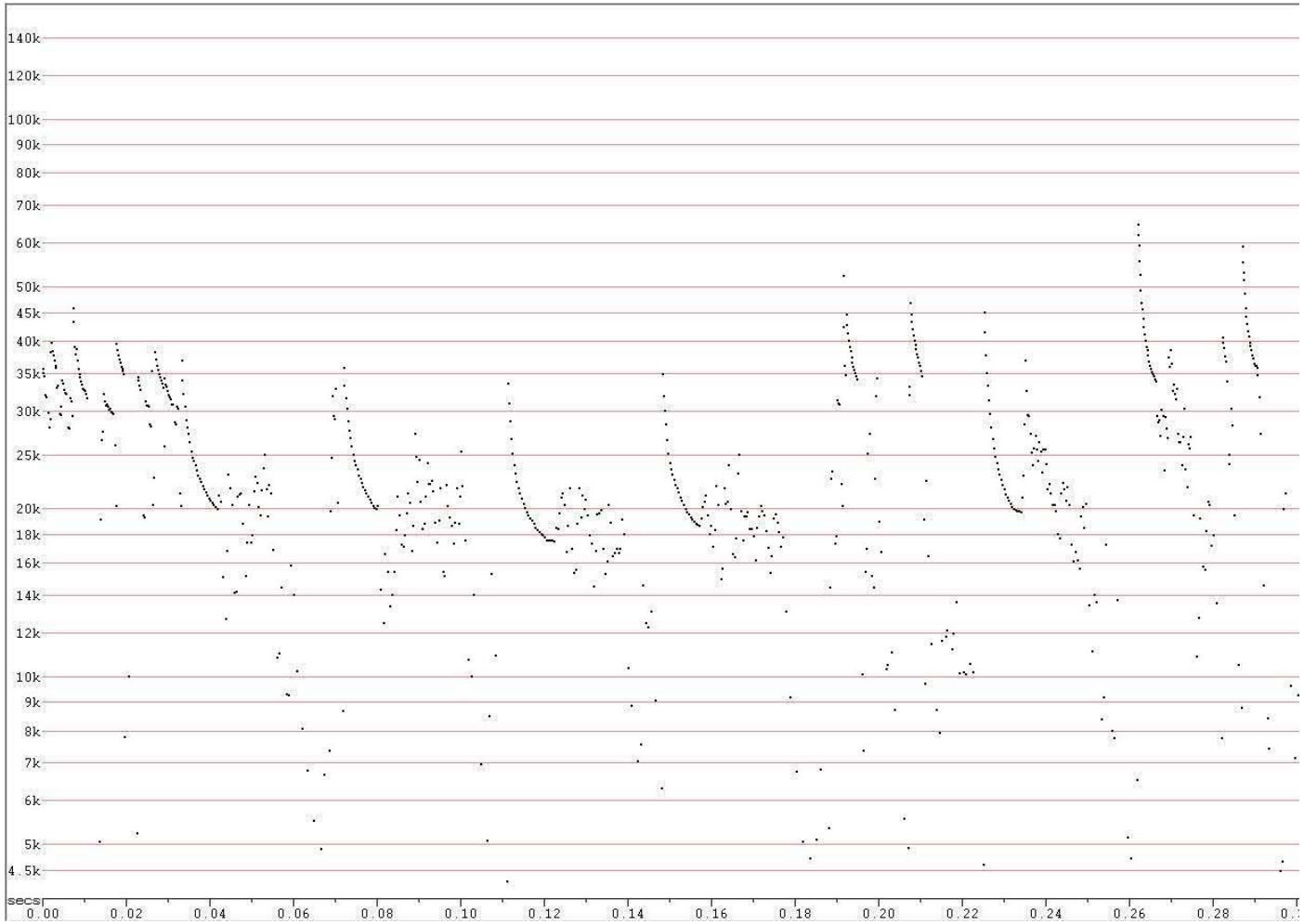


Little Bentwing-bat *Miniopterus australis*

Calls identified based on call shape (down-sweeping tail) and characteristic frequency (56kHz).

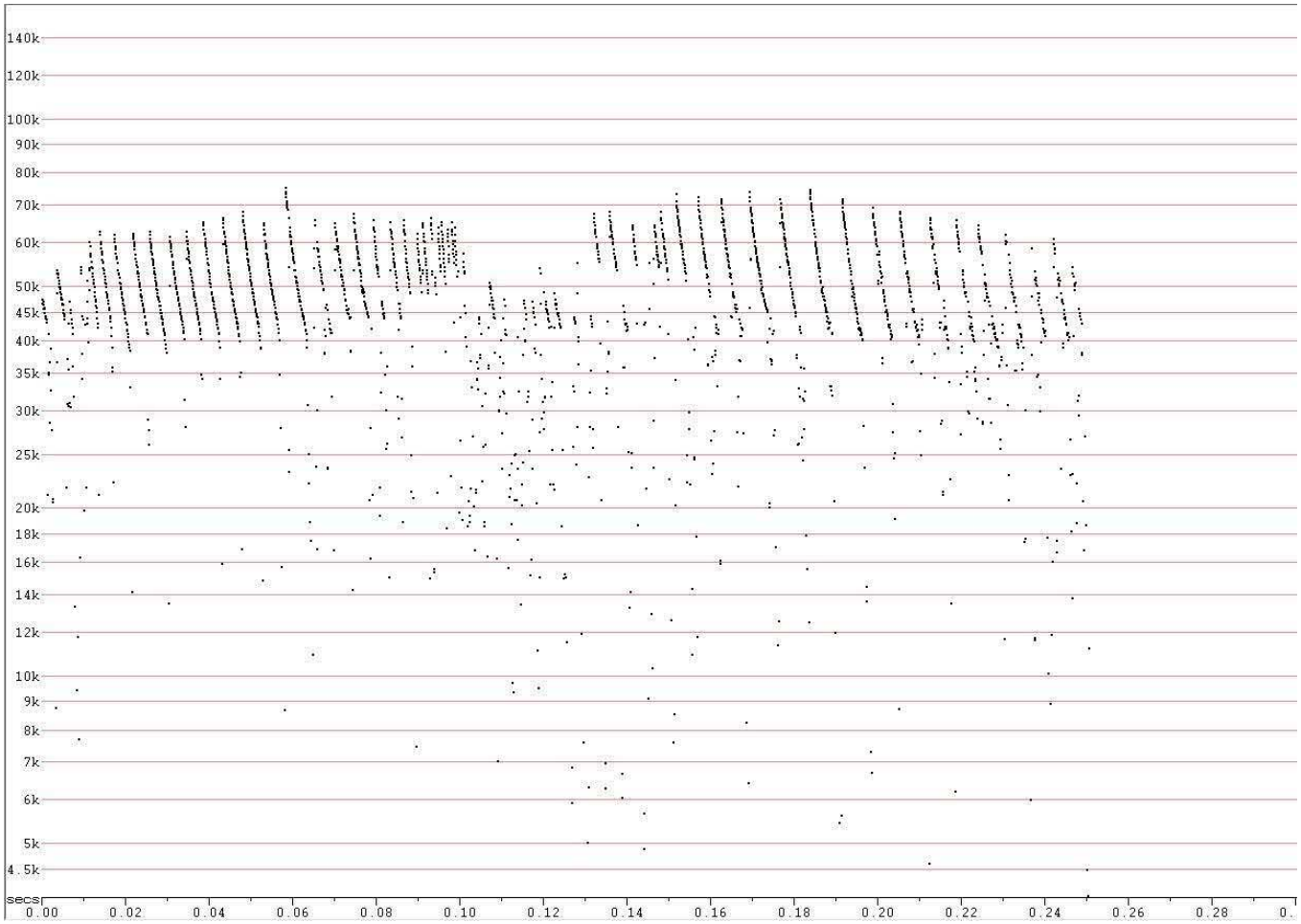
Yellow-bellied Sheathtail-bat *Saccolaimus flaviventris*

Calls identified based on characteristic frequency (18 - 20kHz).



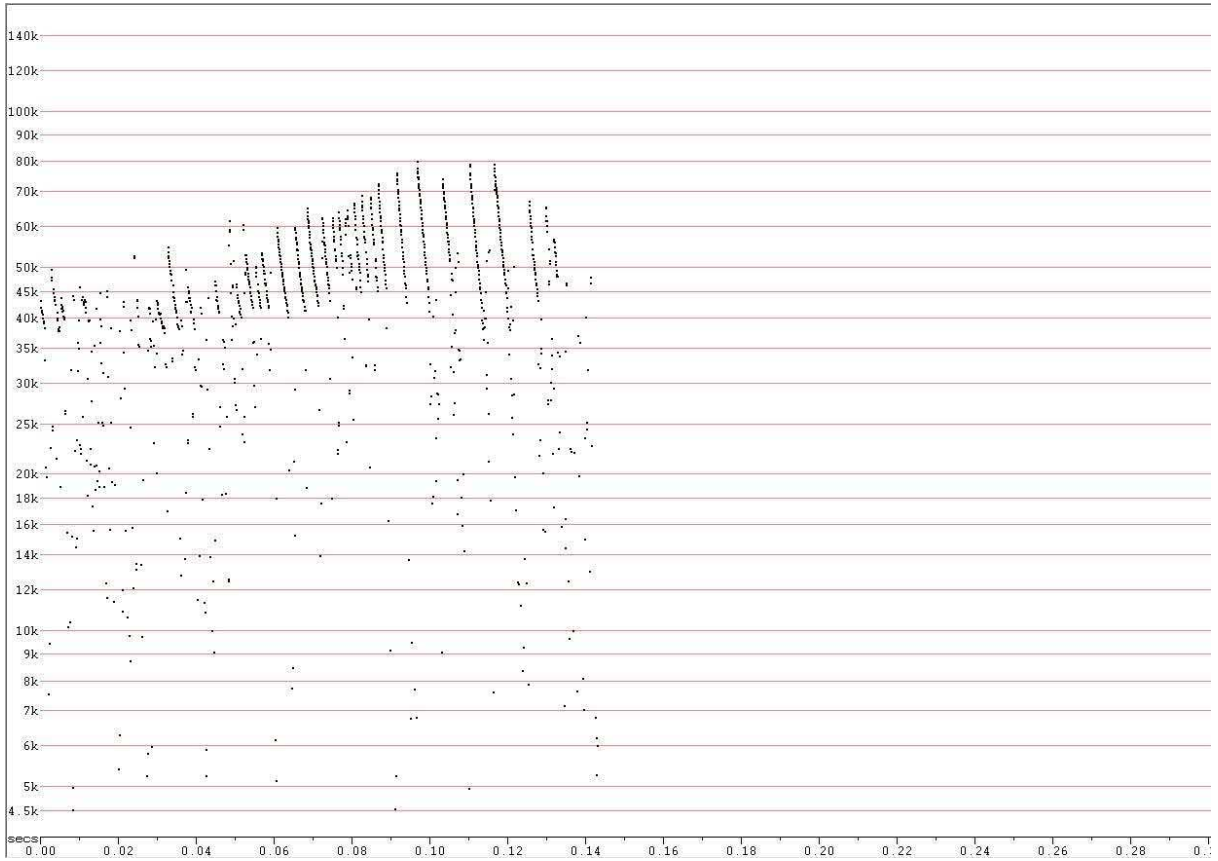
Southern Myotis *Myotis macropus*

Calls identified as ‘possible’ for Southern Myotis based on call parameters such as length of sequence (typically comparatively shorter sequences from *Nyctophilus* sp. due to quieter calls), call frequency range (starting at 80kHz, ending at 35kHz) and call shape (slight ‘kink’ in some pulses at approximately 50kHz).



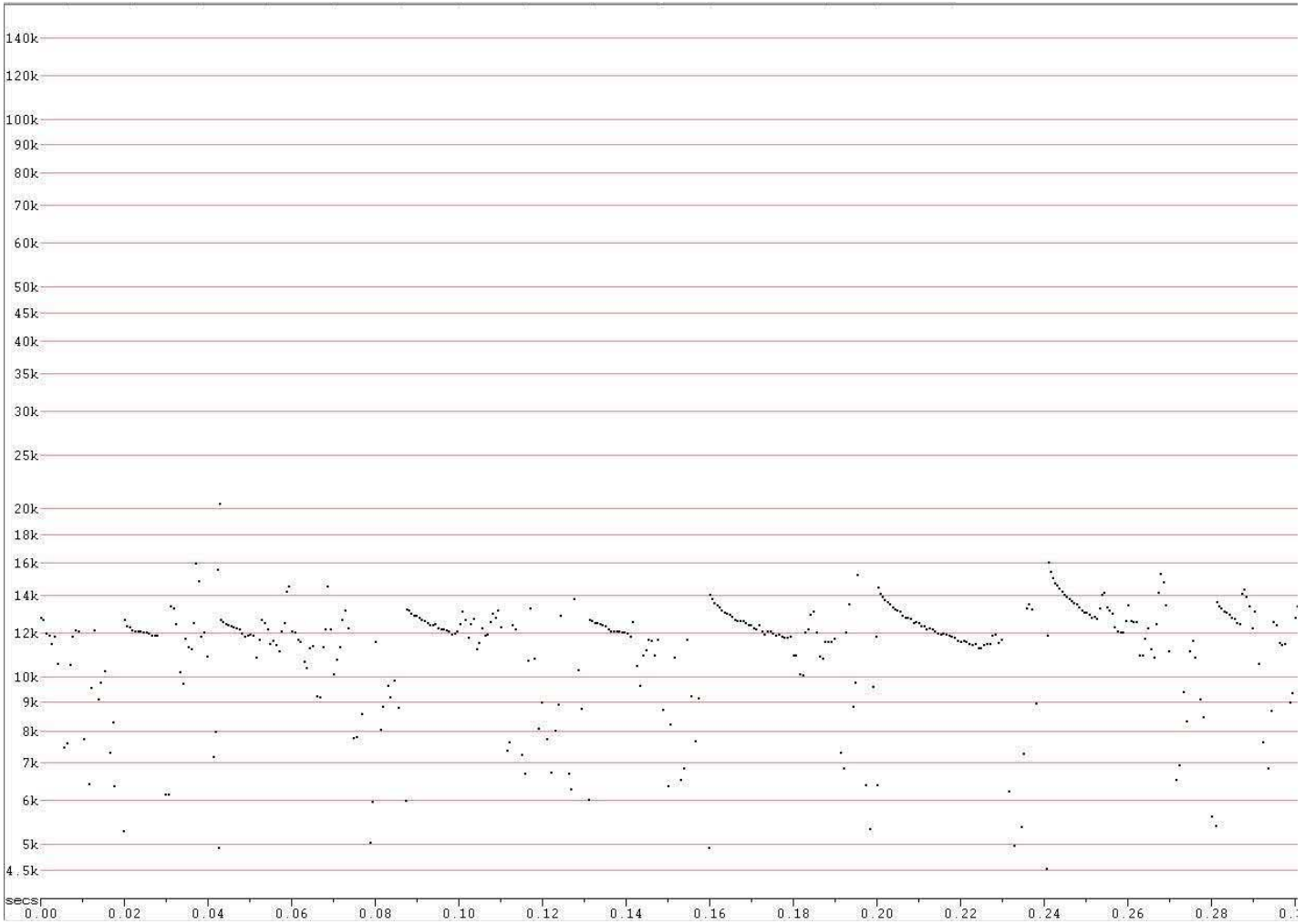
Unidentified Long-eared Bat *Nyctophilus* sp.

Steep, near vertical call shape for all species in the genus *Nyctophilus* are almost identical and cannot be identified to species. Calls are also similar to those of Southern Myotis *Myotis macropus*. Calls identified as *Nyctophilus* sp. based on comparatively short length of sequence due to quieter calls and uniform call shape (no distinctive ‘kinks’ in pulses).



White-striped Freetail-bat *Austronomus (Tadarida) australis*

Calls identified based on call shape and characteristic frequency (< 14kHz) which does not overlap with any other species known to occur in the region.



Annexure G – Significant impact criteria (SIC)

EPBC Significant Impact Criteria Assessments

Common name	Scientific name	EPBC Act	Significant Impact
Ecological Communities			
Cumberland Plain Shale Woodlands and Shale-Gravel Transition Forest		CE	**Likely**
Western Sydney Dry Rainforest and Moist Woodland on Shale		E	Unlikely
Flora			
Sydney Bush-pea	*Pultenaea parviflora*	V	**Likely**
Spiked Rice-flower	*Pimelea spicata*	E	Unlikely
Downy Wattle	*Acacia pubescens*	V	Unlikely
Bynoe's Wattle	*Acacia bynoeana*	V	Unlikely
White-flowered Wax Plant	*Cynanchum elegans*	E	Unlikely
Small-flower Grevillea	*Grevillea parviflora subsp. parviflora*	V	Unlikely
Nodding Geebung	*Persoonia nutans*	E	Unlikely
Fauna			
Australasian Bittern	*Botaurus poiciloptilus*	E	Unlikely
Australian Painted Snipe	*Rostratula australis*	E	Unlikely
Green and Golden Bell Frog	*Litoria aurea*	V	Unlikely
Grey-headed Flying-fox	*Pteropus poliocephalus*	V	Unlikely
Koala (combined populations of QLD, NSW and the ACT)	*Phascolarctos cinereus*	V	Unlikely
Large-eared Pied Bat	*Chalinolobus dwyeri*	V	Unlikely
Regent Honeyeater	*Anthochaera phrygia*	CE	Unlikely
Swift Parrot	*Lathamus discolor*	CE	Unlikely

Ecological Communities

Cumberland Plain Shale Woodlands and Shale-Gravel Transition Forest

Cumberland Plain Shale Woodlands and Shale-Gravel Transition Forest (CPW) is listed as a critically endangered ecological community under the TSC Act and critically endangered under the EPBC Act. CPW occurs on soils derived from Wianamatta Shale and is distributed throughout the driest parts of the Sydney Basin (DEWHA, 2010). Since European settlement, CPW has become highly localised and fragmented, with most remnants under 10 hectares in size in 2009 (DEWHA, 2009). Consequently, impacts to patches that are 0.1 hectares or more in size are likely to be significant.

The tree canopy is typically dominated by Grey Box *Eucalyptus moluccana*, Forest Red Gum *E. tereticornis*, and/or Red Ironbark *E. fibrosa*. Narrow-leaved Ironbark *E. crebra*, Spotted Gum *Corymbia maculata* and Thin-leaved Stringybark *E. eugenioides* occur less frequently. The shrub layer is usually dominated by Blackthorn *Bursaria spinosa*, and it is common to find abundant grasses such as Kangaroo Grass *Themeda australis* and Weeping Meadow Grass *Microlaena stipoides* var. *stipoides* associated with this community (DEWHA, 2010).

Key threats to CPW include (DEWHA, 2009):

- clearing for urban, industrial or rural development,
- fragmentation of native vegetation remnants as a consequence of clearing,
- inappropriate grazing and fire regimes,
- weed invasion. Particularly high impacts are due to invasion by African Olive (*Olea europaea subsp. cuspidata*), Bridal Creeper (*Asparagus asparagoides*), and a range of exotic grasses
- low level of protection in reserves.

CPW is represented in the study area by three Plant Community Types (PCTs):

- Grey Box - Forest Red Gum grassy woodland on shale of the southern Cumberland Plain, Sydney Basin Bioregion (PCT 850)).
- Grey Box - Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin Bioregion (PCT 849).
- Broad-leaved Ironbark - Grey Box - Melaleuca decora grassy open forest on clay/gravel soils of the Cumberland Plain, Sydney Basin Bioregion (PCT 724).

In order to qualify as the listed community under the EPBC Act, a patch must meet the following criteria as defined in the Commonwealth Listing Advice (TSSC, 2009):

- Native tree species present with a minimum projected foliage cover of 10%.
- Patch 0.5 hectares or greater in size.
- Either:
    - Over 50% of perennial understorey vegetative cover is made up of native species.
    - Patch greater than 5 hectares in size and has over 30% native perennial understorey vegetative cover.
    - Patch contiguous with a native vegetation patch greater than 5 hectares in size and has over 30% native perennial understorey vegetative cover.
    - Patch contains at least one tree per hectare that is large (>80 cm dbh) or has a hollow and has over 30% native perennial understorey vegetative cover.

Based on a review of previous vegetation mapping, GIS analysis, site inspection and field data collection, about 128.39 hectares of the above PCTs within the study area meet the

condition threshold criteria for CPW under the EPBC Act. About 45.96 hectares of this is situated within the construction footprint.

Over half of the mapped CPW within the study area is located within Western Sydney Parklands. Here, the majority of the community is revegetation with patches of more mature vegetation. This mature vegetation is characterised by larger, remnant trees with a disturbed ground layer dominated by native grasses, such as *Microlaena stipoides* (Weeping Grass). This vegetation makes up about 70 hectares of CPW in the study area.

The large areas of revegetation within Western Sydney Parklands have been planted within the last 25 years. These areas contain extensive plantings, which can be identified by their evenly spaced rows and uniform age structure. Given that these plantings are likely to have been sourced from local provenance seed, most of the revegetated areas appear to meet the criteria for CPW (TSSC, 2009). As such, the area of revegetated CPW in the study area is about 63.18 hectares.

Some of the areas within Western Sydney Parklands have been managed for conservation and/or as part of a biobanking site. To the west of Western Sydney Parklands, there is a section of the study area that is subject to the biodiversity certification of the Sydney Growth Centres SEPP. About 7.48 hectares of the 45.96 hectares of EPBC Act criteria CPW within the construction footprint is within this biodiversity certified area.

a) Will the project reduce the extent of an ecological community?

Since European settlement, CPW has become highly localised and fragmented. As such, impacts to patches that are 0.1 hectares or more in size are likely to be significant. Within the construction footprint, excluding certified areas, CPW is represented by three PCTs, about 38.48 hectares in size, and including about 20.21 hectares of revegetation.

Areas of CPW to be cleared are distributed throughout the study area in small, fragmented patches, as well as larger intact areas. The larger areas of intact CPW, only slightly fragmented by a powerline easement, smaller roads, bicycle paths, fire trails and driveways, occur in the eastern extent of the study area between Mount Vernon and Cecil Park, largely within Western Sydney Parklands. The revegetation areas are all within Western Sydney Parklands, at the eastern most extent of the study area around Elizabeth Drive near Cecil Park.

Overall, the area of impact represents about 0.4% of the remaining CPW within a 10kilometre radius of the study area. However, not all the CPW within 10 kilometres may meet the EPBC condition threshold criteria, and therefore the percent area of CPW in the study area is likely to be higher than this. As CPW is a critically endangered ecological community and patches more than 0.1 hectares (TSSC, 2009) have the potential to be impacted by the project, the project is likely to reduce the extent of CPW in the study area.

b) Will the project fragment or increase fragmentation of an ecological community, for example by clearing vegetation for roads or transmission lines?

CPW exists in a highly fragmented state with remnants distributed across the Cumberland Plain, most under 10 hectares in size (DEWHA, 2009). About 38.48 hectares of CPW occurs within non-certified areas in the construction footprint.

Areas of CPW occur in fragmented stands in the eastern extent of the study area. Patches of revegetation make up the majority of the CEEC, with more mature stands occurring throughout. Clearing of vegetation as a result of the project would increase the fragmentation of CPW within the study area and wider locality.

c) Will the project adversely affect habitat critical to the survival of an ecological community?

No critical habitat has been declared for CPW. However, critical habitat may also refer to areas that are necessary:

- For activities such as foraging, breeding, roosting, or dispersal.
- For the long-term maintenance of the species or ecological community (including the maintenance of species essential to the survival of the species or ecological community, such as pollinators).
- To maintain genetic diversity and long term evolutionary development, or
- For the reintroduction of populations or recovery of the species or ecological community.

Based on the above list, it is considered that areas in the eastern extent of the study area, particularly areas of revegetation for the recovery and long-term maintenance of CPW, constitute habitat critical to the survival of the community.

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

The project is likely to result in modifications to hydrological regimes and there are likely to be impacts to soil and water caused by increased sedimentation and runoff during construction. However, these should be minimised through implementation of appropriate controls and mitigation measures. While these changes could potentially impact on CPW in the study area, they would be on a very small scale and are unlikely to affect the survival of the community.

e) Will the project cause a substantial change in the species composition of an occurrence of an ecological community, including causing a decline or loss of functionally important species, for example through regular burning or flora or fauna harvesting?

The area of CPW to be directly impacted in the Western Sydney Parklands, while historically disturbed, is in moderate to good condition, characterised by large, remnant trees with a disturbed ground layer dominated by native grasses such as *Microlaena stipoides* (Weeping Grass), although species diversity is low, particularly in the ground layer. This vegetation is interspersed with revegetated stands, with even-aged trees planted in rows over a predominantly native ground layer. Areas of CPW adjoining the construction footprint are in similar condition.

While the project could result in the spread of weeds and increase sedimentation and erosion which could affect the community, appropriate safeguards, controls and mitigation measures implemented and maintained during construction would minimise these impacts. As such, the project is unlikely to result in a substantial change in the species composition of an occurrence of CPW, or a decline or loss of functionally important species within this community.

f) Will the project cause a substantial reduction in the quality or integrity of an occurrence of an ecological community, including, but not limited to:

- ***assisting invasive species, that are harmful to the listed ecological community, to become established?***

There are exotic species in the areas to be disturbed for the project, mainly common exotic grass and weed species. The area of CPW to be directly impacted is in moderate to good

condition, with a disturbed ground layer dominated by native grasses, such as *Microlaena stipoides* (Weeping Grass). The project could result in the spread of invasive species, particularly perennial exotic grasses, in adjoining areas. However, mitigation measures would be implemented during construction to minimise potential impacts. As such, it is unlikely that the project would cause a substantial reduction in the quality or integrity of CPW.

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

The study area is predominantly agricultural land, where fertilisers, herbicides and other chemicals are utilised regularly. It is also likely that during the construction phase vegetation within the study area, including CPW, would be exposed to some chemicals and pollutants. However, mitigation measures would be implemented during construction to minimise potential impacts. As such, it is unlikely that the project would cause a substantial reduction in the quality or integrity of CPW.

g) Will the project interfere with the recovery of an ecological community?

The Approved Recovery Plan for the Cumberland Plain (DECCW, 2011) lists four recovery objectives for the Cumberland Plain. These are:

- To build a protected area network, comprising public and private lands, focused on the priority conservation lands.
- To deliver best practice management for threatened biodiversity across the Cumberland Plain, with a specific focus on the priority conservation lands and public lands where the primary management objectives are compatible with biodiversity conservation.
- To develop an understanding and enhanced awareness in the community of the Cumberland Plain's threatened biodiversity, the best practice standards for its management, and the recovery program.
- To increase knowledge of the threats to the survival of the Cumberland Plain's threatened biodiversity, and thereby improve capacity to manage these in a strategic and effective manner.

The project is inconsistent with the objectives of the recovery plan, as it does not contribute to the conservation of the Cumberland Plain.

Conclusion

While there is approximately 9624.66 hectares of CPW within 10 kilometres of the study area, it is considered likely that a significant impact to CPW would occur as a result of the project, given that about 38.48 hectares of this community would be removed from non-certified areas within the construction footprint.

Given that CPW is listed as critically endangered, it is considered that even with avoidance measures, a significant impact is likely.

Western Sydney Dry Rainforest and Moist Woodland on Shale

Western Sydney Dry Rainforest and Moist Woodland on Shale is listed as Critically Endangered under the EPBC Act. This TEC varies from a low closed rainforest, typically in lower slopes and gullies, to a more open moist woodland form on upper slopes and disturbed sites. Emergent trees can be up to around 25 m high and a lower tree layer is often present (DoEE 2015). The TEC has a highly restricted distribution, confined to sheltered slopes and gullies on steeply sloping, rugged topography mostly in the Cumberland Plain sub-region.

Within the study area, Western Sydney Dry Rainforest and Moist Woodland on Shale has the potential to correspond to the PCT Forest Red Gum - Grey Box shrubby woodland on shale of the southern Cumberland Plain, Sydney (PCT 830).

In order to qualify as the community under the EPBC Act, a patch must meet the following criteria as defined in the Commonwealth Listing Advice (DoEE 2015):

- Patch 0.1 ha or greater in size.
- At least 20 native species present in a 0.04 ha sample plot
- Non-native perennial plants account for no more than 50% of the total vegetation cover in the patch.

Based on a review of previous vegetation mapping, GIS analysis, site inspection and field data collection, all patches of PCT 830 within the study area meet the condition threshold criteria for Western Sydney Dry Rainforest and Moist Woodland on Shale, under the EPBC Act.

Western Sydney Dry Rainforest and Moist Woodland on Shale occurs in the eastern part of the study area on southern-facing slopes within the Western Sydney Parklands. The study area overlaps fragmented smaller patches or the edges of larger patches of this TEC that adjoin the study area.

a) Will the project reduce the extent of an ecological community?

About 0.44 hectares of the TEC exists within the construction footprint and would be impacted by the project. The area of the TEC to be cleared within the study area is situated on the eastern boundary and exists in patches which are subject to edge effects and disturbance as a result of its proximity to the M7 Motorway. The largest patch to be impacted extends east outside of the project boundary and adjoins Shale Hills Woodland to the north and south. It is likely that only the very edge of this patch would be impacted.

Within 10km of the study area, approximately 23.27 hectares of Western Sydney Dry Rainforest and Moist Woodland exists. The area of the TEC within the construction footprint represents 1.5 percent of this. However, it is likely that some of this vegetation within the 10km locality area would not meet the EPBC requirements for a community. The actual percentage is therefore likely to be different to this.

0.44 hectares is a minor reduction in the area of Western Sydney Dry Rainforest and Moist Woodland on Shale. Furthermore, much of the vegetation to be removed is of a low quality

and is currently subject to edge effects. Therefore, while the project would result in a reduction in the extent of the ecological community, it is only considered to be minor.

b) Will the project fragment or increase fragmentation of an ecological community, for example by clearing vegetation for roads or transmission lines?

The Western Sydney Dry Rainforest and Moist Woodland in the study area is currently highly fragmented by the M7 Motorway. The surrounding locality is also highly fragmented by rural and residential development and therefore many of the remaining areas of the TEC exist in isolated patches. The project would increase the existing gap between the stands of the TEC within the study area. However, it is unlikely to fragment any existing patches of the community into two or more sections.

The areas of the TEC to be removed would likely only consist of the vegetation near the existing road edge. This area is currently already subject to edge effects and therefore its removal is not considered significant.

Therefore, the project would not fragment or increase fragmentation of an ecological community.

c) Will the project adversely affect habitat critical to the survival of an ecological community?

No critical habitat has been declared for the Western Sydney Dry Rainforest and Moist Woodland on Shale.

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

The project would result in modifications to hydrological regimes and would likely have impacts to soil and water with increased sedimentation and runoff during construction. However, with the appropriate control measures in place, these impacts would be minor. Therefore, whilst these changes could impact on the TEC, they would be on a relatively small scale and would be unlikely to affect its survival.

e) Will the project cause a substantial change in the species composition of an occurrence of an ecological community, including causing a decline or loss of functionally important species, for example through regular burning or flora or fauna harvesting?

The project is unlikely to result in a substantial change to species composition, occurrence of Western Sydney Dry Rainforest and Moist Woodland or a decline or loss of functionally important species within this community. The removal of about 0.44 hectares of this TEC would have a minimal impact on these factors. The roads edges in the study area are currently subject to invasion by exotic perennial grasses. While the project could result in further spread of these species in retained stands of the TEC, which could further alter species composition, weed control measures would be implemented during construction to minimise impacts.

f) Will the project cause a substantial reduction in the quality or integrity of an occurrence of an ecological community, including, but not limited to:

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

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

The project could result in further spread of weeds, particularly perennial exotic grasses, in retained stands of Western Sydney Dry Rainforest and Moist Woodland. Retained roadside areas are already subject to weed invasion and the project is not likely to substantially reduce the quality or integrity of the ecological community. Weed control measures would be implemented during construction to minimise impacts.

Fertilisers, herbicides and other chemicals could be used during and post-construction. This would occur within the construction footprint, and any inadvertent usage beyond which could impact the growth of species within the ecological community would be at a minor scale. As such, the quality or integrity of Western Sydney Dry Rainforest and Moist Woodland would not be reduced substantially.

Therefore, it is unlikely that the project would assist in the establishment of invasive species or introduce chemicals or pollutants such that it would cause a reduction in the quality or integrity of the TEC.

g) Will the project interfere with the recovery of an ecological community?

There is no adopted or made Recovery Plan for this ecological community. OEH (2018) lists a number of activities to assist Western Sydney Dry Rainforest and Moist Woodland. Not interfering with these activities would help in the recovery of the TEC. These activities include:

- Promote public involvement in restoration activities.
- Sites should be burned in a mosaic pattern, with no more than 30% of the community present in the management area burnt within any 15 year period. Where a management area exceeds 10 hectares, no more than 10% of the community within any management area should be burnt in one planned event. Any area to be subject to a planned burn should be assessed by suitably qualified persons to ensure species present in the area would not be adversely affected by the planned burning event.
- Protect habitat by minimising further clearing of the community. This requires recognition of the values of all remnants.
- Promote regeneration by avoiding prolonged or heavy grazing.
- Protect habitat by controlling run-off entering the site if it would change water, nutrient or sediment levels or cause erosion.
- Weed control.
- Undertake restoration including bush regeneration and revegetation.

While the project would not interfere with most of these activities, it would involve the clearing of about 0.44 hectares of the TEC. However, due to the small, fragmented patch sizes of most of this TEC and the degraded condition within some of these patches, this is not deemed to be significantly detrimental to the recovery of the TEC.

Conclusion

The project would have impacts on about 0.44 hectares of Western Sydney Dry Rainforest and Moist Woodland. Given that the area to be cleared comprises of already fragmented and edge-affected patches, it is considered unlikely that the proposed action represents a significant impact to the community.

Flora Species

Pultenaea parviflora

Pultenaea parviflora is listed as Vulnerable under the EPBC Act. It is a small, erect shrub to 1 m in height with typical pea flowers which flower between August and November. The species is endemic to the Cumberland Plain with its core distribution from Windsor to Penrith and east to Dean Park. There are also outlier populations recorded from Wilberforce and Kemps Creek (OEH, 2017).

Pultenaea parviflora may be locally abundant, particularly with scrubby/dry heath areas within Castlereagh Ironbark Forest and Shale Gravel Transition Forest on tertiary alluvium or laterised clays. It also occurs in transitional areas where communities adjoin Castlereagh Scribbly Gum Woodland. Associated species of *Pultenaea parviflora* include *Allocasuarina littoralis, Angophora bakeri, Aristida spp. Banksia spinulosa, Daviesia ulicifolia, Dodonaea falcata, Entolasia stricta, Hakea sericea, Lissanthe strigosa, Melaleuca nodosa* and *Themeda australis* (OEH, 2017).

Targeted threatened flora surveys in November and December 2017 and August 2018 by Arcadis ecologists identified 260 individuals of *Pultenaea parviflora* adjoining Clifton Avenue within the study area, and 18 individuals in the north of the Western Sydney Parklands adjoining Elizabeth Drive. Of the individuals recorded around Clifton Avenue, 90 are situated within the construction footprint and would be removed as a result of the project. The 18 individuals in the Western Sydney Parklands are located on the boundary of the construction footprint and biodiversity certified land. It is likely that clearance of native vegetation within the construction footprint would result in the loss of these individuals due to fragmentation and degradation of the roadside habitat from edge effects. While a comprehensive stem count has not been finalised due to property access limitations, it is likely that more individuals of the species occur along Clifton Avenue, and there is potentially a larger population in this area.

Pultenaea parviflora is known to be associated with the PCTs Hard-leaved Scribbly Gum - Parramatta Red Gum heathy woodland of the Cumberland Plain, Sydney Basin Bioregion, Broad-leaved Ironbark - Grey Box - Melaleuca decora grassy open forest on clay/gravel soils of the Cumberland Plain, Sydney Basin Bioregion, and Broad-leaved Ironbark - Melaleuca decora shrubby open forest on clay soils of the Cumberland Plain, Sydney Basin Bioregion. These PCTs are mapped in the central section of the study area, around Clifton Avenue.

There is a total of about 14.25 hectares of PCTs known to be associated with *Pultenaea parviflora* in the study area; these areas are therefore considered to form potential habitat for the species.

Approximately 7.29 hectares of this potential habitat is situated within the construction footprint and would be removed as a result of the project

a) Will the project lead to a long-term decrease in the size of an important population of a species?

As defined in the EPBC Act significant impact guidelines for Matters of National Environmental Significance (Department of the Environment, 2013), an ‘important population’ is a population that is necessary for a species’ long-term survival and recovery. This may include populations identified as such in recovery plans, and/or that are:

- key source populations either for breeding or dispersal

- populations that are necessary for maintaining genetic diversity, and/or
- populations that are near the limit of the species range.

The population of *Pultenaea parviflora* adjoining Clifton Avenue in the study area consists of individuals growing in disturbed roadside areas, and scattered plants growing in Broad-leaved Ironbark - Grey Box - Melaleuca decora grassy open forest on clay/gravel soils of the Cumberland Plain, Sydney Basin Bioregion to the north-east of Clifton Avenue. A total of 260 individuals of the species were recorded in this area during surveys in November and December 2017 and August 2018, and it is considered likely that further individuals of the species occur in the fragmented patches of potential habitat within and close to the study area. The population of *Pultenaea parviflora* identified around Clifton Avenue is close to the current known southern limit of the species' distribution (OEH, 2018).

The population of *Pultenaea parviflora* recorded around Clifton Avenue is relatively large for the locality and may be (or have previously been) a key source population for breeding or dispersal and/or a population that is necessary for maintaining genetic diversity in the species; furthermore, it is near the limit of the species' range. It is therefore considered likely to be an important population.

The project would decrease the size of this population with the removal of 90 individuals. This represents 34.6% of the recorded number of individuals around Clifton Avenue. The majority of relatively intact habitat for this population of the species would also be removed, leaving mostly disturbed roadside fragments.

There are 18 plants of *Pultenaea parviflora* recorded within the disturbed, managed road reserve to the east and north-east of Clifton Avenue, immediately adjoining the construction footprint. It is likely that clearance of native vegetation within the construction footprint would result in the loss of these individuals due to fragmentation and degradation of the roadside habitat from edge effects.

It is unlikely that this population could maintain or increase its current size in the long term, due to the lack of remaining suitable habitat available in the immediate vicinity. Therefore, the project would likely lead to a long-term decrease in the size of an important population of *Pultenaea parviflora.*

An additional 18 plants of *Pultenaea parviflora* are located immediately to the north of the construction footprint in the Western Sydney Parklands, at the northern edge of a patch of native vegetation adjoining a cleared easement. It is possible that some of these plants occur within the construction footprint. At minimum, removal of native vegetation from the construction footprint would reduce the area of habitat that the 18 plants of *Pultenaea parviflora* are located within to the narrow corner of a triangular patch of retained native vegetation, cleared on both sides. It is likely that clearance of native vegetation within the construction footprint would result in the loss of these individuals due to fragmentation and degradation of the roadside habitat from edge effects.

b) Will the project reduce the area of occupancy of an important population?

It is likely that an important population of the species exists along Clifton Avenue within the study area. 260 individuals of the species were recorded in this area during surveys in November and December 2017 and August 2018. The project would decrease the size of this population with the removal of 45 individuals.

There is about 14.25 hectares of potential habitat for the species in the study area. Approximately 7.29 hectares of this potential habitat would be removed as a result of the project.

As the population in the construction footprint is considered likely to be an important population and is located on the edge of the species range, this potential habitat within the construction footprint is considered an important area of occupancy for the population. The project would result in the reduction of this area.

Therefore, the project would reduce the area of occupancy of an important population.

c) Will the project fragment an existing important population into two or more populations?

The project would result in the removal of 90 individuals of *Pultenaea parviflora* to the north-east of Clifton Avenue. The areas further to the north-east of the construction footprint in the vicinity of the *Pultenaea parviflora* individuals to be removed was searched for this species, but it was not recorded. Numerous plants of *Pultenaea parviflora* were recorded to the south-west of the construction footprint, most of which are located within disturbed roadside areas. As such, it is assumed that the *Pultenaea parviflora* to be directly impacted forms the north-eastern extent of this population, and therefore the population would not be fragmented into two or more populations as a result of the project.

d) Will the project adversely affect habitat critical to the survival of a species?

No areas of critical habitat have been identified for *Pultenaea parviflora.*

e) Will the project disrupt the breeding cycle of an important population?

The following is currently known about the life cycle of *Pultenaea parviflora* (OEH, 2017):

- Flowering may occur between August and November depending on environmental conditions. Pollinators are unknown.
- The species is likely to be dispersed by ants due to the presence of an aril on its seed. There is no evidence that it spreads vegetatively.
- Current estimates are that reproductive maturity is not reached for 3-4 years, and peak reproduction until 5-6 years. The individual lifespan is estimated at about 20 years.
- Individuals are killed by fire and re-establish from soil-stored seed.

The project would involve the removal of 90 individuals of the species which form part of an important population. By removing these individuals, their breeding cycle would be impacted. Furthermore, the removal of the soil surrounding the individuals would clear the seed bank, eliminating their chance of recruitment in the future. The project would therefore likely disrupt the breeding cycle of an important population, mainly as a result of removing individual plants and seeds.

f) Will the project modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline?

There is a total of about 14.25 hectares of suitable habitat for *Pultenaea parviflora* within the study area*.* Approximately 7.29 hectares of this potential habitat would be removed as a result of the project.

Within a 10 kilometre buffer of the study area, 299.37 hectares of suitable habitat for *Pultenaea parviflora* exists. The suitable habitat within the study area represents about 5 percent of this. The suitable habitat within the construction footprint which would be removed represents about 2.4 percent of this habitat in the 10km buffer from the study area. As this suitable habitat within the study area is located on the edge of the species range it is considered particularly important to the species. This 2.4 percent is therefore a significant

proportion of the species habitat in the locality.

Clearance of native vegetation within the construction footprint would result in further fragmentation and degradation of roadside habitat adjoining the construction footprint from edge effects. It is likely that habitat, including occupied habitat, in these areas would decrease in quality to the extent that the species is likely to decline.

g) Will the project result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat?

Invasive grasses including *Eragrostis curvula* are recognised as a potential threat to *Pultenaea parviflora* (OEH 2017). The introduction of exotic grasses not only increases competition and shading which is detrimental to the species, but also increases the biomass within the vegetation community. This fuels fires which, if occurring too frequently (generally <10 years), does not allow the seed bank to re-establish (Department of the Environment, 2018).

Exotic grasses including *Eragrostis curvula* are present in the study area, including within the occupied habitat for the species in the construction footprint and in the road reserve to the west of Clifton Avenue, around areas containing large numbers of the species. The project may facilitate the spread of seeds or fragments of plant to areas where these grasses are not present, via plant or contaminated topsoil. This could include areas of potential habitat for the species.

h) Will the project introduce disease that may cause the species to decline?

The project is unlikely to result in the introduction of disease to the population of *Pultenaea parviflora* in the study area.

i) Will the project interfere substantially with the recovery of the species?

There is no adopted or draft recovery plan for this species. However, the NSW Department of the Environment, Climate Change and Water (2005) have identified six priority actions to help recover this species:

- Fire intervals of 10–15 years (where there are no needs for asset protection zones).
- Protect areas of known and potential habitat from clearing and further fragmentation.
- A community awareness program.
- Research into pollinating species for *Pultenaea parviflora.*
- Identify and survey potential habitat for the species.
- Monitor known populations.

While the project would not interfere with most of the priority actions, it would involve clearing and further fragmentation of areas of known and potential habitat for the species, contrary to one of the priority actions. However, mitigation measures would involve minimising vegetation removal and avoiding, where possible, the clearing of individuals and habitat for *Pultenaea parviflora.* Fire management would also be a part of construction and operational management and therefore the project is not expected to increase fire intervals.

Conclusion

An important population of *Pultenaea parviflora* has been recorded within the study area with 278 individuals identified. Of these, 90 individuals are located within the construction footprint and would be directly impacted by the project, and an additional 36 are likely to be indirectly impacted. Approximately 7.29 hectares of potential habitat for the species would be removed. This represents a significant proportion of potential habitat in the wider locality and

as such it is possible that the project would lead to a decrease in the availability of habitat such that the species would decline. Similarly, the project may lead to a long term decrease in the size of an important population, reduce the area of occupancy of an important population and disrupt the breeding cycle of an important population.

Therefore, there is likely to be a significant impact on *Pultenaea parviflora.* A referral to the Commonwealth Minister for the Environment is needed.

Pimelea spicata

Pimelea spicata is listed as Endangered under the EPBC Act. *Pimelea spicata* is a slender, low growing shrub that was once widespread on the Cumberland Plain, but now occurs in two distinct areas, the Cumberland Plain (Narellan, Marayong, Prospect Reservoir areas) and the Illawarra (Lansdowne to Shellharbour to northern Kiama) (DoEE 2017). On the Cumberland Plain, the species occurs on undulating to hilly country on Wianamatta shale, in open woodlands and grasslands of Grey Box, Narrow-leaved Ironbark, Forest Red Gum, Blackthorn and Kangaroo Grass (DoEE 2017).

Associated species in the Cumberland Plain sites are Grey Box *Eucalyptus moluccana*, Forest Red Gum *E. tereticornis* and narrow-leaved ironbark *E. crebra*. Blackthorn *Bursaria spinosa* is often present at sites (and may be important in protection from grazing) and kangaroo grass *Themeda australis* is usually present in the groundcover (also indicative of a less intense grazing history) (OEH, 2017).

There are scattered records of *Pimelea spicata* within 5 kilometres of the study area to the north of the eastern section. The closest records are within one kilometre from the eastern and western section of the study area.

Pimelea spicata is known to be associated with the PCTs Grey Box - Forest Red Gum grassy woodland on shale of the southern Cumberland Plain, Sydney Basin Bioregion, Grey Box - Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin Bioregion, and Forest Red Gum - Grey Box shrubby woodland on shale of the southern Cumberland Plain, Sydney Basin Bioregion. These PCTs are mapped in the Western Sydney Parklands and in scattered patches in the central and western sections of the study area. It is assumed that habitat for *Pimelea spicata* would occur in the better quality patches of the PCTs.

There is an estimated total of 154.48 hectares of potential habitat for the species in the study area. Approximately 42.53 hectares of this potential habitat would be removed as a result of the project.

Surveys carried out in November and December 2017 by Arcadis ecologists found 26 individuals of this species within the PCT Forest Red Gum - Grey Box shrubby woodland on shale of the southern Cumberland Plain, Sydney Basin Bioregion. The population lies 15 metres outside the study area and would not be impacted by the project.

a) Will the project lead to a long-term decrease in the size of a population?

A total of 26 individuals of the species were recorded outside the study area during surveys in November and December 2017. These individuals would not be removed during construction.

Therefore, as the individuals of this species would not be impacted by the project, the project would not lead to a long-term decrease in the size of a population.

b) Will the project reduce the area of occupancy of the species?

The associated PCTs for *Pimelea spicata* are mapped in the Western Sydney Parklands and in scattered patches in the central and western sections of the study area. It is assumed that habitat for *Pimelea spicata* could occur in the better quality patches of the PCTs. Targeted surveys for the species, while the species was confirmed to be in flower in the locality, did not record it in these areas.

There is an estimated total of 154.48 hectares of potential habitat for the species in the study area. Approximately 42.53 hectares of this potential habitat would be removed as a result of the project.

As much of this potential habitat exists in fragmented patches and the species has a low dispersal range, it is also unlikely that the species would inhabit much of this area in the future.

Therefore, it is unlikely that the project would reduce the area of occupancy of the species.

c) Will the project fragment an existing population into two or more populations?

The population of *Pimelea spicata* is located outside the study area and consists of approximately 26 individuals. These individuals would not be removed during construction or impacted in any other way by the project. Therefore, the project would not fragment an existing population into two or more populations.

d) Will the project adversely affect habitat critical to the survival of a species?

No areas of critical habitat have been identified for *Pimelea spicata.*

e) Will the project disrupt the breeding cycle of a population?

The following is known about the life cycle of *Pimelea spicata* (OEH, 2017) (Department of the Environment, 2018):

- Adult *Pimelea spicata* plants flower and fruit prolifically throughout the year with peaks in spring and autumn
- Established plants can resprout from a substantial, carrot-like, tap root after disturbances such as fire, grazing or accidental herbicide spray
- It is estimated that *Pimelea spicata* requires more than three years to develop a taproot sufficient for vegetative regeneration
- Regrowth following disturbance results in substantial depletion of the underground taproot and a reduced ability to recover from further disturbances
- Vigorous resprouting and seed germination often occur after fire or other disturbance
- Although seed germination levels are usually low (approximately 2%), studies indicate that smoke promotes the germination of *Pimelea spicata* up to a maximum of 30%
- Flowers may be self-pollinating, although fruit production is variable. Fruit are not dispersed well, with most seedlings germinating close to the adult (within 30cm or so according to P. hogbin). A soil seedbank develops and is maintained in the presence of a suitable disturbance regime.

It is unlikely that the project would disrupt the breeding cycle of the species. No individuals of *Pimelea spicata* would be removed and therefore their future chance of reproduction would not be impacted. By removing the nearby soil in the construction footprint, the soil seedbank would be cleared. However, as the species generally has a low dispersal distance of within 30cm (OEH, 2017), it is unlikely that there is below ground presence of this species in the construction footprint. Similarly, as no other individuals of the species have been recorded in the construction footprint, it is highly unlikely that they exist in the seedbank outside of the area surrounding the known population.

Therefore, as no individuals of *Pimelea spicata* would be removed by the project, it is unlikely that the project would impact on the breeding cycle of the species.

f) Will the project modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline?

There is an estimated total of 154.48 hectares of potential habitat for the species in the study area. Approximately 42.53 hectares of this potential habitat would be removed as a result of the project

Within 10km of the study area, 6468.72 hectares of suitable habitat for *Pimelea spicata* exists. The suitable habitat within the construction footprint represents 2.38 percent of this. Due to the low quality and fragmented condition of this habitat within the construction footprint this does not represent a significant amount of habitat in comparison to the wider locality.

The habitat in the construction footprint is highly fragmented by rural residential development. As such, many patches of habitat exist in small, fragmented patches which are heavily impacted by grazing, exotic species and edge effects. They are therefore of low quality.

Furthermore, many of these patches are isolated from other areas of habitat. As the species has a low dispersal distance, it is highly unlikely that these patches would be occupied by the species in the future. Remaining areas have some connectivity to other populations and could potentially be used as habitat in the future.

While the project would increase fragmentation, it is considered fairly negligible due to the high amount of current fragmentation.

Therefore, while the project would result in the removal of some potential habitat for *Pimelea spicata,* it is not considered a significant amount and is therefore unlikely to result in the decline of the species.

g) Will the project result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species' habitat?

Weed invasion is listed as a key threat to *Pimelea spicata* by the Department of Environment (2018). A variety of environmental weeds threaten the species by competition including *Chrysanthemoides monilifera subsp. rotundata, Lantana camara, Rubus fruticosus, Olea europaea ssp. africana* and *Cenchrus clandestinus.* A number of these species have been recorded on site. The project may facilitate the spread of seeds or fragments of these exotic species to areas where these grasses are not present. This could include areas of potential habitat for the species.

h) Will the project introduce disease that may cause the species to decline?

The project is unlikely to result in the introduction of disease to the population of *Pimelea spicata* in the study area.

i) Will the project interfere with the recovery of the species?

A national recovery plan has been adopted to assist in the long-term protection of *Pimelea spicata.* Objectives of the recovery plan include:

- Conserve *P. spicata* using land-use and conservation planning mechanisms.
- Identify and minimise the operation of threats at sites where *P. spicata* occurs.
- Develop and implement a survey and monitoring program that will provide information on the extent and viability of *P. spicata*.

- Provide the community with information that assists in conserving the species.
- Raise awareness of the species and involve the community in the recovery program.
- Conduct research that will assist future management decisions.

It is unlikely that the project would interfere with any of the recovery plan objectives.

Conclusion

No individuals of *Pimelea spicata* would be impacted by the project. Furthermore, the potential habitat for the species within the construction footprint does not represent a significant amount of habitat in comparison to the wider locality. The project is also unlikely to fragment an existing population into two or more populations, disrupt the breeding cycle or reduce the area of occupancy of the species. Therefore, the project is unlikely to have a significant impact on *Pimelea spicata.*

Acacia pubescens

Acacia pubescens is listed as Vulnerable under the EPBC Act.

Acacia pubescens is a spreading shrub to 5 m high. The species is confined to the Sydney region, with most occurrences on the Cumberland Plain.

Acacia pubescens is known to be associated with the PCTs Hard-leaved Scribbly Gum - Parramatta Red Gum heathy woodland of the Cumberland Plain, Sydney Basin, Broad-leaved Ironbark - Grey Box - Melaleuca decora grassy open forest on clay/gravel soils of the Cumberland Plain, Sydney Basin Bioregion, Grey Box - Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin Bioregion and Grey Box - Forest Red Gum grassy woodland on shale of the southern Cumberland Plain, Sydney Basin Bioregion . These PCTs are mapped in the central and western sections of the study area.

There is a total of about 155 hectares of potential habitat for *Acacia pubescens* mapped in the study area. About 49.39 hectares of this potential habitat would be removed as a result of the project.

Targeted surveys for *Acacia pubescens* carried out in November 2017 by Arcadis ecologists found no individuals of this species within the study area.

a) Will the project lead to a long-term decrease in the size of an important population of a species?

An 'important population' is a population that is necessary for a species' long-term survival and recovery. This may include populations identified as such in recovery plans, and/or that are:

- key source populations either for breeding or dispersal
- populations that are necessary for maintaining genetic diversity, and/or
- populations that are near the limit of the species range.

As no individuals of the species where recorded during targeted surveys it is considered unlikely that an important population would occur in the study area.

Furthermore, no individuals of the species would be removed as a result of the project. The nearest known records of the species exist just outside the study area. These individuals would not be impacted by the project.

Therefore, the project would not lead to a long-term decrease in the size of an important population.

b) Will the project reduce the area of occupancy of an important population?

It is considered unlikely that an important population exists within the study area.

The nearest known records of the species exist just outside the study area. This is potentially an important population. While these individuals would not be impacted by the project, the adjoining vegetation would be. This is largely riparian vegetation which is not suitable habitat for the species.

There is a total of about 155 hectares of potential habitat for *Acacia pubescens* mapped in the study area. About 49.39 hectares of this potential habitat would be removed as a result of the project. It is unlikely that the species currently exists in this area as it was not recorded during targeted surveys.

Therefore, the project would not reduce the area of occupancy of an important population.

c) Will the project fragment an existing important population into two or more populations?

It is considered unlikely that an important population exists within the study area.

The nearest known records of the species exist just outside the study area. This is potentially an important population. These individuals would not be impacted by the project. The population currently exists in a highly fragmented area, with rural residential development and roads severing and isolating the existing populations. The project would not further exacerbate this or isolate some individuals from the existing population. Therefore, the project would not fragment an existing population into two or more populations.

d) Will the project adversely affect habitat critical to the survival of a species?

No areas of critical habitat have been identified for *Acacia pubescens.*

e) Will the project disrupt the breeding cycle of an important population?

The following is currently known about the life cycle of *Acacia pubescens* (OEH 2017):

- Longevity is unknown, but clonal species have been known to survive for many decades.
- Flowers from August to October. Pollination of Acacia flowers is usually by insects and birds. The pods mature in October to December.
- Recruitment is more commonly from vegetative reproduction than from seedlings. The percentage of pod production and seed fall for this species appears to be low.
- Acacia species generally have high seed dormancy and long-lived persistent soil seedbanks. It is thought that the species needs a minimum fire free period of 5 - 7 years to allow an adequate seedbank to develop.

It is considered unlikely that an important population exists within the study area. The nearest known records of the species exist just outside the study area. This is potentially an important population. While these individuals would not be impacted by the project, the nearby soil would be removed. While there is a chance that the species may exist in the seedbank of this soil it is unlikely that these would ever germinate and survive. This is because the habitat is either riparian or cleared vegetation which is not ideal for the species.

Therefore, the project is unlikely to disrupt the breeding cycle of an important population.

f) Will the project modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline?

The PCT's which are known to be associated with *Acacia pubescens* are mapped in the central section of the study area. This potential habitat forms a total of about 155 hectares in the study area. About 49.39 hectares of this potential habitat would be removed as a result of the project.

Within 10km of the study area, approximately 7986.67 hectares of suitable habitat for *Acacia pubescens* exists. The suitable habitat within the construction footprint represents 0.62 percent of this. Approximately this amount would be cleared by the project. This habitat in the construction footprint does not represent a substantial proportion of potential habitat for the species in the wider locality.

The habitat in the locality is also highly fragmented by rural residential, industrial and residential development. As such, many patches of potential habitat in the construction footprint exist in small, fragmented patches which are heavily impacted by grazing, exotic species and edge effects. They are therefore of low quality. While the project would increase this fragmentation, and create further barriers to the species' dispersal, due to the high amount of existing fragmentation and low quality habitat this is not considered significant.

Given that there are records of the species near the study area, the suitable habitat in the study area could potentially be occupied by the species in the future. However much of this habitat is fragmented and disturbed and not considered ideal habitat.

Due to the small amount of potential habitat in the construction footprint in comparison to the wider locality and the low condition of the existing habitat, it is 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.

g) Will the project result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat?

Invasive grasses including African Lovegrass, Paspalum and Briza species are considered a threat to the species by preventing recruitment. Exotic grasses including these species are abundant in the study area and the project may facilitate the spread of seeds or fragments of plant to areas where these grasses are not present, via plant or contaminated topsoil. This could include areas of potential habitat for the species. However, with the appropriate control measures enforced, the likelihood of this happening is significantly reduced**.**

h) Will the project introduce disease that may cause the species to decline?

The project is unlikely to result in the introduction of disease that may cause the species to decline.

i) Will the project interfere substantially with the recovery of the species?

A national recovery plan has been made for this species. The plan consists of 13 recovery actions which aim to meet the overall objective.

These actions include:

- identify sites that are a high priority to protect;
- carry out negotiations with public authorities to increase protection of sites;
- liaise with private landholders to increase protection of sites;
- negotiate with public authorities to implement threat and habitat management programs on public lands;
- informed environmental assessment and planning decisions are made;
- undertake studies into the genetic variability of the species;
- investigate the cause of disease in the species;
- research other aspects of the species' biology, ecology and distribution;
- encourage community involvement;
- provide advice and assistance to private landholders;
- maintain a database on the species;
- NPWS to be advised of any consents or approvals which affect *A. pubescens*;
- re-assess conservation status of species.

The project would not interfere with these activities and therefore not interfere substantially with the recovery of the species.

Conclusion

No individuals of *Acacia pubescens* were recorded during targeted surveys. The nearest known records of the species exist just outside the study area. While it is unlikely that an important population exists within the study area, it is possible that the population just outside the study area is an important population. This population would not be impacted. The project is therefore unlikely to lead to a long term decrease or reduce the area of occupancy of an important population. It is also unlikely to decrease and fragment the availability or quality of habitat to the extent that the species is likely to decline or fragment an existing population or disrupt its breeding cycle. Therefore, the project is unlikely to have a significant impact on *Acacia pubescens.*

Acacia bynoeana

Acacia bynoeana is listed as a Vulnerable species under the EPBC Act. It is a semi-prostrate shrub to a metre high. It is found in central eastern NSW, from the Hunter District (Morisset) south to the Southern Highlands and west to the Blue Mountains. The species is currently known from about 30 locations, with the size of the populations at most locations being very small (1-5 plants). *A. bynoeana* occurs in heath or dry sclerophyll forest on sandy soils. It seems to prefer open, sometimes slightly disturbed sites such as trail margins, edges of roadside spoil mounds and in recently burnt patches.

There is a total of about 31.86 hectares of potential habitat for *Acacia bynoeana* mapped in the study area. Approximately 13.38 hectares of this potential habitat would be removed as a result of the project.

This species is more typically associated with sandy soils, either containing tertiary alluvium or derived from underlying Hawkesbury sandstone. Although the species is associated with some shale based ecological communities, this is not preferred habitat. It is considered unlikely that an important population would occur within the study area, therefore it is unlikely that the project would result in a significant impact to the species.

Targeted surveys for *Acacia bynoeana* carried out in November and December 2017 by Arcadis ecologists found no individuals of this species.

a) Will the project lead to a long-term decrease in the size of an important population of a species?

An 'important population' is a population that is necessary for a species' long-term survival and recovery. This may include populations identified as such in recovery plans, and/or that are:

- key source populations either for breeding or dispersal
- populations that are necessary for maintaining genetic diversity, and/or
- populations that are near the limit of the species range.

As no individuals of the species where recorded during targeted surveys it is considered unlikely that an important population would occur in the study area.

Furthermore, no individuals of the species would be removed as a result of the project. The nearest known records of the species exist approximately 11 kilometres from the study area boundary and would not be impacted by the project.

Therefore, the project would not lead to a long-term decrease in the size of an important population.

b) Will the project reduce the area of occupancy of an important population?

It is considered unlikely that an important population exists within the study area.

Furthermore, no individuals of the species would be removed as a result of the project. The nearest known records of the species exist approximately 11 kilometres from the study area boundary and would not be impacted by the project.

There is a total of about 31.86 hectares of potential habitat for Acacia bynoeana mapped in the study area. Approximately 13.38 hectares of this potential habitat would be removed as a result of the project.

It is therefore highly unlikely that an important population of *Acacia bynoeana* would be impacted by the project. As such, the project would not reduce the area of occupancy of an important population.

c) Will the project fragment an existing important population into two or more populations?

It is considered unlikely that an important population exists within the study area.

Furthermore, no individuals of the species would be removed as a result of the project. The nearest known records of the species exist approximately 11 kilometres from the study area boundary and would not be impacted by the project.

Therefore, as there are no important populations within or nearby the study area, it is considered highly unlikely that the project would fragment an existing population into two or more populations.

d) Will the project adversely affect habitat critical to the survival of a species?

No areas of critical habitat have been identified for *Acacia bynoeana.*

e) Will the project disrupt the breeding cycle of an important population?

The following is known about the life cycle of *Acacia bynoeana* (Department of the Environment , 2018):

- The flowers are borne in the summer from September to March, and the pods occur from November to January
- It is not known whether the species is capable of self-pollination or purely outcrossing. Bynoe's Wattle is likely to be pollinated by small native bees and wasps
- Seed production is minimal, and seedlings are rare, and there is little local dispersal of seed
- Plants are not always apparent and appear periodically, perhaps in response to local disturbance
- The species is clonal and is capable of spreading vegetatively via underground stems, and as a result, populations have a clustered form with various levels of clonality

It is considered unlikely that an important population of the species exists within the study area. Furthermore, as the nearest known records of the species are approximately 11 kilometres from the study area, and seed production is minimal in the species, it is unlikely that they exist in the seedbank within the study area.

Therefore, as no individuals of the species would be removed by the project, and it is unlikely the species exists in the seedbank within the study area, it is highly unlikely that the project would disrupt the breeding cycle of an important population of *Acacia bynoeana.*

f) Will the project modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline?

This species is more typically associated with sandy soils, either containing tertiary alluvium or derived from underlying Hawkesbury sandstone. Although the species is associated with some shale based ecological communities, this is not preferred habitat. There is a total of about 31.86 hectares of potential habitat for *Acacia bynoeana* mapped in the study area. Approximately 13.38 hectares of this potential habitat would be removed as a result of the project.

Within 10 kilometres of the study area approximately 5547.29 hectares of suitable habitat for *Acacia bynoeana* exists. The suitable habitat within the construction footprint represents 0.24 percent of this. This habitat in the construction footprint does not represent a substantial proportion of potential habitat for the species in the wider locality.

Furthermore, it is unlikely that this habitat in the construction footprint would be occupied by the species in the future due to the large distance from current known important populations and the species reliance on clonal, vegetative reproduction.

The habitat in the locality is also highly fragmented by rural residential, industrial and residential development. As such, many patches of potential habitat in the construction footprint exist in small, fragmented patches which are heavily impacted by grazing, exotic species and edge effects. They are therefore of low quality. The project would increase this fragmentation, which would decrease the potential habitat available to the species. However, the current fragmentation already poses a significant barrier to the species occupying the habitat within the construction footprint and as such any further fragmentation created by the project is negligible.

Therefore, the project would not modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.

g) Will the project result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat?

Weed invasion is considered a threat to *Acacia bynoeana.* Exotic grasses are abundant in the study area and the project may facilitate the spread of seeds or fragments of plant to areas where these grasses are not present, via plant or contaminated topsoil. This could include areas of potential habitat for the species. However, with the appropriate control measures enforced, the likelihood of this happening is significantly reduced**.**

h) Will the project introduce disease that may cause the species to decline?

The project is unlikely to result in the introduction of disease that may cause the species to decline.

i) Will the project interfere substantially with the recovery of the species?

There is no adopted or made recovery plan for this species. However, there is a list of activities to assist the species compiled by OEH (2017). These include:

- Ensure that personnel planning and undertaking hazard reduction burns are able to identify the species and are aware of its habitat.
- Implement fire regimes which maintain floristic and structural diversity. Until optimal fire frequency is known, avoid repeated burning of habitat at intervals of less than five years.
- Alert road and track maintenance staff to the presence of a threatened species.
- Where possible, limit movement of people through Bynoe Wattle populations.
- Use signs to alert visitors to the presence of this species and advise how their behaviour can affect its survival.
- Control threatening weeds where necessary.
- Investigate appropriate fire regime for the species.
- Mark Bynoe's Wattle sites and potential habitat onto maps used for planning road maintenance work.

- Mark Bynoe's Wattle sites and potential habitat onto maps used for planning hazard reduction work.

The project would not interfere with these activities and therefore not interfere substantially with the recovery of the species.

Conclusion

No individuals of *Acacia bynoeana* were recorded during targeted surveys and the nearest known records of the species exist 11 kilometres from the study area. It is therefore highly unlikely that an important population of the species exists within the study area. The project is therefore highly unlikely to lead to a long term decrease or reduce the area of occupancy of an important population. Similarly, it would not fragment an existing important population into two or more populations or disrupt it's breeding cycle. While some potential habitat for the species would be removed as a result of the project, it is unlikely that the species would occupy this habitat in the future. Therefore, the project is unlikely to have a significant impact on *Acacia bynoeana.*

Cynanchum elegans

Cynanchum elegans is listed as Endangered under the EPBC Act.

Cynanchum elegans is a climber or twiner with a highly variable form. It is a clonal species with underground suckering stems and is rarely stoloniferous. Mature stems have a fissured corky bark and can grow to 10 metres high and 3.5 centimetres thick. *Cynanchum elegans* occurs on a variety of lithologies and soil types, usually on steep slopes with varying degrees of soil fertility. It occurs mainly at the ecotone between dry subtropical rainforest and sclerophyll forest/woodland communities. In the Illawarra region and Cumberland Plain, most of the populations of *Cynanchum elegans* are found in small isolated remnant patches of dry rainforest.

Vegetation communities where the species has been recorded include Forest Red Gum aligned open forest and woodland scrub or woodland on steep basalt scree-slopes at some inland sites and Spotted Gum (*Corymbia maculata*) aligned open forest and woodland.

There is a total of about 166.92 hectares of potential habitat for the species in the study area in the form of PCT 830, PCT 835, PCT 849 and PCT 850. Approximately 45.76 hectares of this potential habitat would be removed as a result of the project.

Targeted surveys for *Cynanchum elegans* carried out by Arcadis ecologists in November 2017 found no individuals of this species within the study area.

a) Will the project lead to a long-term decrease in the size of a population?

No individuals of the species were recorded in the study area during targeted surveys in November 2017. It is therefore unlikely that a population exists within the study area. The nearest record of the species exists approximately 200 metres to the east of the study area. This record is from 1993 and would not be impacted by the project. Apart from this record, the nearest records are over 9 kilometres from the study area and are also over 20 years old. Any individuals of the species here would also not be impacted by the project. While the project would result in the removal of approximately 45.76 hectares of potential habitat for C*ynanchum elegans,* as no individuals have been recorded in the area it is considered highly unlikely that it would result in a long-term decrease in the size of a population.

b) Will the project reduce the area of occupancy of the species?

There is a total of about 166.92 hectares of potential habitat for the species in the study area. Approximately 45.76 hectares of this potential habitat would be removed as a result of the project.

While there is a record of the species in close proximity to the study area, it is unlikely that the species has a significant presence in the soil seedbank as studies have shown that the seeds of the species are wind dispersed and released in a viable, non-dormant state and hence do not persist in the soil seedbank (NSW NPWS, 2002).

Many patches of potential habitat in the study area exist in small, fragmented patches which are heavily impacted by grazing, exotic species and edge effects. They are therefore of low quality and unlikely to be occupied by the species in the future.

c) Will the project fragment an existing population into two or more populations?

It is considered unlikely that a population exists within the study area.

As no individuals were recorded during targeted surveys it is highly unlikely that any

individuals of the species would be removed as a result of the project. The nearest known record of the species is nearby the study area but is over 20 years old and therefore not reliable. Any individuals here would not be impacted or further isolated from other individuals.

Therefore, as there are no populations within the study area, and the project would not impact on any populations outside of the study area, it is considered highly unlikely that the project would fragment an existing population into two or more populations.

d) Will the project adversely affect habitat critical to the survival of a species?

No areas of critical habitat have been identified for *Cynanchum elegans.*

e) Will the project disrupt the breeding cycle of a population?

The following is known about the life cycle of *Cynanchum elegans* (Department of the Environment, 2018):

- White-flowered Wax Plant is a clonal species and is capable of suckering in response to occasional physical disturbance including slashing and grazing
- Little is known of the reproductive biology of White-flowered Wax Plant although an individual cultivated at Wollongong Botanic Gardens was capable of flowering and producing fruit within two years of germination
- Flowering occurs primarily between August and May, with the peak in November depending on the condition of the site and weather anomalies. Flower abundance can vary from sparse to prolific and seed production is variable, unreliable and of low levels
- The fruit is a pointed follicle, 4–6 cm long, containing up to 25 seeds. Pre-dispersal seed predation by unidentified moth larvae (Lepidoptera) has been observed at a number of sites and may affect the fecundity of some sub-populations
- The seeds of White-flowered Wax Plant are wind dispersed. Studies have shown that they are viable and released in a non-dormant state and hence are unlikely to persist in the soil seedbank

As no individuals were found during targeted surveys, it is considered unlikely that a population of the species exists within the study area. While there is a record of the species in close proximity to the study area, it is unlikely that the species has a significant presence in the soil seedbank as the species has low levels of seed production and seeds of the species are wind dispersed and released in a viable, non-dormant state and hence do not persist in the soil seedbank.

Therefore, the project is unlikely to disrupt the breeding cycle of a population of *Cynanchum elegans.*

f) Will the project modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline?

There is a total of about 166.92 hectares of potential habitat for the species in the construction footprint. Approximately 45.76 hectares of this potential habitat would be removed as a result of the project. Within 10km of the study area, approximately 8887.64 hectares of suitable habitat for *Cynanchum elegans* exists. The suitable habitat within the construction footprint represents 0.5 percent of this. Up to this amount would be cleared by the project. This is not a substantial proportion of potential habitat for the species in comparison to the wider locality.

The habitat in the study area is also highly fragmented by rural residential development and roads. As such, many patches of potential habitat in the study area exist in small, fragmented patches which are heavily impacted by grazing, exotic species and edge effects. They are therefore of low quality. The project would increase this fragmentation, which would decrease the potential habitat available to the species. However, the current fragmentation already poses a significant barrier to the species occupying the habitat within the study area and as such any further fragmentation created by the project is fairly negligible.

Therefore, the project would not modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.

g) Will the project result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species' habitat?

Weed invasion is recognised as a threat to *Cynanchum elegans.* Current populations of the species are affected by a variety of weeds including *Araujia sericifera, Lantana camara, Delairea odorata, Chrysanthemoides monilifera*, and *Olea europaea var. africana.* These species alter the natural habitat, including potential changes to nutrient levels, and probably reducing capacity for regeneration. A number of these species have been observed in the study area. The project may facilitate the spread of seeds or fragments of these exotic species to areas where these species are not present. This could include areas of potential habitat for the species.

h) Will the project introduce disease that may cause the species to decline?

The project is unlikely to result in the introduction of disease that may cause the species to decline.

i) Will the project interfere with the recovery of the species?

There is no adopted or made recovery plan for this species. However, there is a list of priority recovery actions for *Cynanchum elegans* (NSW DECC, 2005). These include:

- Determine and implement appropriate fire management practices.
- Consider off-site impacts in the assessment of nearby developments.
- Prevent inappropriate water run-off entering sites.
- Install fencing to exclude livestock and machinery, and control access where required.
- Protect areas of known and potential habitat from clearing and further fragmentation.
- Restore degraded habitat using bush regeneration techniques (note that it is crucial that workers are able to distinguish the species from the exotic Moth Vine).
- Undertake weed control.
- Monitor the health of known populations.
- Mark sites and potential habitat onto maps used for planning maintenance work.
- Map known sites and conduct searches of potential habitat for new sites.
- Include this species in regional information packages on rainforest communities and management.
- Undertake genetics and pollinator studies directed to improving management of the species.
- Undertake habitat restoration and ecotone maintenance.

While the project would not interfere with most of the priority actions, it would involve clearing of

potential habitat. However, mitigation measures would involve minimising vegetation removal and avoiding, where possible, the clearing of potential habitat.

Therefore, the project would not interfere substantially with the recovery of the species.

Conclusion

No individuals of *Cynanchum elegans* were recorded during targeted surveys. The nearest record exists approximately 200 metres from the study area and would not be impacted by the project. The project is therefore unlikely to lead to a long term decrease or reduce the area of occupancy of a population. Similarly, it would not fragment an existing population into two or more populations or disrupt it's breeding cycle. While some potential habitat for the species would be removed as a result of the project, this is not considered a significant amount in comparison to habitat in the wider locality and the habitat is of low quality. Therefore, the project is unlikely to have a significant impact on *Cynanchum elegans.*

Grevillea parviflora subsp. *parviflora*

Grevillea parviflora subsp. parviflora is listed as Vulnerable under the EPBC Act. *Grevillea parviflora subsp. parviflora* is a low spreading to erect shrub occurring on sandy clay loam soils, often with lateritic ironstone gravels. The species is generally found on crests, upper slopes or flats, and its distribution in the Sydney area is associated with the Nepean and Georges Rivers. Small populations occur at Kemps Creek and Voyager Point. It occurs in a range of vegetation types from heath and shrubby woodland to open forest.

Grevillea parviflora subsp. parviflora is known to be associated with the PCTs Hard-leaved Scribbly Gum - Parramatta Red Gum heathy woodland of the Cumberland Plain, Sydney Basin and Broad-leaved Ironbark - Grey Box - Melaleuca decora grassy open forest on clay/gravel soils of the Cumberland Plain, Sydney Basin Bioregion. These PCTs are mapped in the central section of the study area.

There is a total of about 13.75 hectares of potential habitat for *Grevillea parviflora subsp. parviflora* in the study area. Approximately 7.29 hectares of this potential habitat would be removed as a result of the project. The species has not been identified in the study area, although 17 records occur within 10 kilometres of it.

Targeted surveys for *Grevillea parviflora subsp. parviflora* carried out in November and December 2017 by Arcadis ecologists found no individuals of this species within the study area.

a) Will the project lead to a long-term decrease in the size of an important population of a species?

An 'important population' is a population that is necessary for a species' long-term survival and recovery. This may include populations identified as such in recovery plans, and/or that are:

- key source populations either for breeding or dispersal
- populations that are necessary for maintaining genetic diversity, and/or
- populations that are near the limit of the species range.

As no individuals of the species where recorded during targeted surveys it is considered unlikely that an important population would occur in the study area.

Furthermore, no individuals of the species would be removed as a result of the project. The nearest records of the species exist just outside the study area. Most of these records are less than 20 years old are located within bushland at Kemps Creek approximately 500 metres to the south of the study area. These are potentially an important population. These individuals would not be impacted by the project.

Therefore, the project would not lead to a long-term decrease in the size of an important population.

b) Will the project reduce the area of occupancy of an important population?

It is considered unlikely that an important population exists within the study area.

The nearest known records of the species exist just outside the study area. This is potentially an important population. These individuals would not be impacted by the project. This population is largely isolated from vegetation within the study area as rural residential development has fragmented the area. Any vegetation that does adjoin is generally highly disturbed and not ideal habitat for the species.

There is a total of about 13.75 hectares of potential habitat for *Grevillea parviflora subsp. parviflora* in the study area. Approximately 7.29 hectares of this potential habitat would be removed as a result of the project. It is unlikely that the species currently exists in this area as it was not recorded during targeted surveys.

Therefore, the project would not reduce the area of occupancy of an important population.

c) Will the project fragment an existing important population into two or more populations?

It is considered unlikely that an important population exists within the study area.

The nearest known records of the species exist just outside the study area. This is potentially an important population. These individuals would not be impacted by the project. The population currently exists in a highly fragmented area, with rural residential development and roads severing and isolating the existing populations. The project would not further exacerbate this or isolate some individuals from the existing population. Therefore, the project would not fragment an existing population into two or more populations.

d) Will the project adversely affect habitat critical to the survival of a species?

No areas of critical habitat have been identified for *Grevillea parviflora subsp. parviflora.*

e) Will the project disrupt the breeding cycle of an important population?

Very little is currently known about the life cycle of *Grevillea parviflora subsp. parviflora.* The following is our current understanding (Department of the Environment, 2018):

- It flowers in April, May and between July and December
- Flowers are insect pollinated and one to two seeds are produced but have limited seed dispersal, probably of less than 2 metres
- After fire or other disturbance, plants are capable of suckering or regenerating from rootstock. After fire, recruitment from seed is uncommon
- Sucker stems usually occur in patches close to the parent plant
- Individuals can live to 25–60 years

It is considered unlikely that an important population exists within the study area. There is potentially an important population just outside the study area. These individuals would not be impacted but soil within the construction footprint would be. However, it is unlikely that the species exists in the soil seedbank within the construction footprint due to its low dispersal distance.

Therefore, the project is unlikely to disrupt the breeding cycle of an important population.

f) Will the project modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline?

The PCT's which are known to be associated with *Grevillea parviflora subsp. parviflora* are mapped in the central section of the study area. This potential habitat forms a total of about 13.75 hectares in the study area. Approximately 7.29 hectares of this potential habitat would be removed as a result of the project.

Within 10 kilometres of the study area, approximately 1295.82 hectares of suitable habitat for *Grevillea parviflora subsp. parviflora* exists. The suitable habitat within the construction footprint represents 0.56 percent of this. Up to this amount would be cleared by the project.

The habitat in the locality is highly fragmented by rural residential, industrial and residential development. As such, many patches of potential habitat in the study area exist in small, fragmented patches which are heavily impacted by grazing, exotic species and edge effects. They are therefore of low quality. Due to this and the low dispersal distance of the species it is unlikely that they would occupy this habitat in the future.

While the project would increase fragmentation in the area, and create further barriers to the species' dispersal, due to the high amount of existing fragmentation and low quality habitat this is not considered significant.

Due to the low condition of the existing habitat and current fragmentation, it is 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.

g) Will the project result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat?

Weed invasion is recognised as a threat to *Grevillea parviflora subsp. parviflora* (Department of the Environment, 2018). A number of invasive weed species have been identified in the stud area. The project may facilitate the spread of seeds or fragments of these exotic species to areas where these species are not present. This could include areas of potential habitat for the species.

h) Will the project introduce disease that may cause the species to decline?

The project is unlikely to result in the introduction of disease that may cause the species to decline.

i) Will the project interfere substantially with the recovery of the species?

There is no adopted or made recovery plan for this species. However, there are a number of actions that may assist the species compiled by OEH (2013). These include:

- Liaise with land managers to encourage the preparation of site management plans and the implementation of appropriate threat abatement measures particularly in fire management, bush regeneration, roadside management, weed control, fencing and signage.
- Mark known sites and potential habitat onto maps used for planning maintenance work.
- Ensure that personnel planning and undertaking road maintenance are able to identify the species and are aware of its habitat.
- Mark and fence off sites during development/road maintenance activities.
- Determine an appropriate fire regime and reinstate an appropriate fire regime (either restrict fire or undertake ecological burns as required).
- Ensure that this subspecies is considered in planning matters on land that contains or may contain populations.
- Undertake weed (including Tick Bush) control using methods that will not impact on populations (avoid spraying in the vicinity of the plants and either hand pull weeds or cut and paint them).
- Ensure populations and their habitat are protected.
- Conduct searches in potential habitat for new populations.
- Investigate the species seed viability, germination, dormancy, longevity and genetic variation

As there are no individuals of the species in the study area, and the potential habitat within the study area is of low quality, the project is unlikely to interfere substantially with the recovery of the species.

Conclusion

No individuals of *Grevillea parviflora subsp. parviflora* were recorded during targeted surveys. The nearest known records of the species exist just outside the study area. While it is unlikely that an important population exists within the study area, it is possible that the population just outside the study area is an important population. This population would not be impacted. The project is therefore unlikely to lead to a long term decrease or reduce the area of occupancy of an important population. It is also unlikely to decrease and fragment the availability or quality of habitat to the extent that the species is likely to decline or fragment an existing population or disrupt its breeding cycle. Therefore, the project is unlikely to have a significant impact on *Grevillea parviflora subsp. parviflora.*

Persoonia nutans

Persoonia nutans is listed as Endangered under the EPBC Act. *Persoonia nutans* is an erect to spreading shrub restricted to the Cumberland Plain in western Sydney, between Richmond in the north and Macquarie Fields in the south. The species is confined to aeolian and alluvial sediments and occurs in a range of sclerophyll forest and woodland vegetation communities, with the majority of individuals occurring within Agnes Banks Woodland or Castlereagh Scribbly Gum Woodland.

Persoonia nutans is known to be associated with the PCTs Hard-leaved Scribbly Gum - Parramatta Red Gum heathy woodland of the Cumberland Plain, Sydney Basin and Broad-leaved Ironbark - Grey Box - Melaleuca decora grassy open forest on clay/gravel soils of the Cumberland Plain, Sydney Basin Bioregion. These PCTs are mapped in the central section of the study area.

There is a total of about 13.75 hectares of potential habitat for *Persoonia nutans* in the study area in the form of PCT 724 and PCT 883. Approximately 7.29 hectares of this potential habitat would be removed as a result of the project.

Persoonia nutans has been recorded within 500 metres to the south of the study area's central section, on Broad-leaved Ironbark - Grey Box - Melaleuca decora grassy open forest on clay/gravel soils of the Cumberland Plain, Sydney Basin Bioregion and Broad-leaved Ironbark - Melaleuca decora shrubby open forest on clay soils of the Cumberland Plain, Sydney Basin Bioregion.

Targeted surveys for *Persoonia nutans* carried out in November 2017 by Arcadis ecologists found no individuals of this species within the study area.

a) Will the project lead to a long-term decrease in the size of a population?

As no individuals of the species where recorded during targeted surveys it is considered unlikely that a population would occur in the study area.

No individuals of the species would be removed as a result of the project. The nearest records of the species exist just outside the study area. These records are from between 1982-2001 and are located within bushland at Kemps Creek approximately 500 metres to the south of the study area. These individuals would not be impacted by the project.

While the project would result in the removal of approximately 7.29 hectares of potential habitat for the species, as no individuals have been recorded in the study area it is considered highly unlikely that it would result in a long-term decrease in the size of a population.

b) Will the project reduce the area of occupancy of the species?

There is a total of about 13.75 hectares of potential habitat for *Persoonia nutans* in the study area. Approximately 7.29 hectares of this potential habitat would be removed as a result of the project.

Many patches of potential habitat in the study area exist in small, fragmented patches which are heavily impacted by grazing, exotic species and edge effects. They are therefore of low quality and not ideal habitat for the species.

However, it is possible that the species exists in the soil seedbank as seeds are dispersed by large birds and mammals, and therefore have a greater dispersal distance, and the length

of time which seeds last in the soil seedbank is unknown. Populations of the species are dynamic and fluctuations in space and time of above ground individuals are natural and common (Department of the Environment, 2018). As such, it is possible that the species occupies the construction footprint below ground.

Therefore, it is possible, yet unlikely due to the poor quality habitat, that the project would reduce the area of occupancy of the species.

c) Will the project fragment an existing population into two or more populations?

It is considered unlikely that a population of *Persoonia nutans* exists within the study area.

The nearest known records of the species exist just outside the study area. These individuals would not be impacted by the project. The study area exists in a highly fragmented area, with rural residential development and roads severing and isolating the existing populations. The project would not further exacerbate this or isolate some individuals from the existing population. Therefore, the project would not fragment an existing population into two or more populations.

d) Will the project adversely affect habitat critical to the survival of a species?

No areas of critical habitat have been identified for *Persoonia nutans.*

e) Will the project disrupt the breeding cycle of a population?

The following is currently known about the life cycle of *Persoonia nutans* (Department of the Environment, 2018):

- An obligate seed regenerator. Fire (or other disturbance) kills all plants and regeneration is dependent upon recruitment from a soil seed bank. Consequently, populations are dynamic throughout the landscape, and fluctuations in space and time of above ground individuals are a natural occurrence
- It is not known how long seeds last in the soil, or if they are all germinated by a single disturbance event. It is considered unlikely that high levels of germination occur without disturbance as a germination trigger
- The species flowers from November to April, with peak flowering in December and January. However, flowering may occur sporadically throughout the year
- Wasps and native bees are likely to be the main pollinators
- Fruiting has been recorded in small plants of 30 cm tall. Plants 1 m tall have supported up to 300 fruit, with larger individuals recorded as carrying "thousands" of fruit
- The fruit is fleshy, with one or two seeds enclosed in a hard woody stone, shed at maturity
- Seed is likely to be dispersed by large birds such as Currawongs (*Strepera graculina*), and mammals such as rats (*Rattus* spp.), kangaroos (*Macropus* spp.) and possums (e.g. *Trichosurus vulpecula*) that eat the fruit

The nearest known records of the species exist just outside the study area. While these individuals would not be impacted by the project, the nearby soil (>500 metres away) would be removed and disturbed. It is possible that the species exists in the soil seedbank as seeds are dispersed by large birds and mammals, and therefore have a greater dispersal distance, and the length of time which seeds last in the soil seedbank is unknown. Furthermore, populations of the species are dynamic and fluctuations in space and time of above ground individuals are natural and common (Department of the Environment, 2018). As such, it is possible that the species occupies the construction footprint below ground. If

so, the project may impact the species life cycle by removing the soil seedbank. However, this is unlikely due to the lack of suitable habitat and its poor quality within the construction footprint.

f) Will the project modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline?

The PCT's which are known to be associated with *Persoonia nutans* are mapped in the central section of the study area. This potential habitat forms a total of about 13.75 hectares in the study area. Approximately 7.29 hectares of this habitat would be removed as a result of the project.

Within 10 kilometres of the study area, approximately 1144.9 hectares of suitable habitat for *Persoonia nutans* exists. The suitable habitat within the construction footprint represents 0.64 percent of this. Up to this amount would be cleared by the project.

The habitat in the locality is also highly fragmented by rural residential, industrial and residential development. As such, many patches of potential habitat in the construction footprint exist in small, fragmented patches which are heavily impacted by grazing, exotic species and edge effects. They are therefore of low quality. While the project would increase this fragmentation, and create further barriers to the species' dispersal, due to the high amount of existing fragmentation and low quality habitat this is not considered significant.

Given that there are records of the species near the study area, the suitable habitat in the construction footprint could potentially be occupied by the species in the future. However much of this habitat is fragmented and disturbed and not considered ideal habitat.

Due to the low condition of the existing habitat, it is 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.

g) Will the project result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species' habitat?

Weed invasion is considered a threat to *Persoonia nutans* as contributing to habitat damage and destruction (Department of the Environment, 2018). A number of invasive weed species have been identified in the study area. The project may facilitate the spread of seeds or fragments of these exotic species to areas where these species are not present. This could include areas of potential habitat for the species.

h) Will the project introduce disease that may cause the species to decline?

Infection of populations by the root-rot fungus *Phytophthora cinnamomi* is considered a threat to *Persoonia nutans* (Department of the Environment, 2018). However, with the appropriate control measures in place the project is unlikely to introduce this fungus to areas of potential habitat for the species.

i) Will the project interfere with the recovery of the species?

A recovery plan has been prepared for this species. The six specific objectives of the recovery plan are (NSW Department of Environment and Conservation, 2005):

- minimise the loss and fragmentation of habitat using land-use planning mechanisms
- identify and minimise the operation of threats at sites where Nodding Geebung occurs

- implement a survey and monitoring program that will provide information on the extent and viability of the Nodding Geebung
- provide public authorities with information that assists in conserving the species
- raise awareness of the species and involve the community in the recovery program
- promote research questions that will assist future management decisions.

The project is unlikely to interfere substantially with the recovery of the species.

Conclusion

No individuals of *Persoonia nutans* were recorded during targeted surveys. It is therefore unlikely that a population exists within the study area. The nearest known records of the species exist just outside the study area. This population would not be impacted. The project is therefore unlikely to lead to a long term decrease or reduce the area of occupancy of the species. It is also unlikely to decrease and fragment the availability or quality of habitat to the extent that the species is likely to decline or fragment an existing population or disrupt its breeding cycle. Therefore, the project is unlikely to have a significant impact on *Persoonia nutans.*

Fauna Species

Australasian Bittern (*Botaurus poiciloptilus*)

The Australasian Bittern *Botaurus poiciloptilus* is listed as endangered under the TSC Act and EPBC Act. It has a widespread distribution but uncommon occurrence across south-eastern Australia. In NSW, it is found throughout most of the state except for the far north-west. The species favours permanent freshwater wetlands containing tall, dense vegetation, particularly bulrushes *Typha* spp. and spikerushes *Eleocharis* spp.

The Australasian Bittern typically breeds in summer, but research suggests breeding can occur anytime from August to January (BirdLife Australia, 2015). Breeding habitat requires deeper water and denser vegetation. Nests are built on platforms of reeds, located in secluded, densely vegetated wetland areas. The species forages predominately at night on frogs, fish, yabbies, spiders, insects and snails in still, shallow water up to 0.3 metres deep, or on platforms of vegetation over deeper water. They are highly cryptic; hiding during the day amongst dense reeds and rushes. They are usually identified from their characteristic call, as opposed to sightings.

Key threats to the species include (OEH, 2018):

- Drainage of wetlands and pond and alteration of natural flow regimes (including accelerated erosion and siltation).
- Reduced water quality as a result of siltation, pollution and salinity.
- Predation by European Red Fox, feral pigs and cats.
- Use of herbicides, pesticides and other chemicals near wetland areas.
- Inappropriate grazing and associated frequent burning of wetland areas.
- Loss and degradation of wetland habitat, including artificial wetland habitat in rice growing areas, due to changes in water management and cropping practices.
- Changes in seasonality and amount of rainfall as well as associated changes in environmental water allocations, driven by climate change.

BioNet (OEH, 2018) lists one record of Australasian Bittern within 10 kilometres of the study area. Several other sporadic records exist from the locality, recorded between 1992 and 2011. The nearest ‘hot spot’ of records exists about 20 kilometres north east of the study area around Wentworth Point (on the Parramatta River). These records range from as early as 1981 and as recent as 2017.

Australasian Bittern have not been recorded within the study area or surrounding area. The majority of the approximately 11.98 hectares of wetland and waterways habitat within the study area consists of 28 constructed farm dams. These dams are subject to disturbance from surrounding agricultural practices and as such, are not likely to support foraging or breeding habitat for the Australasian Bittern.

a) Will the project lead to a long-term decrease in the size of a population?

The Australasian Bittern has only been recorded once within 10 kilometres of the study area, about eight kilometres north west of the site in 2003. Further, most of the records in the surrounding area are more than 20 years old, with clumps of records, indicating more favourable habitat, located about 20 kilometres north east of the study area. The majority of the 11.98 hectares of wetland and waterways habitat within the study area consists of 28 constructed farm dams. These dams are subject to disturbance from surrounding agricultural practices and as such, are not likely to support foraging or breeding habitat for the Australasian Bittern. The removal of approximately 3.69

hectares of wetlands and waterways habitat and about 13 constructed dams within the construction footprint would not lead to a long- term decrease in the size of the population.

b) Will the project reduce the area of occupancy of the species?

In NSW, the area of occupancy for Australasian Bittern is estimated to be between 600 and 800 kilometres squared (km^2) (OEH, 2011). It is highly likely that since 2000, loss of wetland habitat has increased, and this figure is now lower. The majority of the 11.98 hectares of wetland and waterways habitat within the study area consists of 28 constructed farm dams. These dams are subject to disturbance from surrounding agricultural practices and as such, are not likely to support foraging or breeding habitat for the Australasian Bittern. The study area exists within a large area of modified farmland and suburban housing, and more suitable habitat exists in the locality, outside of the study area. For example, scattered records exist within 10 kilometres of the study area but are clumped in one area 20 kilometres north east of the site; suggesting this area contains more suitable habitat for the species. Given this, and the absence of suitable habitat within the study area, the removal of about 3.69 hectares of wetlands and waterways habitat and about 13 constructed dams within the construction footprint would not impact on the area of occupancy of the species.

c) Will the project fragment an existing population into two or more populations?

No population of Australasian Bittern has been identified within the study area. Wetland and waterways within the study area do not provide suitable habitat for the Australasian Bittern. All waterbodies in the study area are currently in a highly fragmented condition and are subject to high levels of disturbance due to agricultural activity. The Australasian Bittern is a highly mobile species that can readily fly between fragmented patches of habitat. Therefore, it is highly unlikely the removal of about 3.69 hectares of wetlands and waterways habitat including 13 constructed dams within the construction footprint would fragment the population of Australasian Bittern into two or more populations.

d) Will the project adversely affect habitat critical to the survival of a species?

No critical habitat has been declared for this species.

e) Will the project disrupt the breeding cycle of a population?

The Australasian Bittern is dependent on permanent or seasonal freshwater wetlands with tall, dense vegetation. Deeper water, with medium to high density reeds, rushes or sedges are required for nesting. The majority of the 11.98 hectares of wetland and waterways habitat within the study area consists of 28 constructed farm dams. These dams are subject to disturbance from surrounding agricultural practices and as such, are not likely to support foraging or breeding habitat for the Australasian Bittern. As such, the species is unlikely to breed in the study area and removal of about 3.69 hectares of wetlands and waterways habitat including 13 constructed dams within the construction footprint would not disrupt the breeding cycle of any local population.

f) Will the project modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline?

The study area does not provide suitable habitat for the Australasian Bittern. Given that there is suitable habitat elsewhere in the locality, and the species is highly mobile, it is unlikely that the removal of about 3.69 hectares of wetlands and waterways habitat including13 constructed dams within the construction footprint is likely to lead to a decline in the species.

g) Will the project result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species' habitat?

Much of the study area is already highly disturbed and modified and contains evidence of invasive fauna (i.e.- European Red Fox *Vulpes vulpes*, European Rabbit *Oryctolagus cuniculus*, Feral Cat *Felis catus*) and weeds. Recommended mitigation strategies include the retention of remnant vegetation where possible, and the removal/control of weeds and feral fauna

The study area does not provide suitable habitat for the Australasian Bittern, and this species is considered unlikely to occur here. As such, the project is highly unlikely to result in additional invasive species becoming established that are harmful to the Australasian Bittern.

h) Will the project introduce disease that may cause the species to decline?

No disease has been identified as a threat to the Australasian Bittern. The study area does not provide suitable habitat for the Australasian Bittern, and this species is considered unlikely to occur here. As such, the project is highly unlikely to introduce disease that may cause the Australasian Bittern to decline.

i) Will the project interfere with the recovery of the species?

Currently, there is no recovery plan for the Australasian Bittern. However, recovery actions for the species have been documented by BirdLife Australia (BirdLife Australia, 2015) and the NSW OEH Saving our Species program (OEH, 2018). Recovery actions target priority habitat and large, permanent wetlands. The study area does not provide suitable habitat for the Australasian Bittern, and this species is considered unlikely to occur here. As such the project does not conflict with the recovery actions listed for this species and will not interfere with the recovery of the Australasian Bittern.

Conclusion

The Australasian Bittern was not recorded within the study area. The majority of the 111.98 hectares of wetland and waterways habitat within the study area consists of 28 constructed farm dams. These dams are subject to disturbance from surrounding agricultural practices and are fragmented in small patches across the study area. The study area does not support foraging or breeding habitat for the Australasian Bittern.

Given the absence of records and suitable habitat within the study area, significant impacts to the Australasian Bittern from the project are considered unlikely.

Australian Painted Snipe (*Rostratula australis*)

The Australian Painted Snipe *Rostratula australis* is listed as endangered under the TSC Act and EPBC Act. A majority of records for this species are restricted to the south-east, particularly around the Murray-Darling Basin. In NSW, many records are from the Murray-Darling Basin including the Paroo wetlands, Lake Cowal, Macquarie Marshes and Fivebough Swamp. In more recent years, they have been recorded at swamps near Balldale and Wanganella. Other important locations with recent records include wetlands on the Hawkesbury River, Clarence Valley, and lower Hunter Valley.

The Australian Painted Snipe inhabits shallow terrestrial freshwater wetlands, preferring fringes of swamps, dams and marshland where vegetation cover exists, such as grasses, lignum, low scrub or open timber. Typical sites include those with rank emergent tussocks of grasses, sedges, rushes, reeds and clumps of lignum *Muehlenbeckia*., canegrass or tea-tree *Melaleuca* sp. Australian Painted Snipe breeding habitat requirements may be quite specific: shallow wetlands with areas of bare wet mud and both upper and canopy cover nearby. Nest records are all, or nearly all, from or near small islands in freshwater wetlands, provided that these islands are a combination of very shallow water, exposed mud, dense low cover and sometimes some tall dense cover. Breeding often occurs in response to local conditions, but generally occurs from September to December. The Australian Painted Snipe is a nocturnal forager, feeding on worms, molluscs, insects and plant-matter on mud-flats and in shallow waters.

Key threats to the species include (OEH, 2018):

- Drainage of breeding sites in wetlands.
- Reduced water quality from siltation and pollution.
- Predation by the European Red Fox and feral cats.
- Use of herbicides, insecticides and other chemicals near wetlands.
- Grazing and associated frequent burning of wetlands.
- Exotic weeds and invasive native plants degrading wetland habitat.
- Poor understanding of the species' breeding ecology.

BioNet (OEH, 2018) lists one record of Australian Painted Snipe within 10 kilometres of the study area. This record is from 2015 and is approximately five kilometres north of the proposed Badgerys Creek crossing. The record appears isolated, as no other records occur within a 20 kilometre radius of the study area. The only sites within the wider locality with multiple records exist about 20 kilometres north east of the study area around Sydney Olympic Park, and about 30 kilometres north around Windsor. Records at the latter are from 1959, 1973 and 1981 while the two records at Sydney Olympic Park are from 2011 and 2017. Australian Painted Snipe have not been recorded within the study area or surrounding area.

The Australian Painted Snipe was not recorded within the study area during surveys. The majority of the 111.98 hectares of wetland and waterways habitat within the study area consists of 28 constructed farm dams. These dams are subject to disturbance from surrounding agricultural practices and are fragmented in small patches across the study area. The study area does not support foraging or breeding habitat for the Australian Painted Snipe.

a) Will the project lead to a long-term decrease in the size of a population?

The Australian Painted Snipe has only been recorded once within 10 kilometres of the study area, about five kilometres north of the site in 2015. This appears to be an isolated record, as no other record of the species occurs within a 20 kilometre radius of the site. Further, clumps of records, indicating more favourable habitat, are located about 20 kilometres north east and 30 kilometres north of the study area.

The majority of the 11.98 hectares of wetland and waterways habitat within the study area consists of 28 constructed farm dams. These dams are subject to disturbance from surrounding agricultural practices and as such, are not likely to support foraging or breeding habitat for the Australian Painted Snipe. The removal of about 3.69 hectares of wetlands and waterways habitat including 13 constructed dams within the construction footprint would not lead to a long-term decrease in the size of the population.

b) Will the project reduce the area of occupancy of the species?

In NSW, the area of occupancy for the Australian Painted Snipe is estimated to be around 1,000 kilometres squared (km^2) (OEH, 2011). It is highly likely that since 2000, loss of wetland habitat has increased, and this figure is now lower. The majority of the 11.98 hectares of wetland and waterways habitat within the study area consists of 28 constructed farm dams. These dams are subject to disturbance from surrounding agricultural practices and as such, are not likely to support foraging or breeding habitat for the Australian Painted Snipe. The study area exists within a large area of modified farmland and suburban housing, and more suitable habitat exists in the locality, outside of the study area. For example, scattered records exist within 10 kilometres of the study area but are clumped in one area 20 kilometres north east of the site; suggesting this area contains more suitable habitat for the species.

Given this, and the absence of suitable habitat within the study area, the removal of about 3.69 hectares of wetlands and waterways habitat including 13 constructed dams within the construction footprint would not impact on the area of occupancy of the species.

c) Will the project fragment an existing population into two or more populations?

No population of Australian Painted Snipe has been identified within the study area. Wetland and waterways within the study area do not provide suitable habitat for the Australian Painted Snipe. All waterbodies in the study area are currently in a highly fragmented condition and are subject to high levels of disturbance due to agricultural activity. The Australian Painted Snipe is a highly mobile species that can readily fly between fragmented patches of habitat. Therefore, it is highly the removal of about 3.69 hectares of wetlands and waterways habitat including 13 constructed dams within the construction footprint would fragment the population of Australian Painted Snipe into two or more populations.

d) Will the project adversely affect habitat critical to the survival of a species?

No critical habitat has been declared for this species.

e) Will the project disrupt the breeding cycle of a population?

The Australian Painted Snipe inhabits shallow terrestrial freshwater wetlands, including temporary and permanent lakes, swamps and claypans. They are also known to use inundated or waterlogged grassland or saltmarsh, dams, rice crops, sewage farms and bore drains. Typical sites include those with rank emergent tussocks of grass, sedges, rushes or reeds, or samphire; often with scattered clumps of lignum *Muehlenbeckia* sp. or canegrass or sometimes tea-tree *Melaleuca sp*. Breeding habitat is specific; the species preferring shallow wetlands with areas of bare wet mud and both upper and canopy cover nearby. Nesting usually occurs on small islands in freshwater wetlands.

The majority of the 11.98 hectares of wetland and waterways habitat within the study area

consists of 28 constructed farm dams. These dams are subject to disturbance from surrounding agricultural practices and as such, are not likely to support foraging or breeding habitat for the Australian Painted Snipe. As such, the species is unlikely to breed in the study area and removal of about 3.69 hectares of wetlands and waterways habitat including 13 constructed dams within the construction footprint would not disrupt the breeding cycle of any local population.

f) Will the project modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline?

The study area does not provide suitable habitat for the Australian Painted Snipe. Given that there is suitable habitat elsewhere in the locality, and the species is highly mobile, it is unlikely that the removal of about 3.69 hectares of wetlands and waterways habitat including 13 constructed dams within the construction footprint is likely to lead to a decline in the species.

g) Will the project result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species' habitat?

Much of the study area is already highly disturbed and modified and contains evidence of invasive fauna (i.e.- European Red Fox *Vulpes vulpes*, European Rabbit *Oryctolagus cuniculus*, Feral Cat *Felis catus*) and weeds. Recommended mitigation strategies include the retention of remnant vegetation where possible, and the removal/control of weeds and feral fauna

The study area does not provide suitable habitat for the Australian Painted Snipe, and this species is considered unlikely to occur here. As such, the project is highly unlikely to result in additional invasive species becoming established that are harmful to the Australian Painted Snipe.

h) Will the project introduce disease that may cause the species to decline?

No disease has been identified as a threat to the Australian Painted Snipe. The study area does not provide suitable habitat for the Australian Painted Snipe, and this species is considered unlikely to occur here. As such, the project is highly unlikely to introduce disease that may cause the Australian Painted Snipe to decline.

i) Will the project interfere with the recovery of the species?

Currently, there is no recovery plan for the Australian Painted Snipe. However, recovery actions for the species have been documented by BirdLife Australia (BirdLife Australia, 2015) and the NSW OEH Saving our Species program (OEH, 2018). Recovery actions target priority habitat and large, permanent wetlands. The study area does not provide suitable habitat for the Australian Painted Snipe, and this species is considered unlikely to occur here. As such the project does not conflict with the recovery actions listed for this species and will not interfere with the recovery of the Australian Painted Snipe.

Conclusion

The Australian Painted Snipe was not recorded within the study area. The majority of the 11.98 hectares of wetland and waterways habitat within the study area consists of 28 constructed farm dams. These dams are subject to disturbance from surrounding agricultural practices and are fragmented in small patches across the study area. The study area does not support foraging or breeding habitat for the Australian Painted Snipe.

Given the absence of records and suitable habitat within the study area, significant impacts to the Australian Painted Snipe from the project are considered unlikely.

Regent Honeyeater (*Anthochaera phrygia*)

The Regent Honeyeater *Anthochaera phrygia* is listed as critically endangered under the TSC Act and the EPBC Act. The Regent Honeyeater inhabits temperate woodlands and open forests of the inland slopes of south-east Australia. Depending on resources, they can also be found in drier coastal woodlands and forests. The species range has reduced dramatically over the past 30 years, now extending between north-eastern Victoria and south-eastern Queensland. In NSW, its distribution is very patchy. Most records are from the Great Dividing Range, Central Coast and Hunter Valley regions. The species is highly mobile, moving across the landscape to take advantage of seasonally occurring foraging resources.

The species inhabits dry open forest and woodland, particularly Box-Ironbark woodland dry Box-Ironbark eucalypt woodland and dry sclerophyll forest associations in areas of low to moderate relief, wherein they prefer moister, more fertile sites available, for example along creek flats, or in broad river valleys and foothills. Regent Honeyeaters prefer to inhabit woodlands that support a significantly high abundance and species richness of bird species, and have significantly large numbers of mature trees, high canopy cover, and an abundance of mistletoe. In NSW, riparian forests containing River Oak *Casuarina cunninghamiana*, and with Needle-leaf Mistletoe *Amyema cambagei*, are important for foraging and breeding.

The Regent Honeyeater is a generalist forager, though it mainly feeds on nectar. Key foraging trees, that produce high volumes of nectar, include Mugga Ironbark, Yellow Box, White Box and Swamp Mahogany. Other tree species may be regionally important. For example, the Lower Hunter Spotted Gum forests have recently been demonstrated to support regular breeding events. Flowering of associated species such as Thin-leaved Stringybark *Eucalyptus eugenioides* and other Stringybark species, along with Broad-leaved Ironbark *E. fibrosa* can also contribute important nectar flows at times. Nectar and fruit from the mistletoes *Amyema miquelii*, *A. pendula* and *A. cambagei* are also utilised. The species is also known to forage on lerp, honeydew and insects.

There are three known key breeding areas, of which two occur in NSW (Capertee Valley and Bundarra-Barraba regions). The Regent Honeyeater breeds between July and January in Box-Ironbark and other temperate woodlands and riparian gallery forest dominated by River Sheoak. The species nests in horizontal branches or forks in tall mature eucalypts, Sheoaks, and Mistletoe haustoria.

Key threats to the species include (OEH, 2018):

- Historical loss, fragmentation and degradation of habitat from clearing for agricultural and residential development, particularly fertile Yellow Box-White Box-Blakely's Red Gum Woodlands.
- Continuing loss of key habitat tree species and remnant woodlands from major developments (mining and agricultural), timber gathering and residential developments.
- Key habitats continue to degrade from lack of recruitment of key forage species and loss of paddock trees and small remnants increasingly fragmenting the available habitat.
- Suppression of natural regeneration of overstorey tree species and shrub species from overgrazing. Riparian gallery forests have been particularly impacted by overgrazing.
- Competition from larger aggressive honeyeaters, particularly Noisy Miners, Noisy Friarbirds and Red Wattlebirds.

- The small population size and restricted habitat availability make the species highly vulnerable to extinction via stochastic processes and loss of genetic diversity, and reduced ability to compete, increased predation and reduced fledging rates.
- Egg and nest predation by native birds and mammals.
- Inappropriate forestry management practices that remove large mature resource-abundant trees. Firewood collection and harvesting in Box-Ironbark woodlands can also remove important habitat components.
- Disturbance at nesting sites leading to reduced nesting success by recreational users.

BioNet (OEH, 2018) lists five records of Regent Honeyeater within 10 kilometres of the study area. The majority of these records are more than 30 years old, however a recent record from 2009 exists approximately seven kilometres south-west of the study area. Records are scattered throughout the landscape and there appears to be no 'hot spot' areas for the species.

The study area contains 197.14 hectares of Woodland and Riparian Forest habitats supporting canopy tree species such as Spotted Gum *Corymbia maculata* and Forest Red Gum *Eucalyptus tereticornis* that are known or likely forage species for the Regent Honeyeater. As such the Regent Honeyeater was determined eligible as a candidate species for targeted surveys.

Targeted surveys were undertaken in autumn/winter, though there was little flowering during this period. Diurnal bird surveys were also conducted throughout 2017 and 2018. The Regent Honeyeater was not recorded within the study area during surveys, and habitat assessments during the survey period determined that the Woodland and Riparian Forest habitats of the study area are highly disturbed and fragmented due to historical clearing and development.

Given the absence of records from the study area and surrounds, the low number of records from the locality and the highly disturbed and fragmented condition of Woodland and Riparian Forest habitat it is considered that the study area does not support foraging or breeding habitat for the Regent Honeyeater.

a) Will the project lead to a long-term decrease in the size of a population?

The Regent Honeyeater has been recorded five times within 10 kilometres of the study area. The majority of these records are more than 30 years old, however a recent record from 2009 was recorded about seven kilometres south-west of the study area.

The Regent Honeyeater was not recorded during targeted surveys undertaken in autumn/winter 2017 and was not recorded during diurnal bird surveys throughout 2017 and 2018. The study area is not located near any of the known breeding areas for the Regent Honeyeater.

The 197.14 hectares of Woodland and Riparian Forest habitat of the study area is highly disturbed and fragmented and is not likely to provide foraging or breeding habitat for the Regent Honeyeater. The removal of about 55.58 hectares of Woodland and Riparian Forest habitat within the construction footprint would not lead to a long-term decrease in the size of the population. It lacks the extensive stands of eucalypts in good condition that can produce prolific flowering events that attract this species during migration.

b) Will the project reduce the area of occupancy of the species?

In NSW, the area of occupancy for the Regent Honeyeater is estimated to be around 200 kilometres squared (km^2) (OEH, 2011). The Regent Honeyeater was not recorded during

targeted surveys undertaken in autumn/winter 2017 and was not recorded during diurnal bird surveys throughout 2017 and 2018. The study area is not located near any of the known areas of important habitat for the Regent Honeyeater.

The 197.14 hectares of Woodland and Riparian Forest habitat of the study area is highly disturbed and fragmented and is not likely to provide foraging or breeding habitat for the Regent Honeyeater. The removal of about 55.58 hectares of Woodland and Riparian Forest habitat within the construction footprint would not reduce the area of occupancy of the species.

c) Will the project fragment an existing population into two or more populations?

No population of Regent Honeyeater has been identified within the study area. The 197.14 hectares of Woodland and Riparian Forest habitat within the study area are highly disturbed and fragmented and do not provide suitable habitat for the Regent Honeyeater. The Regent Honeyeater is a highly mobile species that can readily fly between fragmented patches of habitat. Therefore, it is highly unlikely the removal of about 55.58 hectares of Woodland and Riparian Forest habitat within the construction footprint would fragment a population of the Regent Honeyeater into two or more populations.

d) Will the project adversely affect habitat critical to the survival of a species?

No critical habitat has been declared for this species.

e) Will the project disrupt the breeding cycle of a population?

The Regent Honeyeater inhabits dry Box-Ironbark eucalypt woodland and dry sclerophyll forest associations in areas of low to moderate relief, wherein they prefer moister, more fertile sites available, such as along creek flats, or in broad river valleys and foothills. In NSW, riparian forests containing River Oak *Casuarina cunninghamiana*, and with Needle-leaf Mistletoe *Amyema cambagei*, are also important for feeding and breeding.

The Regent Honeyeater was not recorded during targeted surveys undertaken in autumn/winter 2017 and was not recorded during diurnal bird surveys throughout 2017 and 2018. The study area is not located near any of the known areas of important habitat for the Regent Honeyeater.

The 197.14 hectares of Woodland and Riparian Forest habitat of the study area is highly disturbed and fragmented and is not likely to provide foraging or breeding habitat for the Regent Honeyeater. As such, the species is unlikely to breed in the study area and removal of about 55.58 hectares of Woodland and Riparian Forest habitat within the construction footprint would not disrupt the breeding cycle of any local population.

f) Will the project modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline?

The study area does not provide suitable habitat for the Regent Honeyeater. Given that there is suitable habitat elsewhere in the locality, and the species is highly mobile, it is unlikely that the removal of about 55.58 hectares of Woodland and Riparian Forest habitat within the construction footprint is likely to lead to a decline in the species.

g) Will the project result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species' habitat?

Much of the study area is already highly disturbed and modified and contains evidence of invasive fauna (European Red Fox *Vulpes vulpes*, European Rabbit *Oryctolagus cuniculus*, Feral Cat *Felis catus*) and weeds. Recommended mitigation strategies include the retention of remnant vegetation where possible, and the removal/control of weeds and feral fauna.

The study area does not provide suitable habitat for the Regent Honeyeater, and this species is considered unlikely to occur here. As such, the project is highly unlikely to result in additional invasive species becoming established that are harmful to the Regent Honeyeater.

h) Will the project introduce disease that may cause the species to decline?

No disease has been identified as a threat to the Regent Honeyeater. The study area does not provide suitable habitat for the Regent Honeyeater, and this species is considered unlikely to occur here. As such, the project is highly unlikely to introduce disease that may cause the Regent Honeyeater to decline.

i) Will the project interfere with the recovery of the species?

The National Recovery Plan for the Regent Honeyeater (*Anthochaera phrygia*) (DoE, 2016) describes two recovery plan objectives, and four recovery strategies, for the species. These are:

Recovery plan objectives

- Reverse the long-term population trend of decline and increase the numbers of regent honeyeaters to a level where there is a viable, wild breeding population, even in poor breeding years; and to
- Enhance the condition of habitat across the regent honeyeaters range to maximise survival and reproductive success and provide refugia during periods of extreme environmental fluctuation.

Recovery strategies

- Improve the extent and quality of regent honeyeater habitat.
- Bolster the wild population with captive-bred birds until the wild population becomes self-sustaining.
- Increase understanding of the size, structure, trajectory and viability of the wild population.
- Maintain and increase community awareness, understanding and involvement in the recovery program.

The study area does not provide suitable habitat for the Regent Honeyeater, and this species is considered unlikely to occur here. As such the project does not conflict with the recovery actions listed for this species and will not interfere with the recovery of the Regent Honeyeater.

Conclusion

The Regent Honeyeater was not recorded within the study area during surveys, and habitat assessments during the survey period determined that the 197.14 hectares of Woodland and Riparian Forest habitats of the study area are highly disturbed and fragmented due to historical clearing and development. The study area does not support foraging or breeding habitat for the Regent Honeyeater.

Given the absence of records and suitable habitat within the study area, significant impacts to the Regent Honeyeater from the project are considered unlikely.

Swift Parrot (*Lathamus discolor*)

The Swift Parrot *Lathamus discolor* is listed as endangered under the TSC Act and critically endangered under the EPBC Act. The Swift Parrot occurs as a single migratory population that breeds in Tasmania during spring and summer and migrates to the mainland in autumn and winter; extending from Victoria to the eastern parts of South Australia and south-east Queensland. In NSW, the species mostly occurs on the coast and south-west slopes. The principal over wintering habitat on the mainland is the box-ironbark forests and woodlands inland of the Great Dividing Range in Victoria and NSW. Key habitat for Swift Parrots on the coast and coastal plains of NSW includes Spotted Gum *Corymbia maculata*, Swamp Mahogany *Eucalyptus robusta* and Forest Red Gum *E. tereticornis* forests.

The Swift Parrot is a highly mobile species able to utilise a variety of nectar sources over large areas. On the mainland they occur in areas where prolific eucalypt flowering events occur, or where there are an abundance of sap-sucking bug (lerp) infestations. The species favours Swamp Mahogany, Spotted Gum, Red Bloodwood *C. gummifera*, Mugga Ironbark *E. sideroxylon*, and White Box *E. albens*. Common lerp infested trees include Inland Grey Box *E. microcarpa*, Grey *Box E. moluccana* and Blackbutt *E. pilularis*.

When they return to Tasmania, the species breeds from September to January, nesting in tree hollows and foraging in forests dominated by Tasmanian Blue Gum *Eucalyptus globulus*.

Key threats to the species include (OEH, 2018):

- Habitat loss and fragmentation from forest harvesting, residential/industrial development, agricultural clearing, senescence and dieback.
- Changes in spatial and temporal distribution of habitat due to climate change.
- Reduced food availability due to drought conditions.
- Competition from introduced bees and large, aggressive honeyeaters for food resources.
- Collisions with human made structures resulting in death or injury.
- Psittacine Beak and Feather Disease (PBFD) vulnerability.
- Weed invasion impacting on habitat regeneration and health.
- High fire frequency impacting on food resource availability.
- Aggressive exclusion from forest and woodland habitat by over abundant Noisy Miners.
- Predation by cats (*Felis catus*).
- Illegal capture and trade of wild birds for aviculture.

BioNet (OEH, 2018) lists twenty-one records of Swift Parrot within 10 kilometres of the study area. The majority of these records are recent (less than 20 years old); the closest record being from 2007, within 100 metres of the M7 Motorway/Elizabeth Drive interchange. Targeted surveys were conducted for the species in autumn/winter 2017 and 2018, though there was little flowering during these periods, the species was not identified. Records are scattered throughout the landscape and there appears to be no ‘hot spot’ areas for the species.

Swift Parrot are known to occasionally forage in Western Sydney during their winter migration. The study area contains marginal foraging resources such as Spotted Gum and

Forest Red Gum, but these occur in as disturbed woodlands and planted, immature vegetation within Western Sydney Parklands the occasional remnant mature tree occurs throughout. Woodland and Riparian Forest habitat occurs as small patches throughout the study area.

a) Will the project lead to a long-term decrease in the size of a population?

Targeted surveys for this species were undertaken in autumn/winter 2017 and 2018, no Swift Parrots were detected and there was little flowering of potential feed trees during this time.

Given these results and the disturbed, fragmented nature of the potential foraging habitat within the area, it is unlikely that this area would be an important resource for the Swift Parrot population. As such, the removal of about 55.58 hectares of this marginal habitat is unlikely to lead to a long-term decrease in the size of the Swift Parrot population.

b) Will the project reduce the area of occupancy of the species?

The area of occupancy for Swift Parrots is difficult to estimate, as the species is migratory and has very different breeding (Tasmania) and foraging habitat. Using combined figures, the area of occupancy for foraging habitat for Swift Parrots ranged from 18.5 kilometres squared (km^2) to 355 kilometres squared (km^2) (OEH, 2011) (Saunders & Tzaros, 2011). These estimates show that Swift Parrots not only have a restricted area of occupancy but undergo extreme fluctuations in area use across years.

The area contains fragmented, disturbed and immature marginal foraging habitat and it is considered highly unlikely to be an important area of foraging for this species. As such, the removal of up to 55.58 hectares of marginal habitat is unlikely to reduce the area of occupancy of this species.

c) Will the project fragment an existing population into two or more populations?

The study area contains marginal foraging habitat only for this species, which is unlikely to be important to the Swift Parrot population. As such, the project is unlikely to fragment an existing population into two or more populations.

d) Will the project adversely affect habitat critical to the survival of a species?

No critical habitat has been declared for this species.

e) Will the project disrupt the breeding cycle of a population?

The Swift Parrot occurs as a single migratory population that breeds in Tasmania during the summer months and spends the remainder of the year in south-eastern mainland Australia. As such, no breeding habitat will be impacted by the project.

f) Will the project modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline?

The foraging habitat available in the study area is disturbed, fragmented and often immature and is unlikely to provide a valuable resource for the Swift Parrot. The project will result on the removal of 55.58 hectares of this marginal habitat, however this is not considered likely to impact the species significantly.

g) Will the project result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species' habitat?

Much of the study area are highly disturbed and modified and contain evidence of invasive fauna (i.e.- European Red Fox, European Rabbit, Feral Cat) and weeds. As such, the project is unlikely to significantly increase the impacts of these invasive species, since they are

already well established. Management of these threats as part of the environmental management of the project may even reduce their impacts

h) Will the project introduce disease that may cause the species to decline?

Swift Parrot are vulnerable to, and have the potential to be affected by, Psittacine Beak and Feather Disease (PBFD); a listed Key Threatening Process (KTP) for this species. PBFD is spread by the movements of common species carrying the disease and could result in deformities, high nestling mortality, and adult mortality in Swift Parrots. Increased stresses, such as habitat loss and predation, increase their susceptibility to the disease. Signs of PBFD in common bird species were not noted during surveys, and the project is unlikely to aid the spread of PBFD. As such, the project is highly unlikely to introduce disease that may cause the Swift Parrot to decline.

i) Will the project interfere with the recovery of the species?

The National Recovery Plan for the Swift Parrot (*Lathamus discolor*) (Saunders & Tzaros, 2011) describes four recovery objectives for the species. These objectives include:

- To identify and prioritise habitats and sites used by the species across its range, on all land tenures.
- To implement management strategies to protect and improve habitats and sites on all land tenures.
- To monitor and manage the incidence of collisions, competition and Beak and Feather Disease.
- To monitor population trends and distribution throughout the range.

The study area is unlikely to provide sufficient resources to be considered a priority habitat and as such, the project does not interfere with the recovery of the species.

Conclusion

The Woodland and Riparian Forest habitats throughout the study area are highly fragmented, disturbed, and in some area's immature. As such they provide only marginal habitat for the Swift Parrot, which is highly unlikely to be habitat important to the survival of the species. As such the project is unlikely to have a significant impact on this species.

Green and Golden Bell Frog (*Litoria aurea*)

The Green and Golden Bell Frog *Litoria aurea* is listed as endangered under the TSC Act and vulnerable under the EPBC Act. Once widespread and common, the species now occurs in small, fragmented populations at 50 locations across NSW, most of which are situated on or near the coast. Larger populations of Green and Golden Bell Frog in NSW occur around metropolitan Sydney, Shoalhaven and the mid-north coast. There is only one known population on the NSW Southern Tablelands. These populations are classified as key populations. In the absence of genetic information, a population is described as any distributional entity of the species that is separated by distances of up to 10 kilometres, or less if barriers are present that will inhibit interconnection (DEC, 2005).

The Green and Golden Bell Frog is highly mobile, and may move among breeding sites, however, dispersal patterns can vary between populations (Goldingay & Lewis, 1999). Various studies (reported in Goldingay & Lewis 1999) have revealed that the species is capable of moving long distances in a single day/night of up to 1–1.5 kilometres, and mark/recapture studies found individuals moved up to three kilometres. Observations suggest movements of up to five kilometres may be common, and the frog may possibly disperse as far as 10 kilometres.

The Green and Golden Bell Frog inhabits marshes, dams and streams, particularly where bulrushes *Typha* sp. or spikerushes *Eleocharis* spp. are abundant. Optimal habitat includes unshaded water-bodies that have adjacent grassy areas, diurnal sheltering sites available, and are free of predatory fish such as the Plague Minnow/Mosquito Fish *Gambusia holbrooki*. They are known to still occupy sites that are within highly disturbed areas. Breeding occurs in summer when conditions are warm and wet. Sites with a significantly higher proportion of ephemeral (temporary) ponds, rather than sites with fluctuating or permanent ponds, and where predatory fish are absent, are selected for breeding. Males call while floating in the water, and females produce a raft of eggs that sinks to the bottom, often amongst vegetation. Tadpoles feed on algae and plant matter, while adults forage on insects and other species of frog.

Key threats to the species include (OEH, 2018):

- Alteration of drainage patterns and stormwater runoff.
- *Chytridiomycosis* (Frog Chytrid Fungus; *Batrachochytrium dendrobatidis*).
- Predation by feral animals such as the European Red Fox.
- Herbicides and other weed-control measures.
- Road mortality, where populations are already small due to other threats.
- Predation by exotic fish such as *Gambusia holbrooki*.
- Loss of suitable breeding habitat through alteration by infilling and destruction of wetlands.
- Limited knowledge of the status of the population and threats.
- Land management practices, particularly on private land, may promote grazing and loss of breeding habitat.
- Changes in salinity due to sea level rise (frogs are unable to breed in waters with salt concentrations of greater than six parts per 1000).
- Overgrowth of pond vegetation leading to declining water temperature.
- Small population size.

- Lack of information regarding habitat permanency.
- Drying of breeding habitat as a result of increased temperatures and more frequent droughts.
- Lack of landscape connectivity leading to isolation of small populations.
- Heavy metal pollution.
- Four-wheel drives impacting habitat.

BioNet (OEH, 2018) lists twenty-one records of Green and Golden Bell Frog within 10 kilometres of the study area. The majority of these records are isolated occurrences, several hundred metres from major drainage lines or other waterbodies. The majority of records are also more than 50 years old. One relatively recent record, from 1999, records the species about three kilometres west of the study area. Targeted surveys were conducted across seven nights between 22 February and 17 October 2018 and the species was not identified.

Suitable foraging, breeding and dispersal habitats for the Green and Golden Bell Frog occur in up to 28 farm dams covering 11.98 hectares across the study area. Dams must have emergent vegetation to be considered to provide suitable habitat for this species. The majority of the waterbodies with emergent vegetation are subject to disturbance from surrounding agricultural practices. Impacts to potential foraging, breeding and dispersal habitats for the Green and Golden Bell Frog would be up to about 3.69 hectares of land and about 13 waterbodies.

a) Will the project lead to a long-term decrease in the size of an important population of a species?

An 'important population' is a population that is necessary for a species' long-term survival and recovery. This may include populations identified as such in recovery plans, and/or that are:

- Key source populations either for breeding or dispersal.
- Populations that are necessary for maintaining genetic diversity and/or;
- Populations that are near the limit of the species range.

Key source populations either for breeding or dispersal

Eight key source populations exist within the greater Sydney Region, representing some of the largest, but most disturbed and isolated populations of Green and Golden Bell Frog. No key source populations occur within the study area. The closest key populations are the Georges River and Greenacre populations, approximately 10 kilometres south-east and 20 kilometres west from the study area respectively. Twenty-one historical records of the Green and Golden Bell Frog occur within 10 kilometres of the study area. The majority of these records are more than 50 years old and are considered isolated occurrences. The closest record to the study area was recorded in 1999, about three kilometres west of the study area.

Populations that are necessary for maintaining genetic diversity

Detailed genetic information is lacking for the Green and Golden Bell Frog. As such, definitions of separate populations are defined as being separated by distances of up to 10 kilometres or over shorter distances where barriers prevent interconnection. Preliminary analyses have suggested that genetic differentiation between proximal populations occurs. If a population of Green and Golden Bell Frogs does exist within the study area, it is likely to be small and isolated and therefore are not necessary for maintaining genetic diversity.

Nearby key source populations around the Georges River and Greenacre are more likely to be important for maintaining genetic diversity (DEC, 2005) (OEH, 2018).

Populations that are near the limit of the species range

No Green and Golden Bell Frogs have been found within the study area. However, marginal habitat occurs, and the study area is within the species range. In NSW Green and Golden Bell Frogs have been recorded as far west as Wimbledon, north to Brunswick Heads and south to Nadgee on the Victorian border. Therefore, any potential Green and Golden Bell Frog populations located within the study area would not be near the limit of the species range.

b) Will the project reduce the area of occupancy of an important population?

No Green and Golden Bell Frogs have been detected during surveys. If a population occurs, it would be small and isolated and located between two larger source populations (Georges River and Greenacre). Any impacts on individuals within the construction footprint or surrounds would not reduce the area of occupancy of an important population.

c) Will the project fragment an existing important population into two or more populations?

Not applicable. There are no important populations of Green and Golden Bell Frog within the study area.

d) Will the project adversely affect habitat critical to the survival of a species?

No critical habitat has been declared for this species.

e) Will the project disrupt the breeding cycle of an important population?

The study area supports marginal habitat for this species, and any individuals that occur are unlikely to form an important population, due to minimal, isolated habitat. As such, the project will not disrupt the breeding cycle of an important population.

f) Will the project modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline?

The project would result in the removal of a small amount of potential foraging, breeding and dispersal habitat for the Green and Golden Bell Frog. Given that there is other suitable habitat in the locality, and the species is highly mobile (dispersing as far as 10 kilometres), it is unlikely that the removal of 3.69 hectares and about 13 waterbodies of potential habitat is likely to lead to a decline in the species.

g) Will the project result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat?

Much of the study area are highly disturbed and modified and contain evidence of invasive fauna (i.e.- European Red Fox, European Rabbit, Feral Cat) and weeds. As such, the project is highly unlikely to significantly increase invasive species impacts to Green and Golden Bell Frog habitat.

h) Will the project introduce disease that may cause the species to decline?

Green and Golden Bell Frogs are known to be affected by chytridiomycosis (chytrid fungus); listed as a Key Threatening Process (KTP) for this species. The fungus is water borne and transmitted by motile zoospores which attach to keratinised areas of frog skin and tadpole mouthparts. Therefore, it is likely spread by direct contact or through exposure to infected water. Chytrid fungus is not known to occur in the study area or in the locality (SoE, 2016),

and the project is unlikely to aid the spread of chytrid fungus. As such, the project is highly unlikely to introduce disease that may cause the Green and Golden Bell Frog to decline.

i) Will the project interfere substantially with the recovery of the species?

The Draft Recovery Plan for the Green and Golden Bell Frog (*Litoria aurea*) (DEC, 2005) describes five recovery objectives for the species. These include:

- Increase the security of key GGBF populations by way of preventing the further loss of GGBF habitat at key populations across the species range and where possible secure opportunities for increasing protection of habitat areas.
- Ensure extant GGBF populations are managed to eliminate or attenuate the operation of factors that are known or discovered to be detrimentally affecting the species.
- Implement habitat management initiatives that are informed by data obtained through investigations into the general biology and ecology of the GGBF through a systematic and coordinated monitoring program.
- Establish, within more than one institution, self-sustaining and representative captive populations (particularly 'at risk' populations) of the Green and Golden Bell Frog for the primary purpose of maintaining 'insurance' colonies for re-establishment and supplementation of populations of the species (captive breeding and translocation).
- Increase the level of regional and local awareness of the conservation status of the Green and Golden Bell Frog and provide greater opportunity for community involvement.

Assuming the presence of a population of Green and Golden Bell Frogs is present within the construction footprint, then the project is unlikely to be consistent with the objectives of the recovery plan.

Conclusion

The project will result in the removal of 3.69 hectares and about 13 waterbodies of marginal foraging, breeding and dispersal habitat for the Green and Golden Bell Frog. Most of the water bodies within the study area host *Gambusia holbrooki*, which eats Green and Golden Bell Frog tadpoles, making such areas unsuitable for this species.

If there is a population of this species within the study area, it is likely to be small and isolated and unlikely to contribute significantly to the surrounding source populations. Therefore, any impacts from the project are unlikely to lead to a decline in the species.

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

The Grey-headed Flying-fox *Pteropus poliocephalus* is listed as vulnerable under the TSC Act and EPBC Act. The species generally occurs within 200 kilometres of the east coast of Australia, ranging from Rockhampton in Queensland to Adelaide in South Australia. They inhabit subtropical and temperate rainforests, tall sclerophyll forests and woodlands, heaths and swamps, as well as urban gardens and cultivated fruit crops. They are a highly nomadic species, and movement patterns are largely unpredictable.

Grey-headed Flying-fox roost and breed in large aggregations known as camps, which are situated in the exposed branches of trees, and can support numbers greater than 70,000. Site fidelity to camps is very high; with some being used for over a century (DoEE, 2017). Camps are generally located within 20 kilometres of regular food sources and are commonly located in gullies, close to water, and in vegetation with a dense canopy (DoEE, 2017).

The species can travel up to 50 kilometres from the camp to forage, frequently making movements greater than 20 kilometres. Grey-headed Flying-fox forage on nectar and pollen of native trees, preferring *Eucalyptus*, *Melaleuca* and *Banksia* species. They also forage on fruits of rainforest trees and crops, vines and cultivated gardens (DoEE, 2017) (OEH, 2018).

Annual mating commences in January, but conception normally occurs in early autumn. Young are usually born between September and October after a gestation period of approximately six months. The young are initially carried around by the mother, but after several weeks are left in the camp while the mother forages. Young normally leave the camp in late summer to begin foraging for themselves.

Key threats to the species include (OEH, 2018):

- Loss of roosting and foraging sites.
- Electrocution on powerlines, entanglement in netting and on barbed-wire.
- Heat stress.
- Conflict with humans.
- Incomplete knowledge of abundance and distribution across the species' range.

BioNet (OEH, 2018) lists numerous records across the study area and wider locality. These records are most likely fly-overs and opportunistic records of the species foraging. Clumping of records occur at known camps. According to the National Flying-fox monitoring viewer with data from 2012 (DoE, 2018), there are no recorded Flying-fox camps within a five kilometre radius of the study area. Three Flying-fox camps are located within 15 kilometres of the study area. The closest camp is located at Wetherill Park, approximately seven kilometres to the north-east of the study area, with anywhere from 500 to 2,500 individuals counted during surveys between 2012 and 2016. Grey-headed Flying-fox were recorded during nocturnal surveys, undertaken across four sites within the study area between the 22 and 29 August 2018. Specifically, the species was recorded during spotlight transects flying overhead or roosting in large trees (such as *Eucalyptus moluccana* in Western Sydney Parklands).

Woodland, Riparian Forest and scattered eucalypts in the study area provides potential foraging habitat for the Grey-headed Flying-fox. The project would result in the removal of about 55.58 hectares of potential foraging habitat for the species.

a) Will the project lead to a long-term decrease in the size of an important population of a species?

An 'important population' is a population that is necessary for a species' long-term survival and recovery. This may include populations identified as such in recovery plans, and/or that are:

- Key source populations either for breeding or dispersal.
- Populations that are necessary for maintaining genetic diversity and/or;
- Populations that are near the limit of the species range.

Key source populations either for breeding or dispersal

The Grey-headed Flying-fox has no separate or distinct populations, the important population is the population of flying foxes in Australia. As such, there are no key source populations in the study area. Locations of current and historical breeding camps have been mapped for the National Flying-fox Monitoring Program (NFFMP) (DoE, 2018). No Flying-fox camps exist within the study area. However, three Flying-fox camps, one listed as a Nationally Important Flying-fox Camp, are located within 15 kilometres of the study area. These camps can support up to 10,000 individuals. The study area could be utilised by individuals from these camps for foraging, as the species can travel up to 50 kilometres from the camp to forage, frequently making movements greater than 20 kilometres (DoEE, 2017). However, they do not currently use the study area for permanent roosting or as a maternity camp.

Populations that are necessary for maintaining genetic diversity

The Grey-headed Flying-fox constantly exchanges genetic information between camps throughout its geographic range. The flying foxes that forage within the study area would be moving among at least three camps within 15 kilometres. The removal of about 55.58 hectares of foraging resources will reduce the quality of the study area for foraging but will not interfere with genetic exchange among nearby camps.

Populations that are near the limit of the species range

The Grey-headed Flying-fox has historically occupied forests and woodlands in the coastal lowlands, tablelands and slopes of south-eastern Australia, from Bundaberg in Queensland to Geelong in Victoria, with rare sightings outside its range. More recently, camps have established in South Australia (Adelaide), the Australian Capital Territory and inland areas of central and southern New South Wales and Victoria. As such, individuals or local populations found within the study area would not be near the limit of the species range.

Considering all the above information, members of an important population (the Australian population) utilise the study area for the 197.14 hectares of foraging habitat, but the removal of 55.58 hectares is unlikely to significantly impact the Australian Grey-headed Flying-fox population.

b) Will the project reduce the area of occupancy of an important population?

Foraging resources will be reduced for local sub-populations of Grey-headed Flying-fox in camps within 15 kilometres of the study area, however this will not significantly impact on an important population, and therefore will not reduce the area of occupancy of an important population.

c) Will the project fragment an existing important population into two or more populations?

The study area represents foraging habitat only, removal of a part of this may have some impact on the foraging behaviour of the local sub-population but will not fragment an existing important population.

d) Will the project adversely affect habitat critical to the survival of a species?
No critical habitat has been declared for this species.

Will the project disrupt the breeding cycle of an important population?

Not applicable. There are no important populations of Grey-headed Flying-fox within the study area.

e) Will the project modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline?

The project would result in the removal of about 55.58 hectares of foraging habitat for the Grey- headed Flying-fox. However, the study area does not contain any camps and foraging resources are still plentiful within the study area (approximately 142 hectares will remain). In addition, other parts of the Western Sydney Parklands and other tracts of woodland are available for foraging within the immediate vicinity. Furthermore, Grey-headed Flying-fox are highly mobile and are known to forage widely (up to 50 kilometres from their camp). As such, it is unlikely that the removal of about 55.58 hectares of potential foraging habitat will lead to a decline in the species.

f) Will the project result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat?

Sections of the study area are highly disturbed and modified and contain evidence of invasive fauna (i.e.- European Red Fox, European Rabbit, Feral Cat) and weeds. As such, the project is highly unlikely to result in significant additional invasive species impacts within foraging habitat for the Grey-headed Flying-fox.

g) Will the project introduce disease that may cause the species to decline?

Grey-headed Flying-foxes are known to carry at a number of diseases, some of which have been found to be dangerous to humans (e.g. Hendra and Lyssa virus). Impacts of disease is not well understood in the Grey-headed flying-fox population, although incidence of disease in the population is low (DoEE 2017). The removal of about 55.58 hectares of foraging habitat is unlikely to introduce disease that may cause the Grey-headed Flying-fox to decline.

h) Will the project interfere substantially with the recovery of the species?

The Draft Recovery Plan for the Grey-headed Flying-fox (*Pteropus poliocephalus*) (DoEE, 2017) lists two recovery objectives for the species. These are:

- To improve the Grey-headed flying-fox national population trend by reducing the impact of threatening processes on Grey-headed Flying-foxes through habitat identification, protection, restoration and monitoring, and;
- To assist communities and Grey-headed flying-fox to coexist through better education, stakeholder engagement, research, policy and continued support to fruit growers.

Nine additional, specific objectives are detailed within the plan. The project is inconsistent with the objectives of the recovery plan, as it does not contribute to the conservation of the Grey-headed Flying-fox.

Conclusion

The project will result in the removal of up about 55.58 hectares of foraging habitat for the Grey- headed Flying-fox. There are likely to be >30,000 individuals of the species within a 50 kilometre radius of the study area (DoE, 2018). However, it is unlikely that the foraging habitat within the study area, consisting of woodland, forest and scattered eucalypts, would be important in supporting this sub-population. It will impact on foraging resources. However, this impact is unlikely to be significant, since there will still be significant resources remaining, both within the study area and within reach of the camps within 15 kilometres of the study area.

Koala (combined populations of QLD, NSW and the ACT) (*Phascolarctos cinereus*)

The koala *Phascolarctos cinereus* (combined populations of QLD, NSW and the ACT) is listed as vulnerable under the TSC Act and EPBC Act. It has a fragmented distribution throughout eastern Australia, extending from north-east Queensland to the Eyre Peninsula in South Australia. In NSW, it predominately occurs on the central and north coasts with some populations located west of the Great Dividing Range. The species is associated with a wide range of temperate, tropical and sub-tropical forests as well as semi-arid communities.

Koalas forage on the foliage of more than 70 eucalypt species and 30 non-eucalypt species. However, they appear to exhibit strong preferences for particular species and between individual trees. Eucalyptus species are consumed as the primary food resource, while other genera such as Corymbia, Lophostemon and Melaleuca may also be incorporated into the diet as a supplementary resource. Specifically, swamp mahogany *E. robusta* and grey gum *E. propinqua* are recognised as the most preferred koala food trees. Forest Red Gum *Eucalyptus tereticornis* and Grey Box *E. moluccana* are present in the study area. *E. tereticornis* is considered a primary food tree and *E. moluccana* a secondary food tree (DECC, 2008). Due to their highly specialised diet, food availability is believed to be a key determinant of high quality koala habitat (Moore & Foley, 2000).

Koalas are generally solitary but have complex hierarchies and a highly defined social structure at the local aggregation level. One male will dominant a territory, which will overlap several females and sub-ordinate males on the periphery. Home range is highly variable, increasing with increasing quality of habitat. Females breed from two years of age and produce one young per year.

Key threats to the species include (OEH, 2018):

- Loss, modification and fragmentation of habitat.
- Vehicle strike.
- Predation by roaming or domestic dogs.
- Intense prescribed burns or wildfires that scorch or burn the tree canopy.
- Koala disease.
- Heat stress through drought and heatwaves.
- Human-induced climate change.
- Inadequate support for fauna rehabilitation.
- Poor understanding of sources of trauma and mortality.
- Poor understanding of population distribution and trend.
- Poor understanding of animal movements and use of habitat.

BioNet (OEH, 2018) lists thirteen records of Koala within 10 kilometres of the study area. A majority of these records are recent (less than 20 years old). Two records from 2003, and one from 2002, occur 500 metres south of the south-eastern extent of the study area, adjacent to the M7 Motorway in Western Sydney Parklands.

Spot Assessment Technique surveys (SAT) (Phillips & Callaghan, 2011) were undertaken for the Koala throughout the study area and across the year in both 2017 and 2018. Further, nocturnal surveys, involving call-playback and spotlighting transects, were conducted between the 22 and 29 August 2018. No evidence of koala use of the area was found. Few

records exist within the locality, likely due to high levels of disturbance from agricultural activity and barriers preventing movement. Approximately 25 kilometres south, around Campbelltown, Appin and Dharawal National Park, are 'hot spots' where large numbers of koalas have been recorded.

In accordance with the referral guidelines, the Koala habitat assessment tool has been applied in order to assess whether habitat critical to the survival of the Koala is likely to exist in the study area. A score of '5' was calculated, which suggests the study area contains habitat critical to the survival of the Koala. Key food trees, Forest Red Gum and Grey Box are present in the study area. Impacts to potential foraging and movement habitat for the Koala would be a maximum of about 55.58 hectares, of which about 33.02 hectares contains mature, established feed trees in densities greater than 15%. The remaining 22.56 hectares of potential habitat is mostly immature or young planted feed trees in the Western Sydney Parklands. The Koala prefers feed trees greater than 25.5 cm diameter at breast height (dbh) (DECC, 2008), and the majority of eucalypts in the Western Sydney Parklands have a dbh less than 25.5 cm; which is less preferable to the Koala. Potential Koala food trees within the construction footprint would be avoided if possible, however for the purposes of assessment, they are assumed to be removed.

Western Sydney Parklands represents the largest area of potential habitat for the species within the study area. The study area largely follows an existing landscape barrier – Elizabeth Drive. Vegetation clearing in this area would widen this barrier to movement. The study area would also result in fragmentation of riparian vegetation in the landscape, some of which contains Koala feed trees.

a) Will the project lead to a long-term decrease in the size of an important population of a species?

An 'important population' is a population that is necessary for a species' long-term survival and recovery. This may include populations identified as such in recovery plans, and/or that are:

- Key source populations either for breeding or dispersal.
- Populations that are necessary for maintaining genetic diversity and/or;
- Populations that are near the limit of the species range.

Key source populations either for breeding or dispersal

No Koala Management Areas are within the study area. No endangered or key source populations occur within the study area. Within the Sydney Basin, an important population exists in the Wedderburn/Campbelltown area, approximately 25 kilometres south of the study area. Thirteen historical records of the Koala occur within 10 kilometres of the study area. The closest records were recorded in 2002 and 2003, about 500 metres south of the south-eastern extent of the study area.

Populations that are necessary for maintaining genetic diversity

Geographic variations in morphology indicates that there are three subspecies of Koala (DECC, 2008). However, genetic analysis indicates that Koalas consist of many highly differentiated populations, as opposed to three highly differentiated subspecies (DECC, 2008). In NSW, this indicates little gene flow between populations, which is expected to be exacerbated by fragmentation of habitat and barriers to movement. No populations of Koala exist within the study area. At best, the study area may occasionally be used as habitat that Koalas would traverse. Nearby key source populations around the Campbelltown and Appin are more likely to be important for maintaining genetic diversity.

Populations that are near the limit of the species range

No populations of Koala exist within the study area. Individuals have the potential to move through the study area. However, in NSW Koalas have been recorded on the central and north coasts with some populations located west of the Great Dividing Range. Therefore, any Koalas found within the study area would not be near the limit of the species range.

Considering all the above information, there are no important populations of Koala within the study area.

b) Will the project reduce the area of occupancy of an important population?

Not applicable. There are no important populations of Koala within the study area.

c) Will the project fragment an existing important population into two or more populations?

Not applicable. There are no important populations of Koala within the study area.

d) Will the project adversely affect habitat critical to the survival of a species?

No critical habitat has been declared for this species.

Will the project disrupt the breeding cycle of an important population?

No Koalas were found during surveys and only marginal habitat is available. The study area may support the occasional transient Koala; however, the project will not interfere with the breeding cycle of an important population of this species.

e) Will the project modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline?

The project would result in the removal of about 55.58 hectares of potential habitat, of which about 33.02 hectares contains mature, established feed trees, for the Koala. Potential Koala food trees within the final project footprint are unlikely to be retained, though they would be avoided during detailed design development where possible. The project would result in an increase in fragmentation, however the landscape is predominately agricultural land and is already subject to high levels of disturbance and fragmentation. The study area also already follows Elizabeth Drive; an existing barrier in the landscape. The absence of direct or indirect evidence of Koala in the study area, and the presence of other suitable habitat for the species to inhabit within Western Sydney Parklands indicates that the removal of 55.58 hectares of potential foraging habitat, of which 33.02 hectares contains established feed trees, is unlikely to lead to a decline in the species.

f) Will the project result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat?

Sections of the study area are highly disturbed and modified and contain evidence of invasive fauna (i.e.- European Red Fox, European Rabbit, Feral Cat) and weeds. As such, the project is highly unlikely to result in significant additional invasive species becoming established that are harmful to the Koala.

g) Will the project introduce disease that may cause the species to decline?

Koala populations in NSW carry the pathogen *Chlamydia*. The disease weakens the individual, causing them to become more vulnerable to death from other causes such as dog attack and severe weather conditions (DECC, 2008). Clinical signs of the disease are expressed when the species is exposed to environmental stresses such as loss of habitat, harassment by predators, nutritional stress or overcrowding (DECC, 2008). Disease is likely

to be present in any koala population persisting in the region. Although it is considered unlikely that koalas persist in the survey area, the project would not introduce any new diseases that may cause this species to decline, nor would it significantly increase the risk of infection from *Chlamydia*.

h) Will the project interfere substantially with the recovery of the species?

The Recovery Plan for the Koala (*Phascolarctos cinereus*) (DECC, 2008) describes seven recovery objectives for the species. These are:

- To conserve koalas in their existing habitat.
- To rehabilitate and restore koala habitat and populations.
- To develop a better understanding of the conservation biology of koalas.
- To ensure that the community has access to information about the distribution, conservation and management of koalas at a national, state and local scale.
- To manage captive, sick or injured koalas and orphaned wild koalas to ensure consistent and high standards of care.
- To manage over-browsing to prevent both koala starvation and ecosystem damage in discrete patches of habitat.
- To coordinate, promote the implementation, and monitor the effectiveness of the NSW Koala Recovery Plan across NSW.

The absence of evidence of the koala during recent surveys, coupled with limited recent records and none within the last decade, indicates the project is unlikely to support a resident population, as such it will not interfere with the objectives of the recovery plan.

Conclusion

The project will result in the removal of 55.58 hectares, of which 33.02 hectares contains mature, established feed trees, for the Koala. However, the study area exists within agricultural land that is already subject to high levels of disturbance and fragmentation, and also follows Elizabeth Drive; an existing barrier in the landscape. As such, it is unlikely that this area represents habitat critical to the survival of the species. The absence of direct or indirect evidence of Koala in the study area, and the presence of other suitable habitat for the species to inhabit within Western Sydney Parklands and the wider locality, such as around Campbelltown and Appin, indicates that there is unlikely to be a resident population present in the study area. At most the Koala may use the area occasionally for dispersal. Given this, significant impacts to the Koala (combined populations of QLD, NSW and the ACT) from the project are considered unlikely.

Large-eared Pied Bat (*Chalinolobus dwyeri*)

The Large-eared Pied Bat *Chalinolobus dwyeri* is listed as vulnerable under the TSC Act and EPBC Act. It is found in areas with extensive cliffs and caves, from Rockhampton in Queensland to Bungonia in the NSW Southern Highlands. In general, the species is rare and has a patchy distribution within NSW. The species roosts predominately on sandstone escarpments in disused mine shafts, caves, overhangs and abandoned fairy martin nests.

The species is found in well-timbered areas containing gullies. Large-eared Pied Bat forage for insects in and around forest canopies in fertile woodlands and forests. Breeding habitat is in caves and appears to require a specific structure (arch caves with dome roosts) (DERM, 2011). Breeding habitat is not present in the study area.

Important populations for this species occur in the sandstone escarpments of the Hunter Valley, Sydney Basin and Southern Tablelands of NSW (DERM, 2011). If Large-eared Pied Bat are utilising the study area, they are unlikely to form an important population as the study area does not contain any sandstone escarpments described in the recovery plan, there is limited roosting and breeding habitat in the locality, and the study area does not occur at the limit of the species range. The species was considered moderately likely to occur during the biodiversity assessment for the nearby Northern Road Upgrade, Bringelly to Glenmore Road (Jacobs 2017), however this project is further to the west towards the Blue Mountains. Animals roosting in the sandstone escarpments of the Blue Mountains National Park, may use the Northern Road area for occasional foraging, this is less likely within the current project's study area.

Key threats to the species include (OEH, 2018):

- Clearing and isolation of forest and woodland habitats near cliffs, caves and old mine workings for agriculture or development.
- Loss of foraging habitat close to cliffs, caves and old mine workings from forestry activities and too-frequent burning, usually associated with grazing.
- Damage to roosting and maternity sites from mining operations, and recreational caving activities.
- Use of pesticides.
- Disturbance to roosting areas by goats.

There are no records of Large-eared Pied Bat within the study area (OEH, 2018). The closest records are from 2002 and 2003, about 10 kilometres north-west of the study area, recorded in Mulgoa Nature Reserve. Targeted surveys, using Anabat echolocation call recording, were undertaken across six sites within the study area, between the 9 and 20 November 2017. The Large-eared Pied Bat was not recorded.

The project would result in the removal of a maximum of about 55.58 hectares of potential foraging habitat for the species. Woodland in the study area is already heavily fragmented, and the landscape has been highly disturbed and fragmented largely due to extensive agricultural activities.

a) Will the project lead to a long-term decrease in the size of an important population of a species?

An 'important population' is a population that is necessary for a species' long-term survival and recovery. This may include populations identified as such in recovery plans, and/or that are:

- Key source populations either for breeding or dispersal.

- Populations that are necessary for maintaining genetic diversity and/or;
- Populations that are near the limit of the species range.

Key source populations either for breeding or dispersal

Within NSW, the largest concentration of this species appears to be in the sandstone escarpments of the Sydney basin and northwest slopes of NSW. The species has also been recorded from a few locations in the sandstone escarpments of the Morton National Park at the southern end of its range. Further survey is required throughout its known range to determine the size and distribution of existing populations. It is unlikely that a key source population exists within the study area as it does not contain sandstone escarpments such as those identified in the recovery plan (DERM, 2011) and the study area, as well as the wider locality, does not contain suitable roosting or breeding habitat for the species.

Populations that are necessary for maintaining genetic diversity

Detailed genetic information is lacking for the Large-eared Pied Bat. It is thought that small, fragmented sub-populations may be at greater risk of extinction from random events due to loss of genetic variability. No populations of Large-eared Pied Bat exist within the study area, and therefore are not necessary for maintaining genetic diversity.

Populations that are near the limit of the species range

No populations of Large-eared Pied Bat exist within the study area. Individuals have the potential to be found to occasionally forage in the area, however the species is distributed from Queensland to NSW. Therefore, any potential Large-eared Pied Bat located within the study area would not be near the limit of the species range.

Considering all the above information, there are no important populations of Large-eared Pied Bat within the study area.

b) Will the project reduce the area of occupancy of an important population?

Not applicable. There are no important populations of Large-eared Pied Bat within the study area.

c) Will the project fragment an existing important population into two or more populations?

Not applicable. There are no important populations of Large-eared Pied Bat within the study area.

d) Will the project adversely affect habitat critical to the survival of a species?

No critical habitat has been declared for this species. ***Will the project disrupt the breeding cycle of an important population?***

Not applicable. There are no important populations of Large-eared Pied Bat within the study area.

e) Will the project modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline?

The project would result in the removal of up to 55.58 hectares of potential foraging habitat for the Large-eared Pied Bat. Woodland in the study area is already heavily fragmented, and the landscape has been extensively modified. Given that there are no important populations or critical habitat on site, and there is more suitable habitat within 10 kilometres of the study area, the removal of 55.58 hectares of potential foraging habitat is unlikely to lead to a decline in the species.

f) Will the project result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat?

Sections of the study area are highly disturbed and modified and contain evidence of invasive fauna (i.e.- European Red Fox, European Rabbit, Feral Cat) and weeds. As such, the project is highly unlikely to result in additional invasive species becoming established that are harmful to the Large-eared Pied Bat or its habitat.

g) Will the project introduce disease that may cause the species to decline?

There are no known diseases for the Large-eared Piet Bat. As such, the project is highly unlikely to introduce disease that may cause the Large-eared Pied Bat to decline.

h) Will the project interfere substantially with the recovery of the species?

The National Recovery Plan for the Large-eared Pied Bat lists five specific objectives for the species (DERM, 2011). These include:

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

The project does not conflict with the recovery objectives listed for this species.

Conclusion

The project will result in the removal of about 55.58 hectares of potential foraging habitat for the Large-eared Pied Bat. Given that the species is highly dependent on the presence of roosting and breeding sites, and none occur within the study area and are limited within the wider locality, it is unlikely that the project will adversely affect habitat critical to the survival of the species. Further, no important populations of the species have been identified within the study area or wider locality. As such, significant impacts to the Large-eared Pied Bat from the project are considered unlikely.

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www.rms.nsw.gov.au/m12
m12motorway@rms.nsw.gov.au

1800 517 155

Roads and Maritime Services
PO Box 973
Parramatta NSW 2124

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