



Sydney Zoo – Bungarribee South

Biodiversity Assessment Report

Prepared for Sydney Zoo

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Contents

Executive summary.....	xi
1 Introduction.....	1
1.1 Project background.....	1
1.2 The project.....	1
1.3 Study area	1
1.4 Context of Biodiversity Assessment Report	2
2 Methodology	5
2.1 Background information.....	5
2.1.1 Assessment Guidelines	5
2.1.2 Database searches.....	5
2.1.3 Previous reports	5
2.2 Assessment methodology	6
2.2.1 Field surveys.....	6
2.2.2 Survey effort	7
2.2.3 Field study personnel	8
2.2.4 Limitations.....	9
3 Landscape features	11
3.1 IBRA bioregions and subregions.....	11
3.2 Mitchell Landscapes	11
3.2.1 Landscape and soils.....	11
3.3 Rivers, stream and estuaries.....	11
3.4 Wetlands.....	11
3.5 Groundwater dependent ecosystems.....	12
3.6 Ecological corridors	12
3.7 Landscape value score.....	13
3.8 Connectivity width assessment	14
3.9 Connectivity condition assessment	14
3.10 Patch size	15
4 Native vegetation.....	17
4.1 Plant Community Types (PCTs).....	17
4.1.1 Forest Red Gum – Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney Basin Bioregion (PCT 835 or BVT HN526).....	17
4.1.2 Grey Box – Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin Bioregion (PCT 849 or BVT HN528)	17
4.2 Other vegetation	18

4.2.1	Exotic grassland	18
4.3	Vegetation zone.....	21
4.4	Matters of National Environmental Significance – Vegetation Communities	22
4.4.1	Cumberland Plain Woodland – Condition A.....	22
5	Threatened species	24
5.1	Ecosystem credit species	24
5.2	Species credit species	25
5.3	Matters of National Environmental Significance – Threatened and Migratory Species	28
6	Avoidance and mitigation measures	29
6.1	Avoidance of impacts	29
6.1.1	Alternate location	29
6.1.1	Utilising existing exotic grassland areas.....	29
6.1.2	Separation of the car park into two sections	29
6.2	Mitigation measures	29
6.2.1	Standard mitigation measures.....	29
6.2.2	Project specific measures.....	30
7	Assessment of impacts	34
7.1	Direct impacts	36
7.1.1	Loss of vegetation and/or habitat	36
7.1.2	Weeds.....	36
7.1.3	Changes to hydrology.....	37
7.2	Indirect impacts	37
7.2.1	Animal pests	37
7.2.2	Impact on relevant Key Threatening Processes.....	38
7.2.3	Connectivity and habitat fragmentation	38
7.2.4	Injury and mortality	39
7.2.1	Runoff and wastewater	39
7.2.1	Rubbish dumping.....	39
7.2.2	Inadvertent impacts to adjacent vegetation	39
7.3	Negligible impacts	39
7.3.1	Bushfire.....	39
7.3.2	Noise, vibration and light	39
7.3.3	Aquatic impacts	40
7.3.4	Groundwater dependent ecosystems.....	40
7.4	Matter of National Environmental Significance.....	40
8	Impact summary and offsets	41
8.1	Areas not requiring assessment or offsets	41

8.2	Ecosystem and species credits requiring offsets	41
8.3	Impacts requiring further consideration	42
8.3.1	Impacts to native vegetation – Cumberland Plain Woodland: Critically Endangered Ecological Community	42
9	Summary and biodiversity credit report	46
	References	52
	Appendix A Likelihood of occurrence	54
	Appendix B Plot and transect field data	63
	Appendix C Plot and transect field data sheets	65
	Appendix D Flora species recorded	78
	Appendix E Fauna species recorded	81
	Appendix F Study area description	82
	Appendix G EPBC Act Significant Impact Criteria	87
	Appendix H FBA Methodology and where addressed in document	98

List of figures

Figure 1: Location map.....3

Figure 2: Site map4

Figure 3: Field survey locations.....10

Figure 4: Connectivity assessment16

Figure 5: Native vegetation and PCTs within study area23

Figure 6: Construction footprint.....35

Figure 7: PCTs requiring offsets.....45

List of tables

Table 1: Summary of survey effort	8
Table 2: Personnel and qualifications	8
Table 3: Area of vegetation in each assessment circle.....	13
Table 4: Linkage width classes before and after development	14
Table 5: Condition of vegetation within the assessment circle before and after development	15
Table 6: Vegetation in the study area	19
Table 7: Vegetation zones and plot requirements.....	21
Table 8: Ecosystem credit species on development site	24
Table 9: Geographic and habitat questions and answers	25
Table 10: List of candidate species credit species and second filtering step	26
Table 11: Avoidance and mitigation measures	32
Table 12: Noxious weed species encountered in study area.....	36
Table 13: Known and potential Key Threatening Processes and impacts on biodiversity.....	38
Table 14: PCTs requiring offset and ecosystem credits	41
Table 15: Flora species recorded within study area.....	78
Table 16: Fauna species list recorded during the field survey.....	81
Table 17: Location of FBA methodology requirements for a 'Biodiversity Assessment Report' and where these are addressed in this report.....	98

Abbreviations

Abbreviation	Description
CEEC	Critically Endangered Ecological Community
CMA	Catchment Management Authority
DotE	Commonwealth Department of the Environment (formerly SEWPaC)
DSEWPaC	Commonwealth Department of Sustainability, Environment, Water, Population and Communities (now DotE)
EEC	Endangered Ecological Community
ELA	Eco Logical Australia Pty Ltd
EP&A Act	<i>Environmental Planning and Assessment Act 1979</i>
EPBC Act	<i>Environment Protection and Biodiversity Conservation Act 1999</i>
FBA	Framework for Biodiversity Assessment
FM Act	<i>Fisheries Management Act 1994</i>
GDE	Groundwater Dependent Ecosystem
I&I NSW	Industry and Investment NSW
IBRA	Interim Biogeographic Regionalisation for Australia
LGA	Local Government Area
MNES	Matters of National Environmental Significance
NPWS	NSW National Parks and Wildlife Service (part of OEH)
NSW Department of Planning and Environment	NSW Department of Planning and Environment, formerly the Department of Planning and Infrastructure
NW Act	<i>Noxious Weeds Act 1993</i>
OEH	NSW Office of Environment and Heritage (formerly Department of Environment Climate Change and Water, DECCW)
SEARs	Secretary's Environmental Assessment Requirements
TEC	Threatened Ecological Community
TSC Act	<i>Threatened Species Conservation Act 1995</i>
VIS	Vegetation Information System

Key terminology

Terminology	Description
BioBanking	A methodology developed by Office of Environment and Heritage (OEH) which provides a transparent, consistent and scientifically-based set of rules to assess biodiversity values. The BioBanking Assessment Methodology provides rules for the number and type of credits that can be created from undertaking conservation management at a biobank site. The methodology also provides rules for the number and type of credits that a development site will require in order to offset its impacts and thus improve or maintain biodiversity values. This project has used the Major Projects Offset Policy and Framework for Biodiversity Assessment (FBA) to assess the number and type of biodiversity credits required (see below).
Clearing	The removal of vegetation or other obstacles at or above ground level.
Construction footprint	The area directly impacted upon by the construction of the project. 'Construction footprint' is used in this technical working paper as an alternative to 'subject site' as defined by DEC (2004). The construction footprint includes all components relating to construction and operation of the project including (but not limited to): • All excavations/construction, including ancillary equipment. • All stormwater/sediment control measures. • All access requirements for construction or ongoing infrastructure maintenance. • All spoil and construction material storage areas.
Direct impacts	Those that directly affect species, populations or ecological communities and their associated habitats. Direct impacts include, but are not limited to, loss of individuals or ecological communities and removal of suitable habitat.
Framework for Biodiversity Assessment	The Framework for Biodiversity Assessment (FBA) is a tool that is applied by accredited ecological consultants. It provides a step by step method to identify and assess impacts on biodiversity. The FBA provides clear guidance on avoiding and minimising the biodiversity impacts of a project. It also provides an objective and repeatable method for determining offset requirements before a development application is submitted.
Indirect impacts	Those which occur when project-related activities affect species, populations or ecological communities in a manner other than direct loss. Indirect impacts include loss of individuals through starvation, exposure, predation by domestic and/or feral animals, loss of breeding opportunities, loss of shade/shelter, hydrological changes, increased soil salinity, erosion, weed invasion, increased noise and/or light, or increased human activity within or directly adjacent to sensitive habitat areas which include sites of known threatened species, endangered ecological communities or features that are potential habitat for threatened species e.g. culverts.
Locality	The locality is defined by a 5 kilometre radius around the study area for the purposes of conducting database search.

Terminology	Description
SEARs	Secretary's Environmental Assessment Requirements. Requirements and specifications for an environmental assessment prepared by the Secretary of the NSW Department of Planning and Environment under the <i>Environmental Planning and Assessment Act 1979</i> .
Site establishment works	Preliminary works carried out prior to the commencement of construction, including: • Installation of environmental controls. • Vegetation clearing. • Establishment of construction facilities.
Stockpile	Temporarily stored materials such as soil, sand, gravel and spoil/waste.
Study area	The area of ecological survey investigation for this report. The study area can be seen in Figure 1 .
The project	The Sydney Zoo project, as described in Section 1.1 .

Executive summary

Sydney Zoo is seeking approval under Part 4 of the *Environmental Planning and Assessment Act 1979* (EP&A Act) for the development and operation of a zoo (Sydney Zoo) within the Bungarribee Precinct in Western Sydney Parklands. The proposal involves the construction of the zoo and associated infrastructure (roads and car parks), and is to be assessed as State Significant Infrastructure via an Environmental Impact Statement (EIS).

The majority of the project takes advantage of previously cleared areas and impacts to the larger stands of Cumberland Plain Woodland have been avoided where possible. Opportunities to avoid impacts in the design were explored, and as a result, the proposed car park has been split into two areas to avoid impacts on Cumberland Plain Woodland.

The assessed construction footprint covers all the areas required for construction and operation of the project. The assessment utilised both desktop analysis and field assessment, using the Framework for Biodiversity Assessment methodology to assess habitat and condition of ecological communities. Targeted survey was conducted for threatened flora species. Potential indirect impacts that have been considered include disruptions to ecological connectivity, injury and mortality to flora and fauna, weeds, hydrological changes, noise, vibration and light.

The project design and construction footprint represents the preferred design for the project. A total of 1.65 hectares of direct impacts on native vegetation associated with the proposed construction footprint have been identified (see **Table 6** and **Table 14**) comprising:

- Grey Box – Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin Bioregion (HN 528) – moderate to good (medium): 0.24 ha
- Grey Box – Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin Bioregion (HN528) – moderate to good (derived native grassland): 0.83 ha
- Forest Red Gum – Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney Basin Bioregion (HN256) – moderate to good (medium): 0.82 ha

The majority of the Cumberland Plain Woodland (CPW) at the site is present as scattered regrowth comprised of a very small number of regenerating eucalypts with an exotic understorey or very small patch of *Microlaena stipoides* beneath the trees. However, the CPW in the east of the site forms the southern tip of a good quality stand of CPW that would meet the criteria for listing as Condition A CPW under the EPBC Act. Vegetation to be impacted in on the fringes of this patch has undergone historical clearance and therefore weed invasion was evident and included exotic grass and herbaceous species. Further, much of this vegetation is regrowth.

Small stands of CPW are also present at the site in the form of Derived Native Grassland.

The River Flat Eucalypt Forest (RFEF) at the site was a modified vegetation community that has undergone revegetation. The patch represented a relatively young stand of replanted RFEF, with the upper stratum supporting young *Eucalyptus amplifolia* (Cabbage Gum) and the mid-storey dominated by various *Acacia* species. The understorey was dominated by a mixture of native and exotic ground cover species with much of the groundlayer browning. Remnant RFEF occurred beyond the western boundary of the site.

No trees had very large hollows of a sufficient size to support breeding and roosting for large forest owls. Up to two trees with hollows in the southeast of the site would be removed for the proposal that provide potential habitat for threatened microbats and other hollow dependent fauna.

The project has substantially avoided biodiversity impacts by utilising, as much as possible, already disturbed areas and designing infrastructure to incorporate vegetation wherever possible. A number of mitigation measures to minimise ecological impacts will be implemented as part of the project. These measures includes: site-specific environmental induction; identification of clearing limits and protective fencing; vegetation clearance procedures; fauna rescue; reuse of habitat elements; erosion and sediment control; weed management and weed monitoring. The areas of CPW and RFEF currently at the site will be enhanced through edge plantings directly adjacent with CPW and RFEF with the incorporation of some native bird attracting species. A vegetated buffer will also be planted around the zoo that will assist in replacing some of the CPW to be removed and will include Cumberland Plain and native eucalypt species.

This Biodiversity Assessment Report assessed the type and quantum of credits as a result of the project using the Framework for Biodiversity Assessment (FBA) methodology to quantify the impacts of the proposal. Vegetation zone 2, the derived native grassland, had a site value of less than 17, and therefore in accordance with the FBA, offsets are not required. Due to the small area of some vegetation zones to be impacted, there is a requirement to merge these vegetation zones, and therefore the various areas of HN528, which in total were less than 0.24 ha, were merged with the HN526 medium vegetation zone for assessing impacts. The calculations identified the following quantum of offsets for the project:

- Forest Red Gum – Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney Basin Bioregion (HN526) – moderate to good (medium): **requiring 23 ecosystem credits**

It was determined that no species credit species were likely to occur within the study area and therefore there are no species credit requirements for the proposal.

Three migratory species listed under the *Environment Protection and Biodiversity Conservation Act* have the potential to utilise the site and the eastern most stand of CPW within the study area would meet the criteria for listing under the EPBC Act. Further the Grey-headed Flying Fox (*Pteropus poliocephalus*) has the potential to utilise the site. Significance Assessments were undertaken for each species and the CPW and concluded that a referral to the Commonwealth Department of the Environment (DotE) is not required.

The *NSW Biodiversity Offsets Policy for Major Projects*, and the associated *Framework for Biodiversity Assessment*, commenced on 1 October 2014, and is in a transitional period for 18 months, with the policy allowing for “a more flexible approach will be permitted to appropriately deal with any technical issues, practical implementation issues or potential perverse outcomes that may arise” (*NSW Biodiversity Offsets Policy for Major Projects*, OEH 2014a, page 5). The proposed development and operation of Sydney Zoo is not a standard type of development, and proposes to deliver the ecological outcomes via substantial native plantings as part of its landscaping plan. The project will also increase the ecological connectivity in an east-west direction between remnant and planted vegetation along Eastern Creek, and a larger area of better condition Cumberland Plain Woodland vegetation to the east of the site. In addition, the development proposes to integrate 17 nestboxes targeting birds and bats as part of the landscaping plan.

An assessment of the potential impacts on groundwater dependent ecosystems and aquatic habitats concluded there would be no significant impact as a result of the proposal. There is likely to be no significant impact to aquatic fauna listed under the *Fisheries Management Act 1994*.

1 Introduction

1.1 Project background

Sydney Zoo is seeking approval under Part 4 of the *Environmental Planning and Assessment Act 1979* (EP&A Act) for the construction and operation of a zoo (Sydney Zoo) within the Bungarribee Precinct in Western Sydney Parklands. The proposal involves the construction of the zoo, car parking, and entrance.

The project was declared to be State Significant Development (SSD). Assessment and approval is being pursued in accordance with the EP&A Act. The Secretary's Environmental Assessment Requirements (SEARs) for the project with regards to Biodiversity are for:

- *Identification of species on-site;*
- *Detail of the potential direct and indirect impacts on any threatened species, populations, endangered ecological communities or their habitats, groundwater dependant ecosystems and any potential for offset requirements;*
- *A detailed description of the measures to avoid, minimise, mitigate and offset biodiversity impacts; and,*
- *An assessment of the proposal and all biodiversity values on the site under the Framework for Biodiversity Assessment 2014.*

This Biodiversity Assessment Report has been prepared to inform the EIS for the Project, and to satisfy assessment of impacts on biodiversity matters being prepared as required by the SEARs.

This report satisfies the requirement to produce a Biodiversity Assessment Report in accordance with the TSC Act. It is noted that Appendix H provides details of how this report meets the layout and requirements of a Biodiversity Assessment Report, as specified in Table 20 (stage 1) and 21 (stage 2) of the Framework for Biodiversity Assessment. The accredited assessor was Steven Ward (accreditation number 0039).

1.2 The project

The proposed development of Sydney Zoo located in South Bungarribee will include the development of a new Zoo containing a number of exhibits including native and exotic animals.

Key features of the project would include:

- Zoo
- Restaurant
- Car parking
- Gift Shop
- Bus Parking
- Roads

Construction of the project is expected to take around 8 – 12 months to complete.

1.3 Study area

The Western Sydney Parklands (WSP) is a 27 km corridor stretching from Quakers Hills to Leppington in western Sydney (WSP 2011). Bungarribee South (referred to as the 'study area' in this report) falls within

the new suburb of Bungarribee which is part of the City of Blacktown Local Government Area (LGA) and is part of the WSP. The Bungarribee Precinct covers an area approximately 216 ha. The study site consists of Lot 11, to be created by the subdivision of Lot 1 DP1103025. Lot 11 will be 16.5 hectares and is located in the most southern portion of the Bungarribee precinct and is bound by major roads Great Western Highway to the south, Doonside road to the east and Eastern Creek flows along the western boundary (**Figure 1**).

The construction footprint is a portion of the study area (**Figure 2**). The operational footprint is fully contained within the construction footprint of the project. The construction footprint has the same meaning as 'development site' in accordance with the FBA.

1.3.1 Construction footprint

The construction footprint is the area proposed to be impacted, cleared and/or disturbed during the construction of the project, including both above ground and underground elements of the project

It is assumed that all vegetation within the construction footprint will be removed. However, the majority of this vegetation is exotic grassland and impacts to larger stands of Cumberland Plain Woodland (CPW) on the site have been avoided as much as possible during the design process.

The construction footprint is shown in **Figure 2** and **Figure 6**. The construction footprint represents the area that would be physically impacted by construction works, including all construction ancillary infrastructures, whereas the operational footprint for the project represents the area that would have all operational infrastructure.

1.4 Context of Biodiversity Assessment Report

The NSW Government has developed a NSW Biodiversity Offsets Policy for Major Projects, including State Significant Development (SSD). As part of an application for a Major Project under the EP&A Act, a proponent must prepare an EIS that addresses the Secretary's Environmental Assessment Requirements (SEARs) provided by the NSW Department of Planning and Environment (DP&E).

Under the NSW Biodiversity Offsets Policy for Major Projects, the SEARs require the Framework for Biodiversity Assessment (FBA) to be applied to assess impacts on biodiversity. The FBA outlines the assessment methodology to quantify and describe the biodiversity values on the development site, and the biodiversity offsets required for any unavoidable impacts.

The FBA negates the need to conduct Assessments of Significance (7-part tests) under the NSW *Threatened Species Conservation Act 1995* (TSC Act). However, the FBA requires proponents to identify and assess the impacts on all *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) listed threatened species and ecological communities that may be on the development site. These have been assessed in **Appendix G** according to EPBC Act impact assessment processes.

The FBA applies only to terrestrial impacts. Section 89J of the EP&A Act states that permits under section 201, 205 or 219 of the *Fisheries Management Act 1994* do not apply to State significant Development. These permits relate to dredging work, harm to marine vegetation and blocking of fish passage.

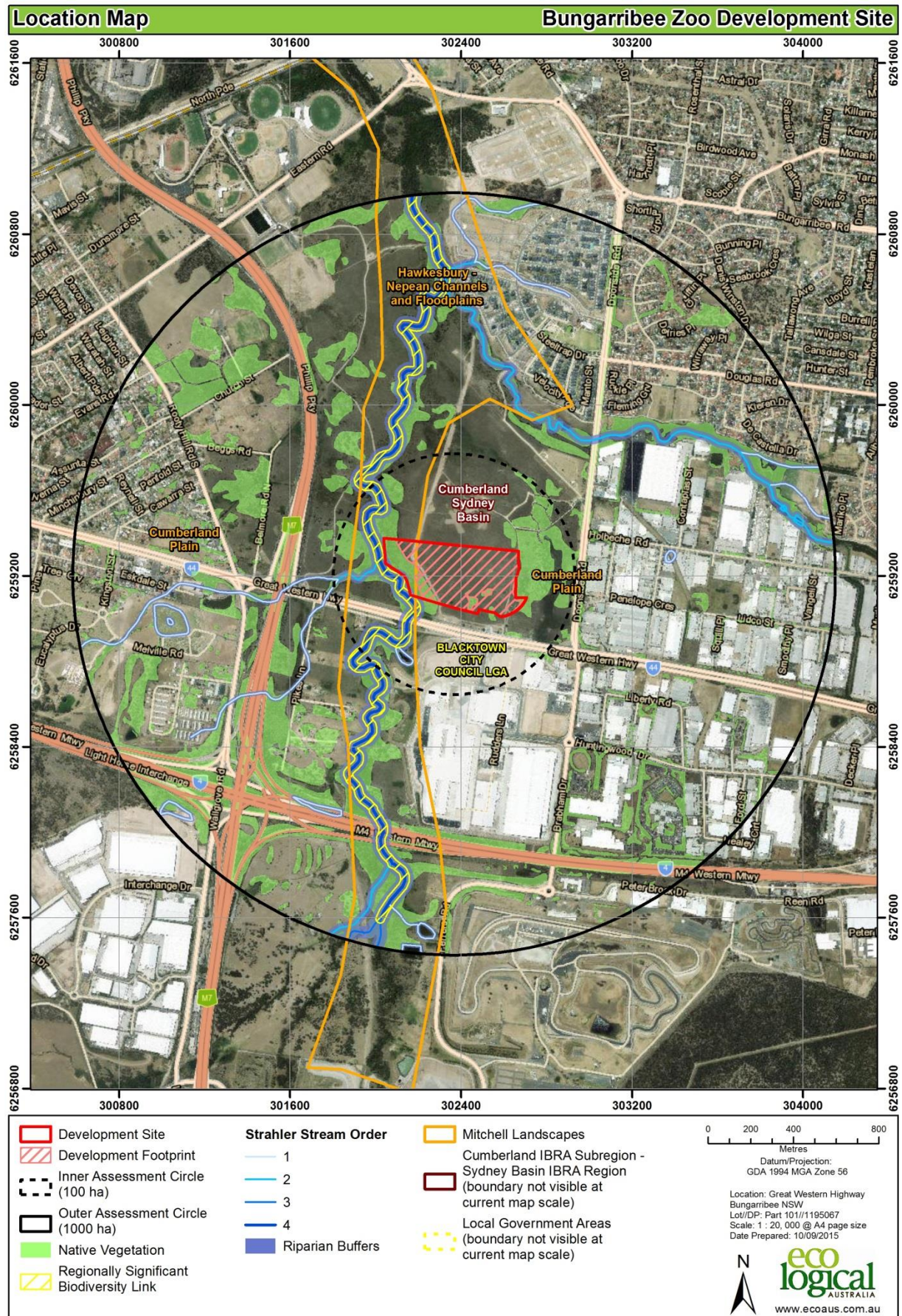


Figure 1: Location map

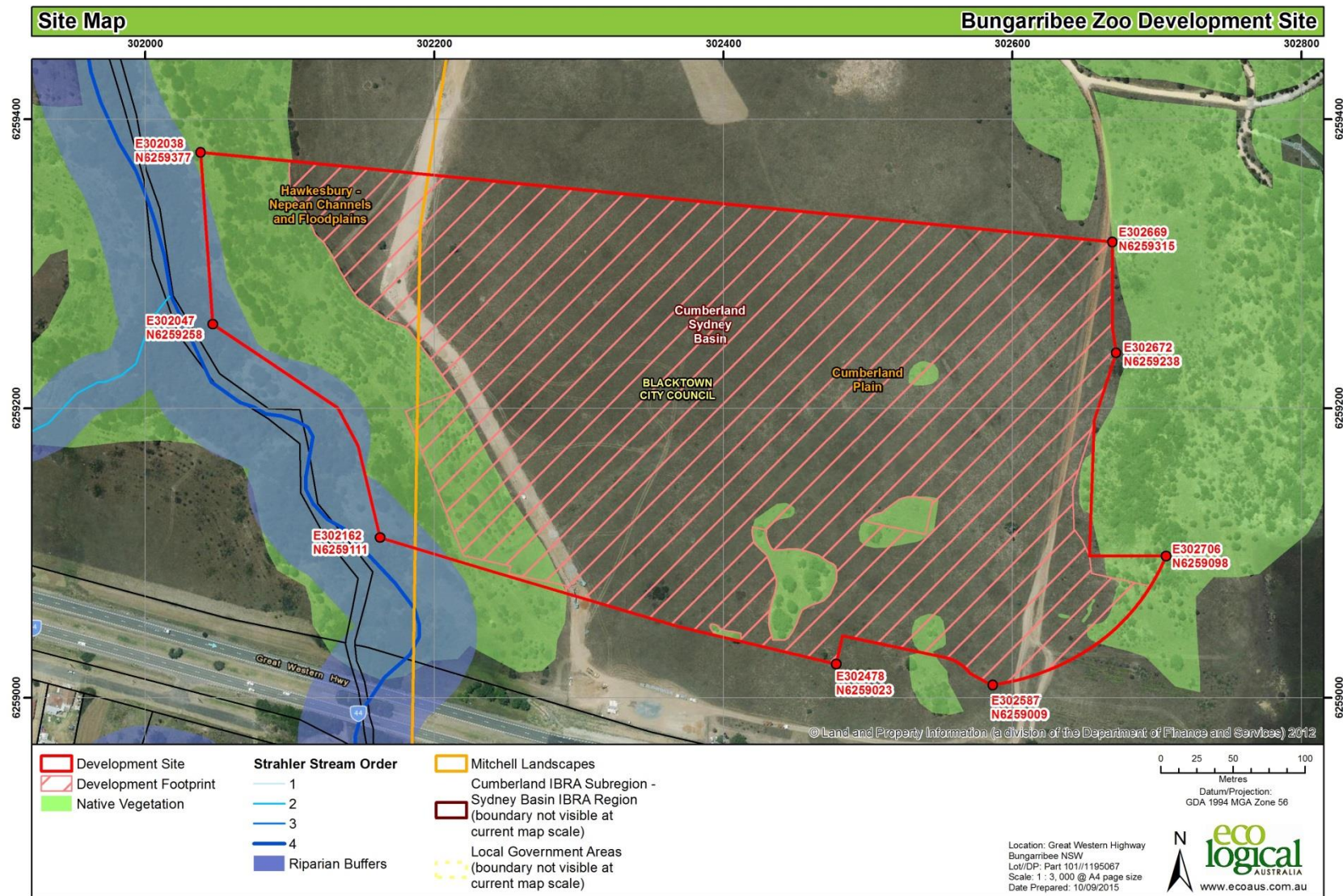


Figure 2: Site map

2 Methodology

2.1 Background information

A number of database searches, aerial photograph, previous reports and studies were used in this assessment, including:

2.1.1 Assessment Guidelines

The assessment presented in this technical working paper was undertaken in accordance with the survey guidelines specified by the SEARs. Updated versions of the guidelines were used if available and were confirmed with Department of Planning and Environment. These include:

- NSW offset policy for major projects (State significant development and State significant infrastructure) (OEH 2014a).
- NSW Framework for Biodiversity Assessment (OEH 2014b).

2.1.2 Database searches

Eco Logical Australia (ELA) reviewed aerial photography as well as the following vegetation and soil datasets which overlap within the study area:

- Western Sydney vegetation mapping (NSW National Parks and Wildlife Service (NPWS 2002).
- Soil Landscapes of the Penrith 1:100,000 Sheet (Bannerman and Hazelton 1990).

Mapping undertaken by Eco Logical Australia in 2014 and 2015 (ELA 2014 and 2015) for the proposed Western Sydney Parklands Bungaribee Precinct - Recreation Facilities Stage 1, 2 and 3 and Bungaribee Zoo Due Diligence provides recent validated vegetation mapping for the study area. However this mapping is primarily limited to the north of current study area and field validation did not occur in the southern portion of Bungaribee. This mapping was used, supplemented by NSW NPWS 2002 mapping. Both of these data sets were combined and then validated and refined in the field.

The following threatened species and predicted species databases were reviewed for the locality:

- OEH Atlas of NSW Wildlife (10 kilometre radius search) (OEH 2015a), accessed 14 July 2015.
- EPBC Act Protected Matters Search Tool (10 kilometre radius search) (DotE 22 May 2015).
- NSW DPI Fisheries threatened and protected species records viewer (Blacktown LGA) (FM Act), accessed 15 July 2015
- NSW DPI Fisheries Key Fish Habitat Map (Sydney LGAs), accessed 15 July 2015.

2.1.3 Previous reports

Eco Logical has undertaken two previous assessments that cover the Bungaribee precinct.

- Eco Logical Australia (2015). Bungaribee Precinct Recreation Facilities – Northern Portion Flora and Fauna Assessment. Prepared for JMD Design
- Eco Logical Australia (2014) Western Sydney Parklands Bungaribee Precinct - Recreation Facilities Stage 1, 2 and 3. Prepared for Western Sydney Parklands Trust

Provided below is summary of each of the reports.

Report 1 (Eco Logical Australia 2015)

A Flora and Fauna Assessment was prepared for the proposed recreation facilities in the northern portion of the Bungarribee precinct in the Western Sydney Parklands (WSP). Field surveys identified the presence of two Threatened Ecological Communities (TEC) Cumberland Plain Woodland and River-flat Eucalypt Forest. *Meridolum corneovirens* (Cumberland Plain Land Snail) was recorded within the study area for this report, in the northern portion of the Bungarribee Precinct, which is outside of the Sydney Zoo study site.

Report 2 (Eco Logical Australia 2014)

A Flora and Fauna Assessment was prepared for the proposed Stages 1, 2 and 3 recreation facilities within the Bungarribee precinct of the Western Sydney Parklands. Field surveys identified two TECs Cumberland Plain Woodland and River-flat Eucalypt Forest.

The vegetation within the study area is continuous with vegetation along Eastern Creek. It provides riparian habitat and open woodland habitat for threatened birds, microchiropteran bats and one invertebrate. One threatened fauna species, *Hieraaetus morphnoides* (Little Eagle) was observed foraging and perching within the study area, in the northern portion of the Bungarribee Precinct, which is outside of the Sydney Zoo study site.

2.2 Assessment methodology

This assessment was undertaken in accordance with the survey guidelines outlined in the *Framework for Biodiversity Assessment* (OEH 2014b). Details are included in **Section 2.1.1**. In addition, the number of vegetation plot/transects utilised in this assessment meets or exceeds the FBA minimum number of plots required (OEH 2014b).

No expert reports are required for this proposal. However, it was noted that the credit calculator did not include any benchmark values for the total length of fallen logs or trees with hollows for vegetation type HN528 Grey Box – Forest Red Gum Grassy Woodland on flats of the Cumberland Plain, Sydney Basin. Consistent with advice received for previous assessments from OEH, “local” benchmark data for the number of trees with hollows and for the length of fallen logs were added, to one (1) and 50 metres respectively, to be consistent with other woodland/open forest vegetation types on the Cumberland Plain. This is consistent with the assessment undertaken for the Brownlow Hill Stages 1 and 2 Biobank Sites and other assessments undertaken by OEH on the Cumberland Plain. As this is an error in the Biobanking Tool datasets, it is not considered that a formal application for the use of local benchmark data be submitted to OEH for approval.

2.2.1 Field surveys

ELA employed a series of field survey methods to undertake the field assessment of the biodiversity values of the study area. The surveys conducted considered the relevant survey guidelines for various threatened species. In a number of instances data from previous surveys was utilised to build on ecological information to inform this assessment. These are identified in **Section 2.1.3**. If information was not available on whether or not threatened species occurred within the study area, then a precautionary approach was adopted, whereby the presence of the species was assumed. This approach is consistent with the FBA and relevant impact assessment guidelines.

The methods used and rationale behind their selection is described below, with field survey locations shown in **Figure 3**. Assessment of vegetation mapping: verification of vegetation communities occurring within the study area to confirm the presence of natural vegetation communities including presence of threatened ecological communities. Vegetation communities were identified from a combination of floristic surveys and transect traverses, and plant community types (PCT) were assigned to vegetation

mapping units from the published PCTs for the Hawkesbury / Nepean (CMA). This was done by comparing the dominant canopy species recorded through the traverses or floristic surveys, the general description of location, soil type and other attributes as described in the profiles (OEH 2015d) and OEH online VIS classification database (OEH 2015c).

- Vegetation polygons assigned to the 'moderate-good' condition category were also assigned to a sub-condition class of poor, moderate or good:
 - Poor condition vegetation had predominantly exotic species in the mid storey and ground cover layers, with very few native species in any stratum.
 - Moderate (medium) condition vegetation had predominantly native species in the mid storey and ground cover layers but had some exotic incursions.
 - Good condition vegetation had very few exotic species in any stratum and were predominantly native and species diverse.
- Biometric plots using the methodology described in the FBA. These plots were undertaken in accordance with the FBA. These plot / transect plots include a 20 metre by 20 metre full floristic plot (described below) and a 20 metre by 50 metre plot identifying number of hollow bearing trees and length of fallen wood. They also include 50 metre transect to collect data on canopy cover, midstorey cover, and ground cover for native and exotic species.
- Floristic surveys as part of the plot / transect survey plots (20 metre by 20 metre quadrats). Due to the highly fragmented nature of vegetation at the site and the small size of some patches / zones, it was not always possible to complete plots within the entire vegetation zone. This was primarily required on vegetation zones in poor condition.
- Random meander survey technique (Cropper 1993) for threatened flora species: targeted searches for threatened species potentially occurring in the study area. This technique is used in preference to systematic, plot based surveys when attempting to detect threatened plants. Random meander in suitable habitat is more likely to detect threatened species than plot or transect based survey used in floristic surveys. This technique is considered preferable in terms of searching large areas of potential habitat and generally allows for greater area coverage than a plot based survey.
- Opportunistic sightings of fauna: identification of faunal species occurring within the study area. The fauna surveys undertaken by ELA consisted of opportunistic sightings whilst conducting other surveys i.e. targeted flora surveys, random meanders and transects. Evidence of fauna usage was noted. No targeted fauna surveys were undertaken.
- Fauna habitat assessments identifying potential habitat for threatened fauna species. Presence of hollow bearing trees and coarse woody debris were recorded as part of the biometric plots. In the absence of fauna surveys, habitat assessments identify important habitat features that may provide potential habitat for threatened fauna. Hollow bearing tree survey was not undertaken.

2.2.2 Survey effort

The survey effort was focused according to the vegetation communities and potential habitat for threatened flora and fauna species within the study area. A summary of the field survey effort for each survey method is provided in **Table 1**.

Weather conditions were fine during all survey periods although significant rainfall occurred between May 2015 and July 2015 (May 2015 68.2 mm & June 2015 60.1 mm) (BOM 2015a).

Table 1: Summary of survey effort

Method	Person hours	Dates	Weather
Floristic surveys	34	29 May 2015 3 July 2015 4 September 2015	Cool and overcast Cool and sunny Warm and sunny
Biometric plots	34	29 May 2015 3 July 2015 4 September 2015	Cool and overcast Cool and sunny Warm and sunny
Fauna habitat assessment	3	29 May 2015 4 September 2015	Cool and overcast Warm and sunny
Cumberland Land Snail targeted search	0.25	4 September 2015	Warm and sunny

Data used from nearest weather station to site – Prospect Reservoir (BOM 2015a)

2.2.3 Field study personnel

This assessment was carried out by appropriately qualified and experienced ecologists and environmental professionals as demonstrated in **Table 2**.

Table 2: Personnel and qualifications

Name	Role	Qualifications
Dr Steven Ward	Project Director	Ph.D., University of Western Sydney, 2002 Honours, University of Wollongong, 1999 BSc (Botany / Zoology), University of Western Australia, 1987 Accredited Biobanking and major projects assessor
Karen Spicer	Ecological Constraints Assessment Biometric Plots	Bachelor of Environmental Science (Biology) Hons 1, University of New South Wales – 1999
Tammy Paartalu	Project Manager Ecology assessment Biometric Plots	Bachelor of Environmental Science (First Class Honours), Macquarie University. AusRivas Certification, University of Canberra Accredited Biobanking and major projects assessor
Danielle Adams-Bennett	Ecology assessment Biometric Plots Cumberland Land Snail search	Bachelor of Animal Science, University of Western Sydney
Andrew Norvill	Constraints Assessment Biometric Plots	Bachelor of Applied Science (Parks, Recreation and Heritage) – Charles Sturt University Certificate II in Conservation and Land Management
Vivian Hamilton	GIS Analysis and Mapping	Bachelor of Environmental Management Macquarie University – 2007

2.2.4 Limitations

Plot locations were recorded with hand-held GPS units, which can have errors in the locations of up to 20 metres in overcast conditions. Furthermore, traces of paths walked recorded using the handheld GPS units can often be sporadic or have greater errors in accuracy as the units can lose satellite reception due to not being in an optimal position, particularly in areas where foliage cover is high.

Vegetation floristic plots undertaken will give indicative flora species lists, but these are not exhaustive of the species present in the study area. The floristic surveys and biometric plots were conducted outside of the optimal survey period for some flora and fauna. Thus, it is possible that flora and fauna species that may occur in the study area were not recorded due to the life cycle and behaviour of species and seasonal considerations.

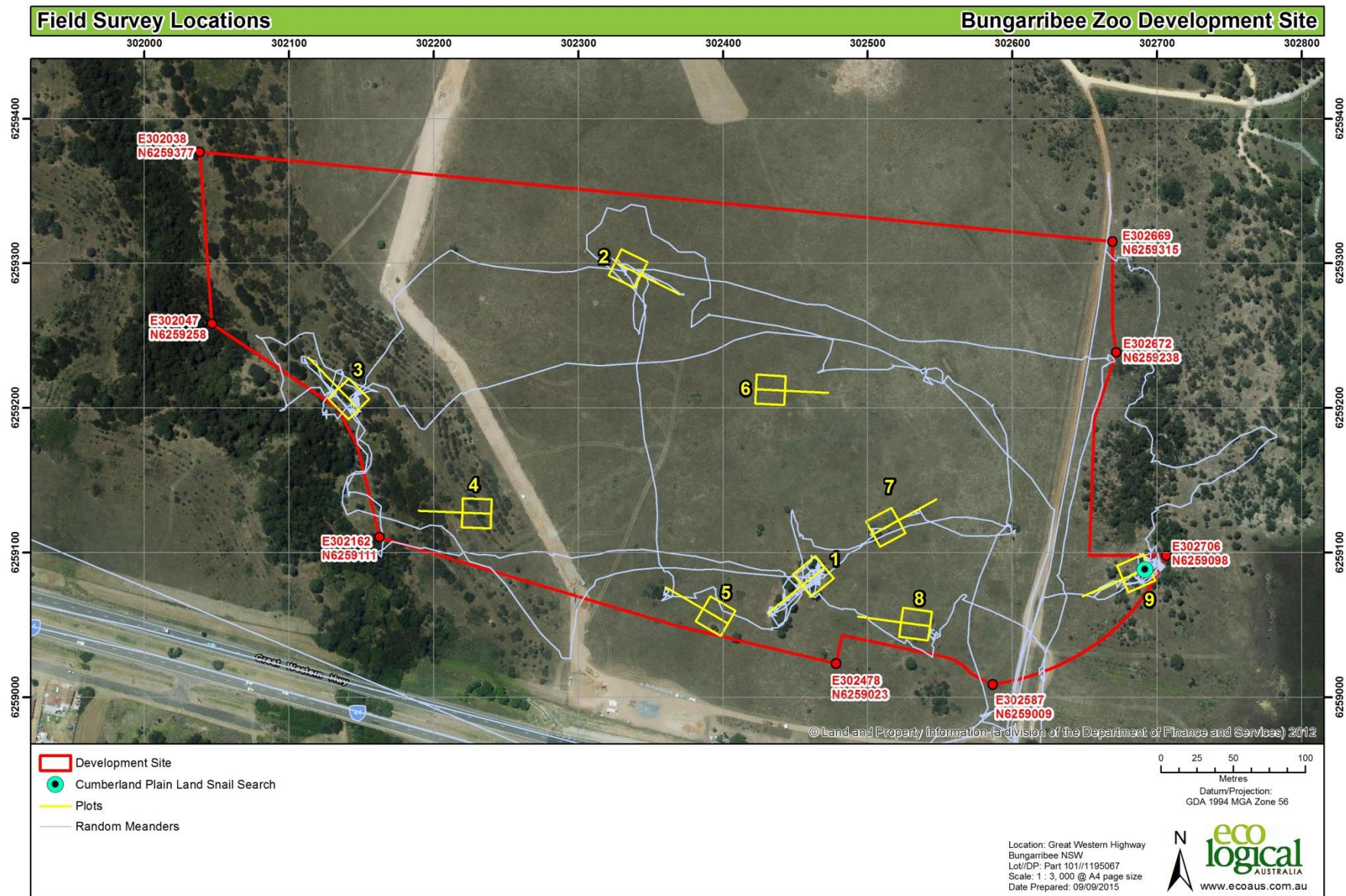


Figure 3: Field survey locations

3 Landscape features

The study area is located within the Sydney Basin Bioregion which extends north to the Hunter Valley, west to Mudgee and south to Batemans Bay. The study area occurs within a highly urbanised setting surrounded by extensive areas of established urban development.

The landscape features of the study area are shown in **Figure 1**.

3.1 IBRA bioregions and subregions

The area for assessment is contained wholly within the Sydney Basin Bioregion. The construction footprint occurs within the Cumberland IBRA subregion. According to the FBA, *'the distribution of the species includes the IBRA subregion in which the development site... is, in the opinion of the assessor, mostly located'*. This subregion was used for the 1000 hectare assessment circle (**Figure 1**).

3.2 Mitchell Landscapes

The construction footprint is covered by two Mitchell Landscapes. The majority of the site is covered by Cumberland, with Hawkesbury – Nepean Channel and Floodplains occurring within riparian corridor (Mitchell 2002) (**Figure 1**). The Cumberland Mitchell Landscape was entered into the calculator.

3.2.1 Landscape and soils

Two main soil landscapes exist within the study area. South Creek soil landscape is confined to the alluvial flat encompassing Eastern Creek and Bungaribee Creek. The soil landscape occurs on floodplains and valley flats on the Cumberland Plains (Bannerman and Hazelton 1990). The dominant soils are brown sandy loam to sandy clay loam with low fertility and high erodibility. Waterlogging and frequent flooding is often experienced within the South Creek soil landscape (Bannerman and Hazelton 1990). The Blacktown soil landscape occurs at higher elevations and includes the south-eastern corner of the study area. Dominant soils include brownish black loam to clay loam with low to moderate fertility (Bannerman and Hazelton 1990). Both soil landscapes are associated with the Wianamatta Group shales and Hawkesbury Sandstone geology. Blacktown soil landscape is often underlain by the Wianamatta group – Ashfield Shales.

3.3 Rivers, stream and estuaries

Two major creek systems feature within the landscape and occasionally flood the surrounding plains. Eastern Creek is a major creek which flows a south – north direction. Bungaribee Creek converge with Eastern Creek in the north. An intermittent tributary flows from the south-east of the study area to the north-west. Native vegetation persists along the creek banks. Moist depressions are scattered at lower elevations within the floodplain which are fed by the unnamed tributary and Eastern Creek during high water flow events (i.e. located north-east of the study area).

3.4 Wetlands

There were no important or local wetlands relevant to the study area. There were no SEPP 14 wetlands in the study area and no SEPP 14 wetlands are to be impacted.

3.5 Groundwater dependent ecosystems

Groundwater Dependent Ecosystems (GDEs) are defined as ecosystems whose current species composition, structure and function are reliant on a supply of groundwater as opposed to surface water supplies from overland flow paths. The frequency of groundwater influence may range from daily to inter-annually, however it becomes clearly apparent when either the supply of groundwater or its quality (or both) is altered for a sufficient length of time to cause changes in plant function. Groundwater use by an ecological community or individual species does not necessarily imply groundwater dependence.

In Australia, the majority of ecosystems have little to no dependence on groundwater, although the full understanding of the role of groundwater in maintaining ecosystems is generally poor. The exception to this is wetland communities, for which it is thought that most have some level of dependence on groundwater resources.

GDEs are generally classified into six categories:

- Terrestrial vegetation – forests and woodland which develop a permanent or seasonal dependence on groundwater, often by extending roots into the water table.
- Base Flow in streams – aquatic and riparian ecosystems that exist in or adjacent to streams that are fed by groundwater base flow.
- Aquifer and cave systems – aquatic ecosystems that occupy caves or aquifers.
- Wetlands – aquatic communities and fringing vegetation that depend on groundwater fed lakes and wetlands.
- Estuarine and near shore marine ecosystems – various ecosystems including mangroves, salt marsh and seagrass, whose ecological function has some dependence on groundwater discharge.
- Terrestrial fauna – fauna species assemblages reliant on groundwater for drinking water.

A final category is also recognised 'not apparently dependant'. This category acknowledges that some ecosystems, particularly wetland and riparian vegetation, might superficially appear to be groundwater dependent while in fact they are dependent entirely on surface flows and or rainfall.

A search of the Atlas of Groundwater Dependent Ecosystems database was conducted, and no groundwater dependent ecosystems within the study area were shown on the database mapping (BOM 2015b). The nearest area of mapped potential for groundwater interaction (ie. a potential is groundwater dependent ecosystem), is approximately 100m to the south of the study area in close proximity to Great Western Highway. Further, as part of the site contamination study two wells for the monitoring of groundwater quality were installed in the western part of the site (MW1 and MW2), and groundwater at these sites occurred at depths of 5.05 and 4.09 m respectively. It would also be expected that groundwater depth would increase in the eastern portion of the site, as this is further away from Eastern Creek. It is therefore not likely that groundwater dependent ecosystems are present within or in close proximity to the study area.

3.6 Ecological corridors

No formal state or regional biodiversity links are present within the study area. Areas of impact are also in proximity to existing urban development. For example, roads bound the study area to the east and south.

Local wildlife corridors do exist at a smaller scale. A regional significant biodiversity corridor exists associated with the riparian buffer around Eastern Creek, which is a fourth order watercourse. Part of riparian buffer falls within the western portion of the study area, but is not impacted upon by the proposed construction or operational footprint.

Given that the regional biodiversity linkage is not impacted, and the other linkages do not meet the definition of state or regional biodiversity links, the project was assessed using site based developments as defined under the FBA (OEH 2014b).

The Western Sydney Parklands, located in the heart of Western Sydney, comprise a 27km corridor stretching from Quakers Hills to Leppington. One of the objectives of the Western Sydney Parklands Management Plan (WSPT 2010) is to secure a bushland corridor for the entire length of the parklands to improve biodiversity.

The links from within the study area will not be severed by the proposed works. The proposed works make use of already cleared or degraded areas of vegetation and will not introduce new access points through any local corridor.

3.7 Landscape value score

The assessment method was chosen in accordance with the site based assessment outlined in the FBA.

Assessment circles with a radius of 1,784 metres (1,000 hectares) and 564 metres (100 hectares) are used to assess the impact of proposals on the surrounding vegetation cover at a landscape and local scale (respectively) (**Figure 1**).

The amount of vegetation within the 100 hectare and 1,000 hectare assessment circles before the development was calculated using ArcGIS using the Native Vegetation of the NSW NPWS GIS layer (NPWS 2002) (excluding the non-native categories). Where this layer did not cover the whole circle, the gaps were filled in manually. To determine the native vegetation cover after development in the 1,000 hectare circle, the total amount of clearing was subtracted from the average. The development footprint was then used to calculate the amount of vegetation loss for 100 hectare each circle. **Table 3** outlines the vegetation in each circle, before and after development, and the average and associated Native Vegetation Cover Class (per cent) to be entered into the Credit Calculator.

Table 3: Area of vegetation in each assessment circle

Circle	Native Vegetation Cover (Before Development)	Native Vegetation Cover (After Development)
1 000 ha circle	186.44 ha (18.64%)	185.62 ha (18.56%)
100 ha circle	26.53 ha (26.53 %)	25.71 ha (25.71%)

A connectivity assessment was conducted using the FBA technique for site based developments (OEH 2014b). The site contained one regionally significant biodiversity link due to having a riparian buffer for a 4th or higher order stream along Eastern Creek although no impacts to this are anticipated (**Figure 4**). Thus the following aspects were considered:

- The width of the current and future connecting link (**Table 4**)

- The condition of the current and future connecting link (overstorey and mid-storey/ground cover) (**Table 5**).

The construction footprint is has connected vegetation to the east and west but does not form a significant linkage between any vegetation zones. As such, the connectivity has not been affected by this development.

3.8 Connectivity width assessment

The current most limiting width within the corridor is approximately 32 metres, thus falling into the greater than 30 – 100 metre linkage width class (**Figure 4**). As the area of minimum width does not occur within the proposed development it does not reduce the minimum width of this link. Professional judgement was used to ascertain that the proposed development will not result in a change in the minimum linkage width class, remaining unchanged at greater than 30-100 metres after development, as the study area is connected to both the north and south riparian vegetation, and these linkages will be retained (**Table 4**).

Table 4: Linkage width classes before and after development

	Linkage Width Class (Before Development)	Linkage Width Class (After Development)
Connectivity Value (Width)	>30-100m	>30-100m

3.9 Connectivity condition assessment

The connectivity condition assessment was undertaken on woody vegetation as woody vegetation types. Two measures were used to assess the condition of the connection:

- The condition of over-storey vegetation before and after development.
- The condition of ground cover vegetation before and after development.

The vegetation within the link is connected to Eastern Creek. Over-storey vegetation before development has been assessed as Projected Foliage Cover (PFC) at $\geq 25\%$ of lower benchmark as field visits and an analysis of aerial photos have indicated the likely presence of some exotic vegetation across the link. The impact of the proposed development on the average overstorey condition across the entire connection is minimal, as the area within the linkage to be cleared is very small. It is therefore expected that the average overstorey condition after development will remain the same.

While it is difficult to estimate the condition of the mid-storey and ground cover through the entire connection, from the field visit and analysis of aerial photos, it is likely that some exotic vegetation would be present due observations made on site. Therefore, the average condition of the mid-storey/ground cover vegetation before development has been assessed to be PFC $\geq 50\%$ of lower benchmark. As previously described, the impact of the proposed development would be minimal on the condition of the connectivity, and the ground cover after development will remain the same (**Table 5**).

Table 5: Condition of vegetation within the assessment circle before and after development

	Width Class (Before Development)	Width Class (After Development)
Connectivity Value (Overstorey Condition)	PFC $\geq$ 25% of lower benchmark	$\geq$ 25% of lower benchmark
Connectivity Value (Mid-storey/Ground Cover Condition)	$\geq$ 50% of lower benchmark	$\geq$ 50% of lower benchmark

3.10 Patch size

Threatened species sub-zones, which form the base units of vegetation zones, were mapped for the impact area. The threatened species sub-zones allow the entry of data such as adjacent remnant area and patch size for individual vegetation zones.

The majority of the vegetation impacted is comprised of fragmented vegetation with small sections in the eastern and western extremities of the study area connected to larger stands of vegetation. Thus the adjacent remnant area and patch size for all threatened species sub-zones was entered as greater than 101 ha hectares.

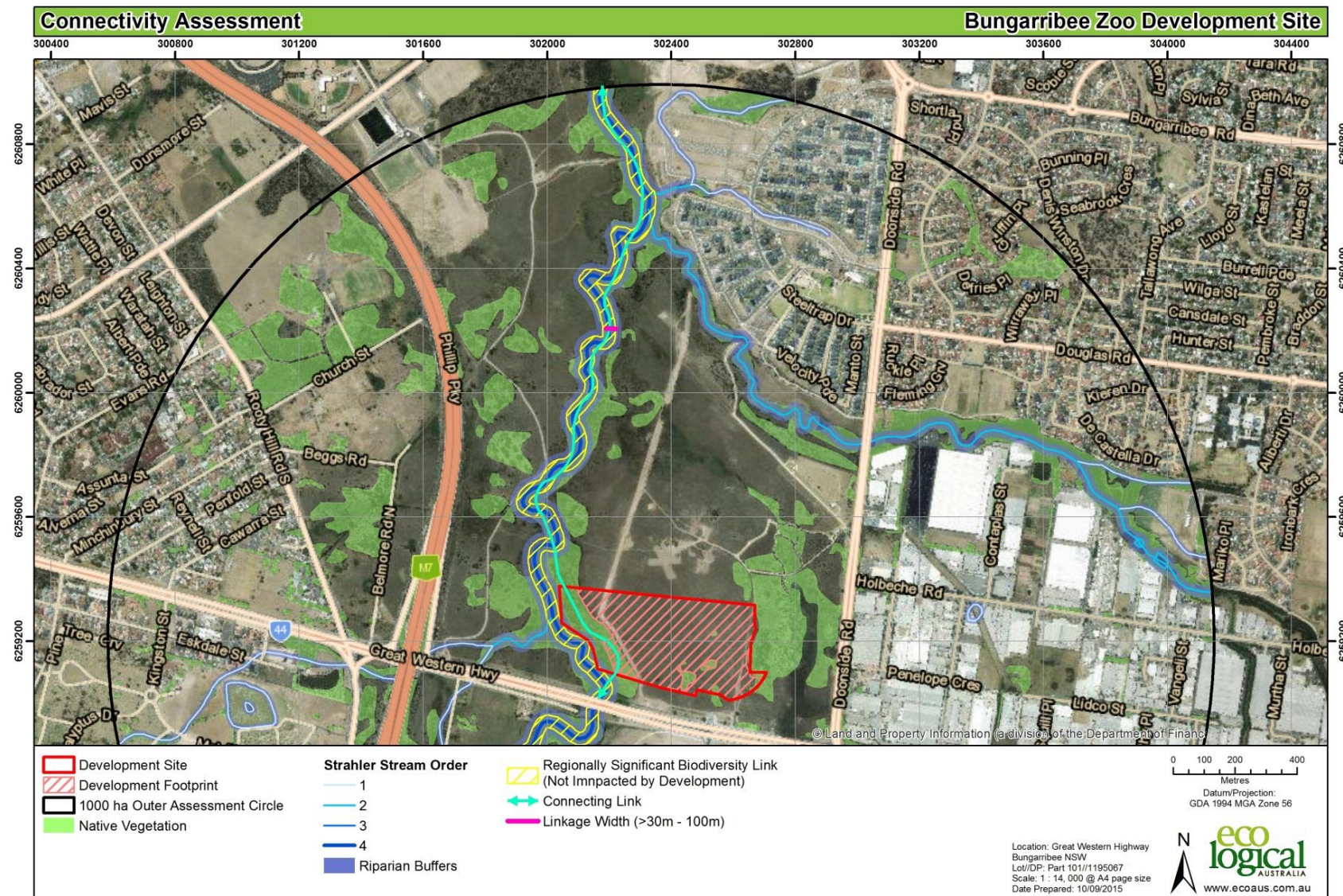


Figure 4: Connectivity assessment

4 Native vegetation

4.1 Plant Community Types (PCTs)

There were two PCTs mapped and assessed in the study area. PCTs within the development site are outlined in **Table 6** and shown in **Figure 5**.

4.1.1 Forest Red Gum – Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney Basin Bioregion (PCT 835 or BVT HN526)

This PCT is also known as River Flat Eucalypt Forest (RFEF) and is in the Coastal Floodplain Wetlands class. It is an Endangered Ecological Community (EEC) under the TSC Act. It is 95 percent (%) cleared in the CMA.

The vegetation was identified using previous mapping by OEH (2013), conducting vegetation validation, comparison of species present with the VIS dataset and the final determination for the listed ecological community under the TSC Act, and conducting two biometric plots in accordance with the FBA method.

Canopy and mid-storey species were used to identify this community from other potential PCTs although this is a modified vegetation community that has undergone revegetation. The patch represented a relatively young stand of replanted RFEF, with the upper stratum supporting young *Eucalyptus amplifolia* (Cabbage Gum) and the mid-storey dominated by various *Acacia* species including *Acacia parramattensis* (Parramatta Wattle) and *Acacia decurrens* (Black Wattle). *Casuarina glauca* (Swamp Oak) was also recorded within the northern biometric plot in this community. Remnant RFEF occurred beyond the western boundary of the site.

The understorey was dominated by a mixture of native and exotic ground cover species with much of the groundlayer browning given the survey season. Dominant species included *Cynodon dactylon* (Couch), *Briza (?) subaristata*, *Axonopus fissifolius* (Narrow-leafed Carpet Grass). *Aristida vagans* (Threeawn Speargrass) was also common in the groundlayer with *Microlaena stipoides* (Weeping Grass) and *Themeda triandra* (Kangaroo Grass) also common but at slightly lower frequencies.

Areas to be removed are quantified in **Table 7**.

4.1.2 Grey Box – Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin Bioregion (PCT 849 or BVT HN528)

This PCT is also known as Shale Plains Woodland which is a sub-community of Cumberland Plain Woodland and is in the Coastal Valley Grassy Woodlands class. It is listed as an EEC under the TSC Act and a Critically Endangered Ecological Community (CEEC) under the EPBC Act. It is 95 % cleared in the CMA.

This PCT occurred in four condition states (ancillary codes):

- CPW Moderate to good – good condition
- CPW Moderate to good – medium condition
- CPW Moderate to good – poor condition
- CPW Moderate to good – derived native grassland

All of the CPW at the site meets the definition of 'moderate to good' under the methodology although ancillary codes have been assigned to represent 'good,' 'medium,' 'poor' and 'derived native grassland' condition patches.

Vegetation in poor condition at the site is present as scattered *Eucalyptus moluccana* with a primarily exotic understorey. Native grass species, particularly of *Microlaena stipoides* appear to increase directly beneath the trees but these are only small patches in a largely exotic landscape. Small patches of *Aristida vagans* are also present.

The moderate (medium) condition stand of CPW occurs in the south of the site. This stands support both mature and juvenile *Eucalyptus moluccana*, a sparse shrub layer and the groundlayer dominated is by native species.

The most commonly recorded groundcover species in areas of CPW include *Axonopus fissifolius* (Narrow-leafed Carpet Grass), *Briza (?) subaristata*, *Aristida vagans*, *Microlaena stipoides* (Weeping Grass), *Lomandra* spp., *Themeda triandra*, *Setaria parviflora* and *Paspalum dilatatum* (Paspalum).

The CPW in the east of the site forms part of a larger patch of CPW that is in good condition and is dominated by native species in all strata. The canopy is dominated by *Eucalyptus tereticornis* and *Eucalyptus amplifolia* with *Angophora floribunda* scattered throughout. *Bursaria spinosa* is common in the understorey as is *Melaleuca decora* and *Daviesia ulicifolia* (Gorse Bitter Pea). Commonly recorded groundcover species include *Aristida vagans*, *Microlaena stipoides* and *Themeda triandra*.

The eastern stand of CPW also meets the criteria for listing under the EPBC Act. The aim of the EPBC Act listing for CPW is to protect better quality and larger stands of CPW on the Cumberland Plain. Therefore, a number of criteria and condition thresholds must be met for a stand of CPW to meet the CEEC definition under the EPBC Act. Vegetation across the majority of the site is highly disturbed, comprising of scattered *Eucalyptus moluccana* trees with a primarily exotic understorey with the exception of the two largest stands of CPW. Whilst scattered trees characteristic of CPW are captured under the TSC Act, the vegetation across most of the site is unlikely to meet the listing criteria under the EPBC Act as it does not meet minimum condition threshold of patch size >0.5 ha and would not meet other condition criteria.

Impacts to the largest stands of CPW have been minimised as much as possible. Areas to be removed are quantified in **Table 7**.

4.2 Other vegetation

4.2.1 Exotic grassland

The majority of the site is comprised of exotic pasture. Given that at the time of the survey much of the grassland was browning and few grasses had inflorescence, identification of some species was difficult. However, exotic grassland areas appear to be dominated by *Cynodon dactylon*, *Briza (?) subaristata*, *Axonopus fissifolius*, *Setaria gracilis* and *Aristida vagans* with *Microlaena stipoides* and *Themeda triandra* occurring but less frequently and often as small patches. This vegetation type was excluded from the calculations.

Table 6: Vegetation in the study area

Vegetation types				Vegetation Zones for analysis purposes					
Vegetation community	Condition	Subcategory	Total in study area (ha)	Veg Zone No.	Plant Community Type (PCT)	Condition	Ancillary code	Total impacted (ha)	Justification
Cumberland Plain Woodland	Moderate to Good	Good*	0.17	1	Grey Box – Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin Bioregion	Moderate to Good	Medium	0.24	This was merged in with River Flat Eucalypt Forest (vegetation zone 3) due to its small size. Vegetation areas smaller than 0.25 hectares are required to be merged to provide the calculations.
		Medium	0.24	1					This was merged in with River Flat Eucalypt Forest (vegetation zone 3) due to its small size. Vegetation areas smaller than 0.25 hectares are required to be merged to provide the calculations.
		Poor	0.23	1					This was merged in with River Flat Eucalypt Forest (vegetation zone 3) due to its small size. Vegetation areas smaller than 0.25 hectares are required to be merged to provide the calculations.
		Derived Native Grassland	0.89	2			Derived Native Grassland	0.83	No change
River Flat Eucalypt Forest	Moderate to Good	Planted	2.45	3	Forest Red Gum – Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney Basin Bioregion	Moderate to Good	Medium	0.58	No change

Vegetation types				Vegetation Zones for analysis purposes					
Vegetation community	Condition	Subcategory	Total in study area (ha)	Veg Zone No.	Plant Community Type (PCT)	Condition	Ancillary code	Total impacted (ha)	Justification
River Flat Eucalypt Forest	Moderate to Good	Remnant	0.20	Excluded from impact assessment as it is not in the development footprint				0.00	No change
Exotic Pasture			12.32	Excluded from impact assessment as it is not native vegetation				12.22	Non-native vegetation and other cleared areas do not need to be included in calculations.
Total			16.5					13.88	

*The 'good' condition CPW meets the criteria for listing as Condition A CPW under the EPBC Act. Of the 0.17 ha within the study area 0.08 ha is to be removed.

4.3 Vegetation zone

The vegetation zones used and their extent within the construction footprint are outlined in **Table 7**, and are assessed for impacts in **section 7**. The vegetation zones and biometric plots used in the assessment are shown in **Figure 5**.

Table 7: Vegetation zones and plot requirements

Vegetation zone	Vegetation Community	Plant community type	Ancillary Code	Area impacted (ha)	Plots required	Plots collected	Description of plots used
1	Cumberland Plain Woodland	Grey Box – Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin Bioregion	Medium	0.24	1	5	Plots collected in the Cumberland Plain Woodland 'good', 'medium', and 'poor' zones. Due to the small size of this vegetation zone it was merged with vegetation zone 3.
2	Cumberland Plain Woodland	Grey Box – Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin Bioregion	Derived Grassland	0.83	1	1	Plots collected in the Cumberland Plain Woodland 'derived grassland' zone.
3	River Flat Eucalypt Forest	Forest Red Gum – Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney Basin Bioregion	Medium	0.58	2	2	All plots collected in the River Flat Eucalypt Forest 'medium' zone. In addition, as this is a merged zone, plots collected from the Cumberland Plain Woodland 'good', 'medium', and 'poor' zones were also used.
Total				1.65	4	9	It is noted that an extra plot was collected from the exotic area

4.4 Matters of National Environmental Significance – Vegetation Communities

4.4.1 Cumberland Plain Woodland – Condition A

The eastern stand of CPW at the site meets the criteria for listing under the EPBC Act (**Figure 5**). The aim of the EPBC Act listing for CPW is to protect better quality and larger stands of CPW on the Cumberland Plain. Therefore, a number of criteria and condition thresholds must be met for a stand of CPW to meet the CEEC definition under the EPBC Act. The eastern most stand of CPW is part of a much larger stand of vegetation that has a patch size > 0.5 ha and an understorey dominated by native species. The canopy is dominated of *Eucalyptus tereticornis* and *Eucalyptus moluccana* and *Bursaria spinosa* thickets are present. The part of the patch that falls within the proposal site supports a more open understorey that grades into an area of Derived Native Grassland. Common understorey species included *Daviesia ulicifolia*, *Bursaria spinosa* and *Acacia falcata*. The groundlayer was dominated by *Aristida vagans*, *Microlaena stipoides* and *Themeda triandra*. This stand has been mapped as Condition A CPW based on the following criteria:

- Patch size is > 0.5 ha
- Understorey is made up of > 50% perennial native species

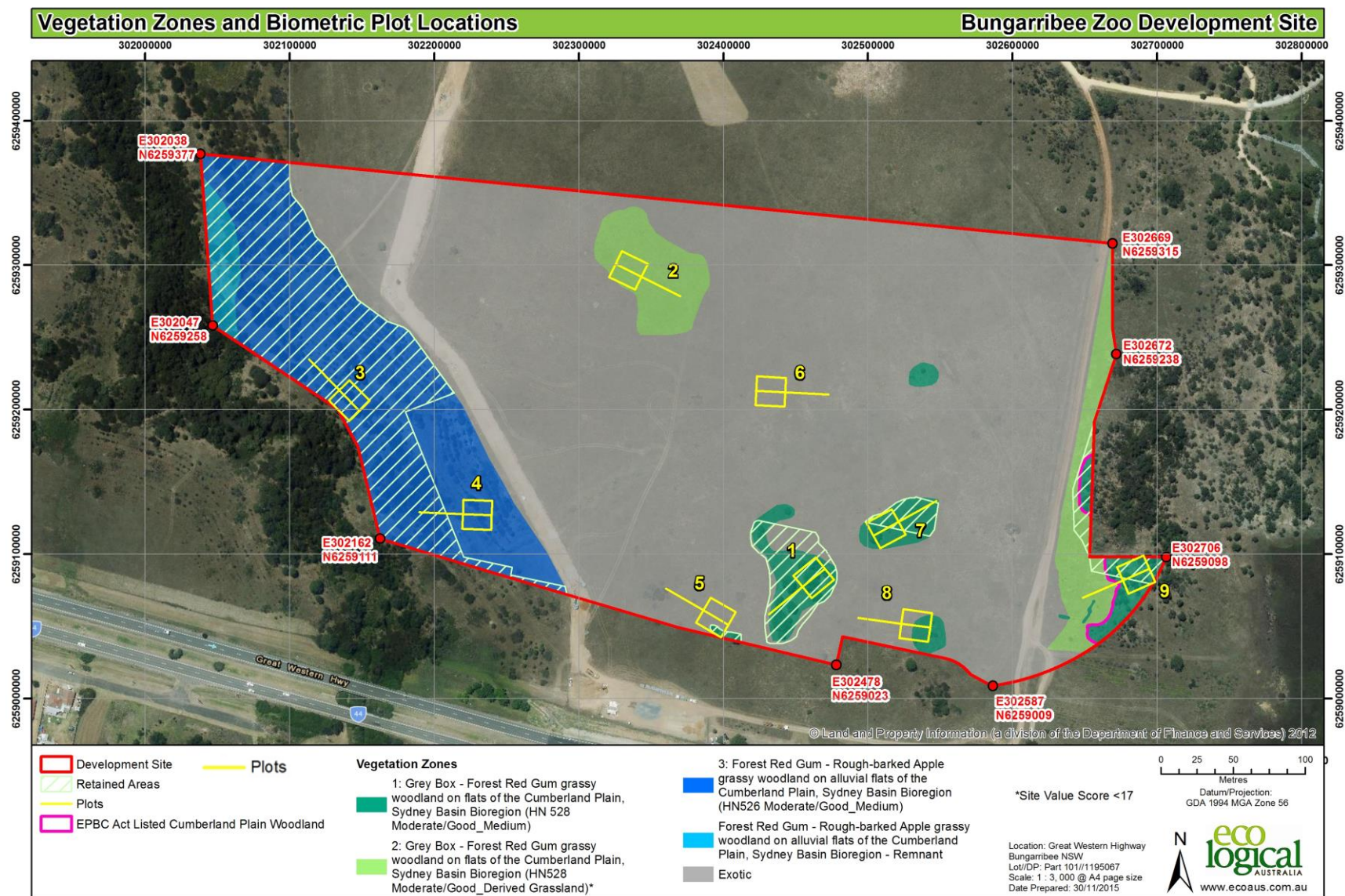


Figure 5: Native vegetation and PCTs within study area

5 Threatened species

5.1 Ecosystem credit species

The FBA requires that a list of threatened species that can be reliably predicted by habitat surrogates be identified. These species are called ecosystem credit species and they are automatically generated based on the PCT, the IBRA subregion of the development site, the condition and patch size of vegetation. The default list of ecosystem species generated is outlined in **Table 8**. It should be noted that because these species have been included in the assessment does not mean that the threatened species is present merely that the species is retained in the assessment by the tool. The default option to retain all of these species was taken.

Table 8: Ecosystem credit species on development site

Scientific Name	Common Name	Threatened species offset multiplier
Barking Owl	<i>Ninox connivens</i>	3.0
Black-chinned Honeyeater (eastern subspecies)	<i>Melithreptus gularis subsp. gularis</i>	1.3
Brown Treecreeper (eastern subspecies)	<i>Climacteris picumnus subsp. victoriae</i>	2.0
Bush Stone-curlew	<i>Burhinus grallarius</i>	2.6
Diamond Firetail	<i>Stagonopleura guttata</i>	1.3
Eastern False Pipistrelle	<i>Falsistrellus tasmaniensis</i>	2.2
Eastern Freetail-bat	<i>Mormopterus norfolkensis</i>	2.2
Flame Robin*	<i>Petroica phoenicea</i>	1.3
Gang-gang Cockatoo	<i>Callocephalon fimbriatum</i>	2.0
Greater Broad-nosed Bat	<i>Scoteanax rueppellii</i>	2.2
Hooded Robin (south-eastern form)	<i>Melanodryas cucullata subsp. cucullata</i>	1.7
Little Eagle**	<i>Hieraaetus morphnoides</i>	1.4
Little Lorikeet	<i>Glossopsitta pusilla</i>	1.8
Masked Owl	<i>Tyto novaehollandiae</i>	3.0
Painted Honeyeater	<i>Grantiella picta</i>	1.3
Powerful Owl	<i>Ninox strenua</i>	3.0
Scarlet Robin	<i>Petroica boodang</i>	1.3
Speckled Warbler	<i>Chthonicola sagittata</i>	2.6
Spotted Harrier	<i>Circus assimilis</i>	1.4
Spotted-tailed Quoll	<i>Dasyurus maculatus</i>	2.6

Scientific Name	Common Name	Threatened species offset multiplier
Square-tailed Kite	<i>Lophoictinia isura</i>	1.4
Swift Parrot	<i>Lathamus discolor</i>	1.3
Turquoise Parrot	<i>Neophema pulchella</i>	1.8
Varied Sittella	<i>Daphoenositta chrysoptera</i>	1.3
Yellow-bellied Sheath-tail-bat	<i>Saccolaimus flaviventris</i>	2.2

* There is a database record for this species in the northern portion of the Bungaribee Precinct for this species, not within the study site itself.

** This species has been recorded in the northern portion of the Bungaribee Precinct, and has not recorded within the study site itself.

5.2 Species credit species

The following questions were asked in the calculator to determine what species would be filtered into the assessment for consideration (**Table 9**). The answers were obtained from the site visit, and in any cases of ambiguity the default answer of 'Yes' was used, as directed by the methodology. It should be noted that an answer of 'yes' does not mean that the threatened species or its habitat is present, merely that the species is retained in the assessment by the tool (an answer of 'no' results in the threatened species being excluded).

Table 9: Geographic and habitat questions and answers

Question: Does any part of the development impact on	Answer
Land containing bark or leaf litter accumulation	Yes
Land containing escarpments, cliffs, caves, deep crevices, old mine shafts or tunnels	No
Land within 5 km of coast in South East Coastal Plains CMA subregion	No
Land within 100 m of emergent aquatic or riparian vegetation	Yes
Wet and damp areas only	No
Land situated in damp, disturbed sites	No
Land within 40 m of freshwater and estuarine wetlands, in areas of permanent water and dense vegetation or emergent aquatic vegetation	No
Land within 40 m of fresh / brackish saline waters of larger rivers or creeks; estuaries, coastal lagoons, lakes and / or inshore marine waters	No
Periodically waterlogged sites (including table drains and farm dams)	No
Alluvial soils	Yes

From review of previous reports and database records, no additional threatened species were added to the list (refer **section 2.1.2** and **section 2.1.3**). Species generated by the tool were used. This list was utilised in step 2 (**Table 10**). The list of candidate species was compared against the habitat features at the site following habitat assessment to determine whether the species is considered present. The resulting list of species is compared against the features in the impact area to determine if there is a requirement for survey.

- the habitat is substantially degraded
- an expert report states that the species is unlikely to be present
- the species is a vagrant and is unlikely to use habitat on the development site
- records of the species are at least 20 years old or have doubtful authenticity.

Table 10: List of candidate species credit species and second filtering step

Species	Common Name	Inclusion / exclusion	Rationale
<i>Ixobrychus flavicollis</i>	Black Bittern	exclude	Habitat at the site is likely to be too degraded for this species and there is limited instream vegetation.
<i>Pomaderris brunnea</i>	Brown Pomaderris	exclude	Areas of potential habitat within the CPW and RFEF will be impacted for the proposal. However, the impacted areas are very small and in the case of CPW degraded. Furthermore, this species has a restricted known distribution which does not include the Blacktown area and random meander survey did not detect any individuals.
<i>Eucalyptus benthamii</i>	Camden White Gum	exclude	Areas of potential habitat within the CPW and RFEF will be impacted for the proposal. However, the impacted areas are very small and in the case of mostly CPW degraded. Furthermore, this species has a restricted known distribution which does not include the Blacktown area and random meander survey did not detect any individuals.
<i>Meridolum corneovirens</i>	Cumberland Plain Land Snail	exclude	Areas of potential habitat restricted to the eastern most stand of CPW, as the vegetation elsewhere is too degraded to be potential habitat. Targeted searches undertaken and this species was not recorded.
<i>Acacia pubescens</i>	Downy Wattle	exclude	Potential habitat present in areas of CPW and RFEF although random meander survey did not detect any individuals.
<i>Cercartetus nanus</i>	Eastern Pygmy-possum	exclude	Habitat on the site does not provide suitable habitat for this species and would be too degraded.
<i>Callocephalon fimbriatum</i> population in the Hornsby and Ku-ring-gai Local Government Areas	Gang-gang Cockatoo population, Hornsby and Ku-ring-gai Local Government Areas	exclude	The site does not occur within any of the listed LGAs.
<i>Litoria aurea</i>	Green and Golden Bell Frog	exclude	Although this species can inhabit disturbed sites, habitat at the site is likely to be too degraded / limited for this species and there is extremely limited instream vegetation. Further the marginal habitat does not occur within the proposed development area and would not be impacted.

Species	Common Name	Inclusion / exclusion	Rationale
<i>Hibbertia</i> sp. Bankstown	<i>Hibbertia</i> sp. Bankstown	exclude	The development site is not located with the listed LGA, sandy soils are not present at the site. There are no known database records for this species within a 5 km radius of the site. Furthermore, random meander survey did not detect any individuals.
<i>Grevillea juniperina</i> <i>subsp. juniperina</i>	Juniper-leaved Grevillea	exclude	Areas of CPW provide potential habitat for this species. However, random meander survey did not detect any individuals.
<i>Phascolarctos</i> <i>cinereus</i>	Koala	exclude	Habitat on the site likely to be too degraded to support this species. Furthermore, there are no known database records for this species in within a 5 km radius of the site.
<i>Marsdenia viridiflora</i> <i>subsp. viridiflora</i> - <i>endangered</i> <i>population</i>	<i>Marsdenia</i> <i>viridiflora</i> subsp. <i>viridiflora</i> in the Bankstown, Blacktown, Camden, Campbelltown, Fairfield, Holroyd, Liverpool and Penrith local government areas	exclude	Areas of CPW provide potential habitat for this species. However, random meander survey did not detect any individuals.
<i>Anthochaera phrygia</i>	Regent Honeyeater	exclude	Species is likely to be a vagrant and is unlikely to use habitat on the development site.
<i>Pimelea spicata</i>	Spiked Rice-flower	exclude	Areas of CPW provide potential habitat for this species. However, random meander survey did not detect any individuals.
<i>Petaurus norfolcensis</i>	Squirrel Glider	exclude	Habitat on the site does not provide suitable habitat for this species and would be too degraded.
<i>Persicaria elatior</i>	Tall Knotweed	exclude	Habitat within the RFEF would be considered marginal for this species. Furthermore, random meander survey did not detect any individuals.
<i>Cynanchum elegans</i>	White-flowered Wax Plant	exclude	Areas of CPW provide potential habitat for this species. However, random meander survey did not detect any individuals.

From this second filtering step (**Table 10**), it is unlikely that any of the above mentioned species credit species would occur on the site.

5.3 Matters of National Environmental Significance – Threatened and Migratory Species

Database searches of the EPBC Act Protected Matters Search Tool (DotE 22 May 2015) identified a number of threatened species and communities and migratory species that have the potential to occur within the study area and sounds (**Appendix A**). However, the study area did not support habitat for the majority of these species. Those considered to have the potential to occur at the site included:

- *Pteropus poliocephalus* (Grey-headed Flying-fox) - vulnerable
- *Apus pacificus* (Fork-tailed Swift) – migratory
- *Ardea alba* (Great Egret) - migratory
- *Ardea ibis* (Cattle Egret) - migratory

There is a Fork-tailed Swift record on the site (OEH 2015a). However, this is a 1983 record with the accuracy noted as 10,000m.

6 Avoidance and mitigation measures

6.1 Avoidance of impacts

Avoidance measures incorporated into the project are characterised by:

- Utilising existing exotic grassland areas
- Modifying the car park footprint to avoid clearing trees in the larger stand of CPW in the south of the site (i.e. separating the car park into two sections)

The proposed design of the project has allowed utilisation of currently disturbed locations within the site. This therefore reduces the project overall footprint and impacts to biodiversity values of the site by limiting the vegetation clearance.

6.1.1 Alternate location

Early scoping investigated the potential of locating the proposal to the east of the site proposed, which would have impacted a much larger area of native vegetation, but the proposal was relocated to previously cleared areas and areas with high dominance of weeds. Given the high level of disturbance at the current proposed site and that the majority of the proposed impact area supports exotic grassland or poor condition CPW, the site selected is considered a good option for the proposal

6.1.1 Utilising existing exotic grassland areas

The proposal has been designed such that the majority of impacts occur within exotic grassland areas and where impacts to native vegetation do occur, they are primarily in areas of exotic grassland that support scattered CPW trees (**Figure 6**).

6.1.2 Separation of the car park into two sections

Given it was not possible to avoid impacts to all CPW at the site, priority in designing the car park was given to the conservation of the majority of the larger stand of stand of CPW in the south of the site. The car park footprint has been separated into two sections to allow for the conservation of the better quality CPW (**Figure 4**).

6.2 Mitigation measures

Mitigation measures aim to reduce the ecological impacts of the Major Project to the greatest extent practicable. The relevant ecological impacts and associated mitigation measures and protocols (standard and project specific) are identified in **Table 11** and described in detail below.

6.2.1 Standard mitigation measures

The following standard mitigation measures will be implemented and include, but are not limited, to the following:

- All contractor staff are to be aware of sensitivity of the surrounding environment including:
 - Threatened ecological communities (CPW, RFEF)
- The boundaries of impact areas should be clearly delineated using fences or similar means to prevent encroachment of the works into the surrounding bushland. Due to the open nature of the site, star pickets and safety tape should be sufficient to identify the areas to be protected and retained.
- Vegetation / woody debris for removal should be used in adjacent areas for habitat features or mulched for soil erosion control.

- Work in riparian zones (i.e. areas of RFEF) would be undertaken to limit impacts on aquatic flora and fauna, and their habitats. This would include measures to preventing run-off into the adjacent vegetation and creek and clearly delineating the construction area boundaries.
- Areas proposed for disturbance where noxious weeds are present should be managed according to the weed class.
- Soil containing seeds from exotic grass species should be removed from the site as soon as practicable and / or stored appropriately to prevent their spread.

6.2.2 Project specific measures

Project specific measures are recommended for species where impacts would remain after the implementation of measures detailed in **Section 6.2.1**, or where additional mitigation measures would further reduce the ecological impact. The primary mitigation measure will be the planting and maintenance of a larger amount of native vegetation than will be removed (1.74 ha will be planted versus 1.65 ha of native vegetation removed, of which approximately half is poor quality derived native grassland).

During Construction

- Extensive planting of 1.74 ha of native vegetation will occur as identified in the landscaping plan (refer to Master Planning report prepared by ASPECT Studios 2015). This is in addition to other non-native planting, and native planting that will include additional species.
- Construction adjacent to drainage lines should be completed during dry periods.
- Storage areas should be located away from the drainage lines to minimise risk of pollution and adverse impact to aquatic ecosystems.
- Installation of sediment and runoff control measures to prevent runoff entering adjacent bushland areas and watercourses.
- A qualified ecologist should be present on site during the removal of the hollow-bearing trees in the eastern part of the site to provide advice to machine operators, to salvage and relocate native fauna if native fauna are encountered and/or injured during tree felling.
- Direct seed with native provenance grass seeds or sterile grasses on exposed areas.
- Wash down machinery before entering the site to limit weed spread.
- Retention of fallen logs and relocation to adjacent areas where possible to provide habitat resources for ground-dwelling species.
- Potential chemical pollutants (e.g. fuels, oils, lubricants, paints etc.) would be stored in appropriate containers within bunded areas within construction compounds to minimise the risk of the pollution of aquatic environments.
- If construction lighting is required at night they should face away from vegetative areas to protect microbats.
- Due to impacts on up to two hollow bearing tree, it is proposed to install 17 nextboxes of a range of styles and types targeting birds and bats as part of the landscaping plan, to replace the tree hollows which may potentially be lost.

Operation

- Prevention of runoff and wastewater from the zoo entering the adjacent watercourse through the implementation of a constructed wetlands and harvesting pond in the west of the site
- Ongoing weed control should be undertaken along the length of the works to reduce the impacts of edge effects on adjacent vegetation.

The final project footprint is identified and assessed in the next chapter.

Table 11: Avoidance and mitigation measures

Impact	Standard mitigation measures	Project Specific	Responsibility	Timing*
Vegetation				
Clearing of native vegetation	- Contractor awareness - Exclusion zones - Re-use of woody debris	- Weed management - Fauna handling - Proposed planting should be consistent with CPW or RFEF species and use provenance seeds	Environmental representative and construction contractor	Pre-construction Construction
Run off	Erosion and sedimentation controls	- Sediment and erosion management and mitigation measures - Re-establishment of native vegetation - Construction and management of a constructed wetland and stormwater harvest ponds in the west of the site	Construction contractor	Pre-construction Construction Operation
Spread of weeds	- Weed management – noxious weeds managed in accordance with their Noxious Weed Class - Soil containing the seeds of exotic grasses should be kept well away from bushland areas and removed from site as soon as possible. - All vehicles entering and exiting the site should be washed down before	- Re-establishment of native vegetation where possible to limit weed spread - Proposed edge planting of CPW species and buffer plantings of Cumberland Plain and native eucalypt species	Environmental representative and construction contractor	Construction Operation
Threatened fauna				
Loss of native fauna from clearance	Clearing vegetation and removal habitat features	Fauna handling – ecologist present during clearing	Environmental representative and fauna handlers	Construction

Impact	Standard mitigation measures	Project Specific	Responsibility	Timing*
Loss of habitat for fauna	Re-use of woody debris	- Re-establishment of native vegetation - Proposed edge planting consistent with CPW and the use of local provenance - Proposed planting of a vegetated buffer around the zoo using Cumberland Plain species and native eucalypts	Environmental representative, construction contractor and vegetation rehabilitation team	Pre-construction Construction Operation
Loss of hollow bearing trees	Re-use as hollow logs in adjacent areas	- Fauna handling – ecologist present during clearing - Proposed installation of 17 nestboxes	Environmental representative, construction contractor and fauna handlers	Construction Operation

* The three categories for timing are:

- Pre-construction = Work in respect of the project that includes design, survey, acquisitions, fencing, investigative drilling or excavation, minor clearing (except where threatened species, populations or ecological communities would be affected), establishing ancillary facilities such as site compounds or other relevant activities determined to have minimal environmental impact (e.g. minor access tracks and adjustments to services/utilities etc).
- Construction = All work in respect of the project other than that defined as a preconstruction activity/work.
- Operation = The operation of the project, but not including commissioning trials of equipment, or temporary use of parts of the project during construction.

7 Assessment of impacts

The potential impacts on biodiversity are discussed in this chapter. Impacts have been identified as both direct, such as direct clearing of vegetation, and indirect such as increases in noise, lighting and downstream riparian impacts.

The project has avoided many of the potential impacts within the study area through the use of large area of exotic grassland and centring those unavoidable impacts on areas of poor condition CPW and RFEF wherever possible. The project has avoided most impacts on larger, better quality CPW which occurs to the east of the project site. The project also incorporates a substantial amount of landscaping and planting.

The project will have both direct and indirect impacts on a range of biodiversity values during the construction and operational phases of the project. Impacts are mainly associated with the construction footprint. The level of indirect impacts is considered to be minimal given the mitigation measures to be implemented (**section 6.2**).

The impact assessment has considered both construction and operational impacts and includes:

- Construction of the zoo, associated car park, access roads and runoff management – construction impact
- Truck movements – construction and operational impact
- Runoff and changes to hydrology - construction and operational impact

The direct impacts (**Section 7.1**) of the project relate to:

- Loss of vegetation/habitat.
- Possibility of weed spread
- Changed hydrology

Indirect impacts (**Section 7.2**) of the project relate to:

- Impact on relevant Key Threatening Processes.
- Connectivity and fragmentation (noting that the landscaping will improve connectivity for mobile species)
- Potential for fauna injury and mortality.
- Runoff and wastewater from the zoo entering watercourses – nutrient runoff
- Potential for inadvertent impacts to adjacent vegetation

Negligible impacts (**Section 7.3**) relate to:

- Bushfire
- Noise, vibration and light
- Groundwater dependant ecosystems
- Aquatic impacts.

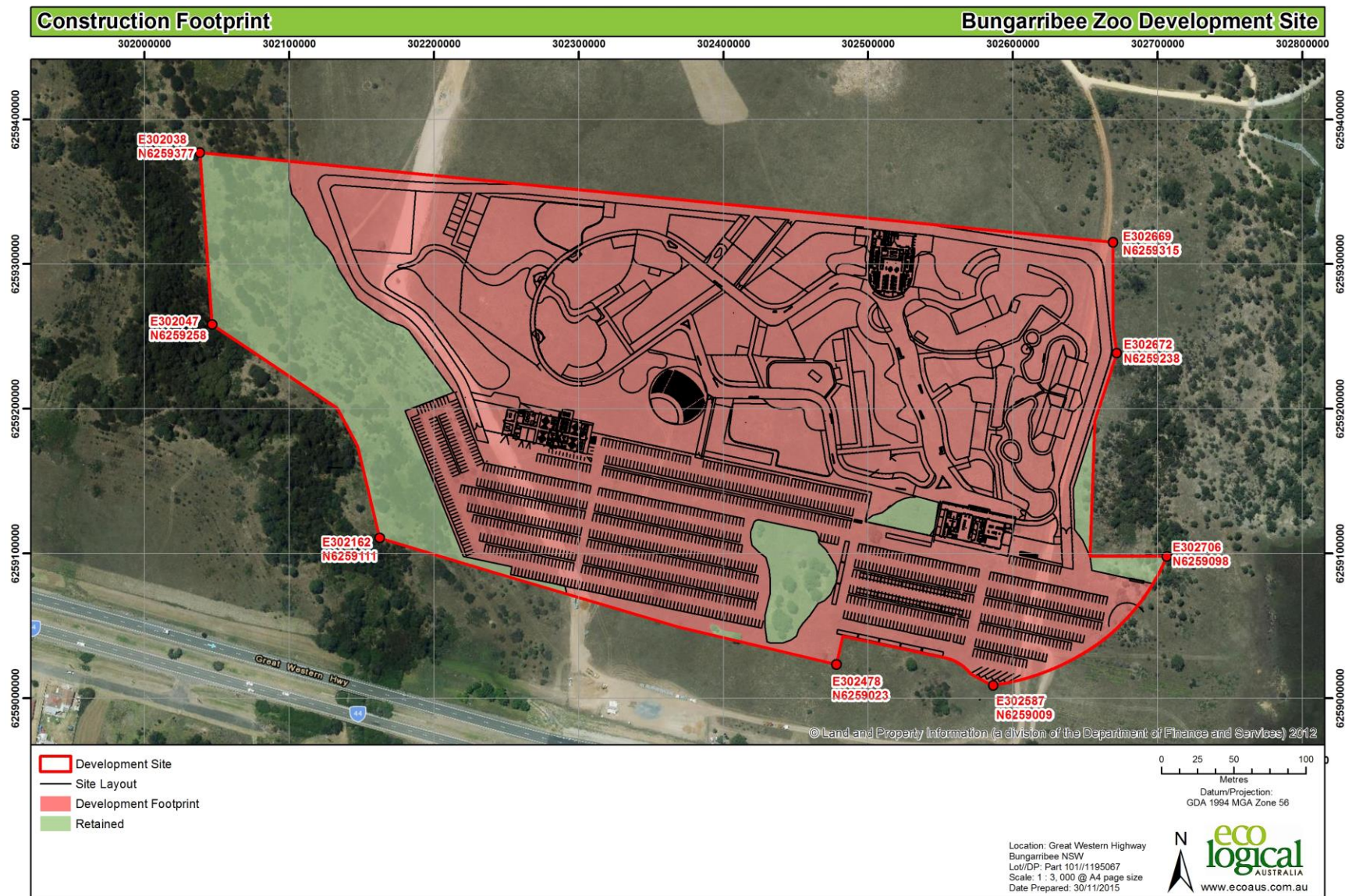


Figure 6: Construction footprint

7.1 Direct impacts

7.1.1 Loss of vegetation and/or habitat

Loss of vegetation and fauna and flora habitat will occur as consequence of the project in the short term, however, the project will include extensive planting and maintenance of a larger amount of native vegetation than will be removed (section 6.2.2), and will be an integral part of the proposal, and thus the time delay will be minimal.

The field survey validated the type and extent of vegetation and various habitats present throughout the study area:

- Two threatened ecological communities have been recorded within the study area
 - Cumberland Plain Woodland
 - River Flat Eucalypt Forest
- No threatened flora species were recorded during the site inspection and therefore it was concluded that none are likely to occur within either the construction footprint or within the study area.
- Ten threatened fauna species and three migratory species have the potential to occur within the study area. However, none were recorded within the study area and the majority of these are ecosystem credit species.

No critical habitat was identified within the study area for any species, communities or populations.

The amount of land subject to the proposed works is 12.32 hectares in total, with a total of 1.65 hectares of native vegetation to be cleared.

There were two hollow bearing trees likely to be impacted by the construction. None of the hollows to be impacted were large enough to be roosting or breeding habitat for large forest owls or large cockatoos.

7.1.2 Weeds

Weeds were abundant within the study area with some areas such as the riparian zones containing prolific weed infestations. Further exotic grass species were prevalent across the study area.

Noxious weeds encountered across the study area are shown in **Table 12**.

Table 12: Noxious weed species encountered in study area

Weed species	Noxious in LGA	Class	Weed of National Significance
<i>Asparagus aethiopicus</i> (Asparagus Fern)	✓	4	✓
<i>Hypericum perforatum</i> (St Johns Wort)	✓	4	✗
<i>Ligustrum sinense</i> (Small-leaved Privet).	✓	4	✗
<i>Opuntia stricta</i> (Prickly Pear)	✓	4	✓
<i>Senecio madagascariensis</i> (Fireweed)	✓	4	✓

Class 4: The growth of the plant must be managed in a manner that reduces its numbers spread and incidence and continuously inhibits its reproduction.

The comprehensive list of weeds can be found in **Appendix D**. A total of 30 weeds species were recorded across the study area.

Given the high presence of weeds in the study area there is potential that vegetation disturbance could potentially create conditions where weeds could invade or intensify. This would have a flow on effect on native flora and fauna by reducing quality of habitat, competition for resources and altering the structure and composition of vegetation communities. Mitigation measures listed in **Section 6.2** would need to be implemented to contain the spread of weeds during the construction and operation of the project. This includes substantial landscaping plantings.

7.1.3 Changes to hydrology

A number of activities may result in impacts to the hydrology of creeks in the project area, namely:

- Increase in paved / hard surfaces associated with the zoo, access paths, roads and car parks
- Wastewater disposal

The development may result in impacts to the hydrology and aquatic ecology of the nearby Eastern Creek. A series of treatment ponds comprised of a constructed wetland and stormwater harvesting pond have been designed to minimise potential adverse impacts on the hydrology of Eastern Creek. Measures to slow the flow and manage run-off at the site have been proposed as part of the mitigation measures to minimise hydrological impacts (refer to the Sydney Zoo *Civil and Structural Assessment* (Lyndsay Dynan 2015)).

7.2 Indirect impacts

7.2.1 Animal pests

Given the study area is disturbed and within a highly urbanised setting it is likely that animal pests would be present within the study area. Most likely pests are:

- European Red Fox (*Vulpes vulpes*)
- European Rabbit (*Oryctolagus cuniculus*)
- Feral Cat (*Felis catus*).

The European Red Fox can be found in a range of habitats. They prey on medium-sized ground-dwelling and semi-arboreal mammals and ground-nesting birds. 'Predation by the European Red Fox *Vulpes vulpes*' is a Key Threatening Process listed under both the EPBC Act and the TSC Act. Animal scats likely to belong to the European Red Fox were noted within the study area. The project is not likely to increase the presence of introduced foxes or increase predation of native fauna because no additional tracks will be created which facilitate movement of predators into otherwise uncleared or undisturbed vegetation.

The European Rabbit causes a number of environmental problems in the Australian landscape. The rabbit can increase the likelihood of soil erosion by creating numerous burrows, threaten the survival of a number of native animal species by altering habitat, reducing native food sources, displacing small animals from burrows and attracting introduced predators such as foxes. 'Competition and grazing by the feral European rabbit (*Oryctolagus cuniculus*)' is a listed Key Threatening Process under both the EPBC Act and the TSC Act. Evidence of Rabbits was identified within the study area particularly in the open/disturbed areas of the mountain bike track. The project is not likely to increase the presence of the European Rabbit within the study area because the project is removing only small areas of native vegetation and will primarily clear areas that are heavily weed invaded which are utilised by the European Rabbit.

Cats can be found in almost all terrestrial environments in Australia. Predation by feral cats is a particular problem that affects native fauna such as small mammals (such as rodents, dasyurids, and burramyids) and ground-nesting birds. 'Predation by the feral cat (*Felis catus*)' is a listed Key Threatening Process under both the EPBC Act and the TSC Act. No evidence of feral cats was identified during the field survey

however feral and domesticated cats are likely to forage throughout the study area given the extensive areas of surrounding urban development. Given the likely abundance of cats in the locality, and the nature of the impacts associated with the project, the project is unlikely to increase the abundance of cats, introduce them into new areas, or increase predation pressure on native fauna.

7.2.2 Impact on relevant Key Threatening Processes

A number of Key Threatening Processes have been identified as being relevant. The activities associated with the project would either contribute to the Key Threatening Processes (known) or may potentially contribute to the Key Threatening Processes (potential). These are listed in **Table 13**.

Table 13: Known and potential Key Threatening Processes and impacts on biodiversity

Key Threatening Process	Relevance to the project	Potential or known
Clearing of native vegetation (TSC Act) Land clearance (EPBC Act)	Clearing of vegetation including native vegetation would be undertaken as part of the project. There would be a need to offset the loss of native vegetation in accordance FBA Major Projects Offset Policy. This is discussed in section 8 .	Known
Invasion of native plant communities by exotic perennial grasses (TSC Act)	There is the potential for seeds of exotic grass species to spread further into adjacent areas if strict soil management protocols are not implemented during construction. These include the correct treatment of noxious weeds and measures to prevent propagules spreading to adjacent bushland as outlined in section 6.2.2 .	Potential
Invasion and establishment of exotic vines and scramblers (TSC Act)	Exotic vines and scramblers are present within the study area particularly within the riparian vegetation along Eastern Creek. Movement of vehicles, equipment and people during the construction phase carries a risk of introduction and spread of these exotic vines and scramblers and well as disturbing intact vegetation can increase the risk of weed infestations. Appropriate mitigation measures are to be implemented to limit the spread of weeds and reduce the risk of weed infestations of areas.	Potential
Loss of Hollow-bearing Trees (TSC Act)	The project would result in permanent removal two hollow-bearing trees, but impact on other hollows have been avoided.	Known
Removal of dead wood and dead trees (TSC Act)	One of the hollow-bearing trees to be removed is a stag. The reuse of these hollows within adjacent areas has been included in section 6.2.2 .	Known

7.2.3 Connectivity and habitat fragmentation

Currently across the area for development, there are some small areas of potential “stepping stone” habitat in the form of the fragmented CPW patches, and native species using these areas would be highly mobile. Some consolidated vegetation is present on both the eastern and western boundaries of the site, and a small areas of this vegetation will be removed, but this will not affect ecological connectivity.

The proposal includes significant landscape plantings, which will improve ecological connectivity as the plantings mature.

7.2.4 Injury and mortality

During the construction of the project, injury or mortality may occur as a result of vegetation clearing or direct collision with vehicles and equipment within the construction site. Although some mobile species may be able to move away quickly and easily such as some birds, others may be slower to move away or may not relocate at all such as some reptiles and amphibians, potentially resulting in injury or mortality of the individual.

Although the project has the potential result in some injury or mortality of fauna species, the project is unlikely to cause a significant increase in fauna injury or mortality incidents. This is because truck movements along the access roads will be speed limited allowing fauna to move off the road.

7.2.1 Runoff and wastewater

There is the potential for runoff from the zoo and particularly animal enclosures to increase nutrient loads in adjacent areas and within Eastern Creek. However, a combination of a constructed wetland and stormwater harvesting ponds will be installed to filter nutrients before it is discharged from the site.

7.2.1 Rubbish dumping

Given the car park in the west will be adjacent to the riparian vegetation and there are roads proposed adjacent to the vegetation in the east of the site, there is the potential for rubbish dumping as these areas will be much more accessible. This can be minimised through the provision of fauna proof bins within the car park areas and through the erection of signage outlining the potential penalties for illegal rubbish dumping.

7.2.2 Inadvertent impacts to adjacent vegetation

There is the potential for inadvertent impacts to adjacent vegetation during operation of the zoo through trampling of bushland areas, rubbish disposal etc. However, this could be minimised through the incorporation of buffer / perimeter plants which would restrict access to the adjacent bushland areas. Plantings are proposed to the north of the roundabout in the east of the site and would assist with preventing impacts to the good condition CPW to the east of the proposed zoo.

7.3 Negligible impacts

7.3.1 Bushfire

It is understood there are no permanent built or inhabited structures within areas surrounded by bush, other than road and drainage infrastructure, therefore no hazard reduction would be required within the study area. The project would not result in impediments to the implementation of bushfire protection measures within the study area. It is possible that activities during the construction (e.g. welding) or final use of the above ground part of the assets may result in bushfire igniting and spreading from construction areas. Under section 63 of the *Rural Fires Act 1997*, the obligation to prevent the occurrence and spread of bushfire needs to be factored in. This can be dealt with by emergency management planning, training and escalation protocols on days of increased bushfire risk.

The project would not result in an increased risk of inappropriate fire regimes which may adversely affect the ecological values of the remnant vegetation and associated habitats within the study area and beyond.

7.3.2 Noise, vibration and light

Indirect impacts on biodiversity caused by noise, vibration and light as part of the construction as well as changes in noise or lighting impacts as a result of the operation of the project are likely. Certain threatened species are particularly vulnerable to these indirect impacts.

Threatened species most at risk from indirect noise and vibration are:

- Nocturnal birds (such as Powerful Owl and Barking Owl) may be impacted by daily construction noise which could affect their behaviour, but given there are no roosting resources on site this would be minimal.
- Bats and nocturnal mammals within the study area could be impacted by increased noise during the construction phase of the project and during operational phases.
- Diurnal birds may be indirectly impacted by noise during project construction. Species such as small woodland birds are known to be impacted by noise associated with roads (Reijnen et al, 1995).

Increase in lighting due to the presence of the zoo may alter microbat foraging activity. Construction and operation lighting should face away from vegetated areas.

In general noise and vibration and light are unlikely to have a significant effect on the diurnal and nocturnal threatened birds and diurnal and nocturnal mammals as mitigation measures would be implemented during construction and operation of the zoo by the project. In addition, noise and vibration impacts will be temporary. Works are expected to be conducted over an 8 - 12 month period with a two month heavy machinery period. All construction activities associated with the proposal would be confined to standard construction hours and would not include works after 6.00pm or before 7.00am.

7.3.3 Aquatic impacts

Lack of ecosystem processes and aquatic habitat (e.g. macrophyte beds) limits the type of aquatic fauna that could survive in the parts of Eastern Creek that fall within the study area. Macroinvertebrates present would likely be hardy species suited to disturbed conditions, rather than threatened species that are known to inhabit good quality streams (e.g. Adams Emerald Dragonfly). Impacts to threatened fish are unlikely, given none are expected to occur in Eastern Creek. Further, direct impacts to aquatic habitats within Eastern Creek are not anticipated.

7.3.4 Groundwater dependent ecosystems

As discussed in section 3.5 is not likely that groundwater dependent ecosystems are present within, or in close proximity to, the study area. Furthermore, although the proposal will include moats and bio filtration ponds, they will not be excavated to a depth where they will interact with groundwater, and they will be lined/compacted to ensure water retention in the ponds. The proposal will increase impervious surfaces, but also includes a high level of water collection and reuse for irrigation on site. It is therefore not likely that groundwater recharge level would be significantly affected.

7.4 Matter of National Environmental Significance

Potential habitat for the Matters of National Environmental Significance (NES) identified in **Sections 4.4** and **1.1** is likely to be impacted for the proposal. However, the amount of habitat to be impacted is small with respect to the amount of habitat within the Bungarabee Precinct and locality. EPBC Act Significance Assessments were undertaken and are included in **Appendix G**. Based on the assessments, it was concluded that the proposal was unlikely to have a significant impact on any Matters of NES and an EPBC Referral is not required.

8 Impact summary and offsets

Although avoidance and mitigation measures have been considered and implemented during the design of the project, impacts on native vegetation (including Threatened Ecological Communities) have been identified that require offsetting. The areas and credits required for offsets are outlined below.

8.1 Areas not requiring assessment or offsets

Areas not requiring assessment or offset, including for PCTs are outlined below and shown in **Figure 5**. The areas not requiring assessment were:

- Cleared / exotic areas – associated with tracks and roads, and areas dominated by exotics
- Areas of site value score <17 (CPW – derived grassland).

8.2 Ecosystem and species credits requiring offsets

Ecosystem credits that measure the impact of the Major Project on biodiversity values in the construction footprint are outlined below in **Table 14** and shown in **Figure 7**. Due to the small area of poor, medium and good condition Grey Box - Forest Red Gum grassy woodland on shale of the southern Cumberland Plain, Sydney Basin Bioregion (Cumberland Plain Woodland) being impacted in the assessment (i.e. less than the minimum size of 0.25ha), these vegetation zones were combined with the medium quality Forest Red Gum - Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney Basin Bioregion zone.

No species credit species are likely to occur at the site and as such no species credit offsets are required for the proposal.

Table 14: PCTs requiring offset and ecosystem credits

PCT requiring offsets	Area impacted (ha)	Vegetation zone	Current site value score	Future site value score	Loss in site value score	Offset multiplier	Ecosystem credits required
Grey Box - Forest Red Gum grassy woodland on shale of the southern Cumberland Plain, Sydney Basin Bioregion, (HN528)*	0.83	2	8.85	0.00	8.85	3	0 *
Forest Red Gum - Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney Basin Bioregion, (HN526)	0.82	Vegetation zones 1 and 3 were merged due to small size of vegetation zone 1	32.64	0.00	32.64	3	23

* Site Value is < 17 therefore no offsets required. The location of this zone is shown on Figure 5.

8.3 Impacts requiring further consideration

The FBA specifies that there may be matters where impacts require further consideration by the consent authority. These are impacts that are considered to be complicated or severe. The NSW OEH has listed a number of matters that require further consideration. These matters are as follows:

- Impacts to landscape features (as defined in section 9.2.3 of the FBA – reducing riparian buffers widths)
- Impacts to important wetlands
- Impact on species movement along corridors
- Impacts on native vegetation which is:
 - a Critically Endangered Ecological Community (CEEC), unless the CEEC is specifically excluded from the SEARs
 - an EEC specifically nominated in the SEARs as an EEC that is likely to become extinct or have its viability significantly reduced in the IBRA subregion if it is impacted on by development
- Impacts on threatened species that / where:
 - are critically endangered, unless the critically endangered species is specifically excluded from the SEARs
 - is a threatened species or population that is specifically nominated in the SEARs as a species or population that is likely to become extinct or have its viability significantly reduced in the IBRA subregion if it is impacted on by development
 - the survey or expert report undertaken in Section 6.6 of the FBA confirms that a threatened species is present on the proposed development site, and the threatened species has not been previously recorded in the IBRA subregion according to records in the NSW Wildlife Atlas.
- Impacts on critical habitat

Given that Cumberland Plain Woodland is listed as a CEEC, further consideration of likely impacts from the proposal on this community have been provided below. Impacts to the other matters listed above are not anticipated.

8.3.1 Impacts to native vegetation – Cumberland Plain Woodland: Critically Endangered Ecological Community

Area and condition of CPW

The majority of the CPW at the site is present as scattered regrowth comprised of a very small number of regenerating eucalypts with an exotic understorey or very small patch of *Microlaena stipoides* beneath the trees.

The CPW in the east of the site forms the southern tip of a good quality stand of CPW that would meet the criteria for listing as Condition A CPW under the EPBC Act. However, the vegetation to be impacted is on the fringes of this patch and has undergone previous historical clearance and is regrowth, and weed invasion was evident and included exotic grass and herbaceous species.

Small stands of CPW are also present at the site in the form of poor quality Derived Native Grassland.

Area and condition of CPW within an area of 1000 ha and 10,000 ha

Within an area of 1,000 ha there is currently 105 ha of Shale Plains Woodland mapped and within an area of 10,000 ha there is currently 1478 ha (based on a composite layer of OEH 2013a and NPWS 2002

mapping). The proposed works would represent removal of 0.24% of the total amount of CPW within an area of 1,000 ha and 0.02% within an area of 10,000 ha.

Extant area and overall condition of CPW remaining in the IBRA subregion

CPW has been extensively cleared for urban and rural developments. About 15 % of the original distribution is estimated to remain (based on OEH 2015c VIS database). The proposal removal of 0.24 ha of CPW and 0.83 ha of DNG is unlikely to significantly reduce the amount of CPW remaining within the IBRA subregion.

The study area is contained wholly in the Sydney Basin Bioregion and there is approximately 6,800 ha of CPW mapped within the Bioregion (based on OEH 2015c VIS database). The proposed impact represents 0.02% of the total amount of CPW mapped in the Sydney Basin Bioregion.

Development proposal impact on: Abiotic factors

The proposed works will retain 0.4 ha of 0.64ha of wooded CPW and 0.06 ha of DNG. There may be some disturbance to these areas due to changed water flow patterns across the site or other changes to abiotic factors. However, the proposal intends to retain and enhance areas via landscape planting.

Development proposal impact on: Characteristic and functionally important species

CPW is characterised by an assemblage of species which can be influenced by the size of the site and by its recent disturbance history. The number of species and the above-ground composition of species will change with time since fire, and may also change in response to changes in fire frequency.

A number of characteristic species of this community have been recorded within the site including, *Eucalyptus moluccana*, *Eucalyptus tereticornis*, *Bursaria spinosa* and a variety of groundcover species such as *Themeda triandra*, *Microlaena stipoides* and *Aristida vagans*. The proposed development will result in the removal of some or all these species.

Impacts from the proposed works represents 39% of the wooded CPW located within the study area and 93 % of the DNG within the study area. The retained portion of CPW is likely to support the better quality CPW across the site.

Development proposal impact on: Quality and integrity of an occurrence of CPW through threats and indirect impacts

Due to the location of CPW in the study area, the CPW is currently subject to a variety of disturbances including previous clearing, the establishment of weeds and pest species. There is the potential for weed invasion to be exacerbated by the proposal. The long-term viability of CPW within the study area will be dependent on the implementation of mitigation measures for the project and on-going management as outlined in Section 6.2. It is unlikely that the proposal would threaten the long-term viability of the CPW in directly adjoining areas provided the mitigation measures outlined in **Section 6.2** are implemented. The greatest potential for further weed invasion is within the stand of CPW in the middle of the car park where weeds could be transferred onto site from vehicles. However, the vegetation is already affected by weed species and landscaping is proposed which could reduce the abundance of weeds.

Development proposal impact on: Fragmentation and isolation of an important area of CPW

The two largest stands of CPW are currently separated by exotic grassland and the remainder of the CPW at the site is present as scattered very small patches of regrowth eucalypts. The distance between the largest stands of vegetation in the east and west of the site would not greatly increase although stepping stone habitat in the form of the fragmented CPW trees will be removed. The stepping stone habitat to be removed is unlikely to be significant to the survival of CPW within the Bungarribee Precinct or locality and is unlikely to prevent seed dispersal and pollination. Further most of the CPW at the site

would not be considered an important area of CPW with the exception of the stand in the east of the site. Given the proposed works are to occur in the southern fringe on this stand of CPW, further fragmentation and isolation impacts are not anticipated. Furthermore, as the proposal will incorporate significant landscaping, ecological connectivity is likely to improve as the plantings mature.

Development proposal impact on: Measures proposed to contribute to the recovery of CPW in the IBRA subregion

The conservation measures to offset the proposed impacts have not yet being determined. However, a commitment has been made to landscaping using species characteristic of CPW.

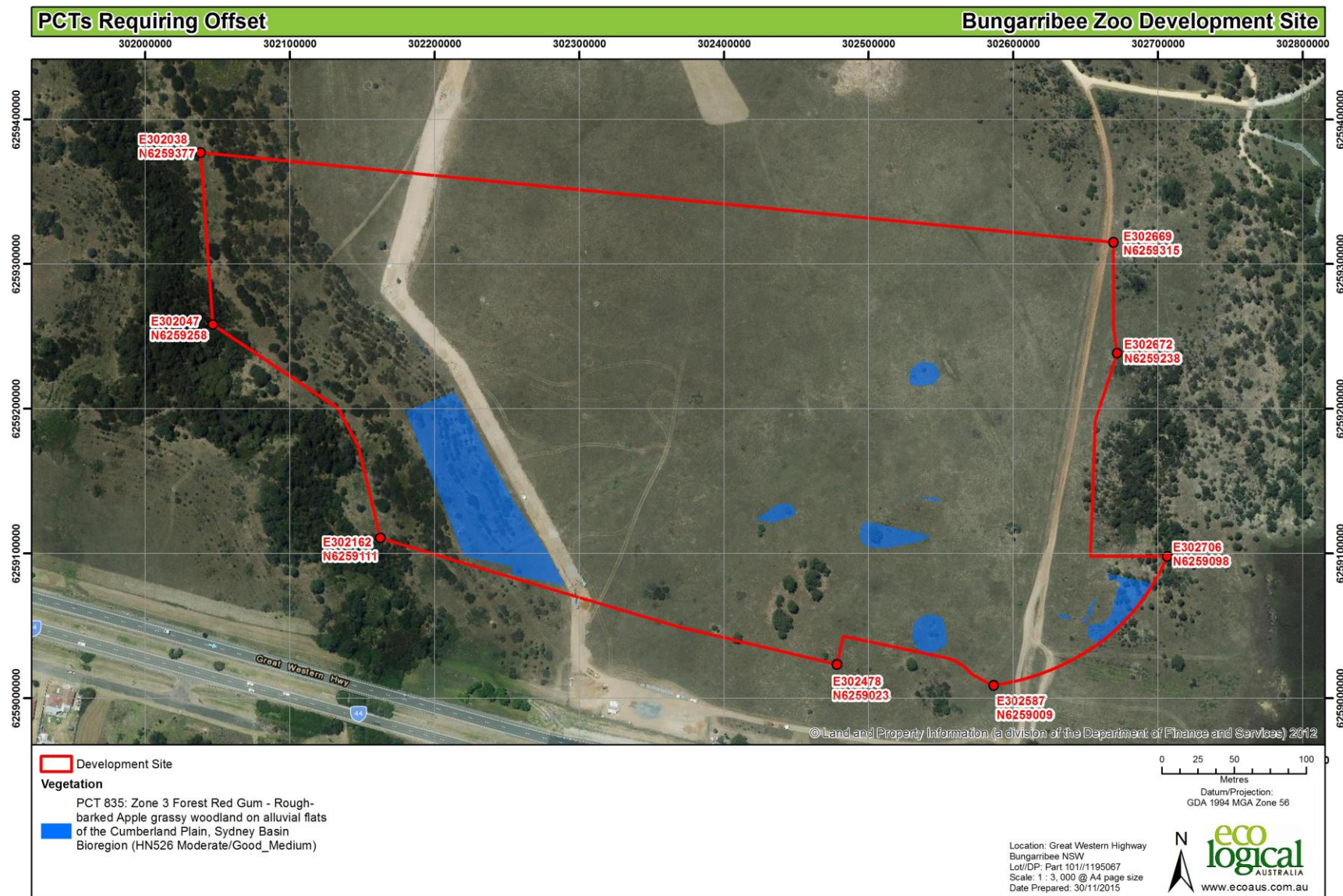


Figure 7: PCTs requiring offsets

9 Summary and biodiversity credit report

This project was assessed as a Major Project in accordance with the Framework for Biodiversity Assessment. The assessed construction footprint covers all the areas required for construction and operation of the project, including excavation, spoil placement, machinery and access roads. ELA approached the assessment by conducting both desktop analysis and field assessment, using the FBA methodology to assess habitat and condition of ecological communities.

One plant community type requires offsets. This was:

- Forest Red Gum – Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney Basin Bioregion (HN256) – moderate to good (medium): **which equates to 23 ecosystem credits**

Species credits are not required, as species credit species are not impacted.

Avoidance of high value ecological matters was achieved through refining the design to avoid the largest and better quality stands of CPW as much as possible and dividing the car park into two sections. Early scoping investigated the potential of locating the proposal to the east of the site proposed, which would have impacted a much larger area of native vegetation, but the proposal was relocated to previously cleared areas and areas with high dominance of weeds.

Mitigation measures have been considered and will be delivered by:

- Delineation of clearance areas
- Management of weed spread
- Storage areas being located away from watercourses and bushland areas
- Storage of potential chemical pollutants (e.g. fuels, oils, lubricants, paints etc.) stored in appropriate containers within bunded areas within construction compounds
- Conducting construction and operation during daylight hours
- Management of traffic within the site
- The presence of a fauna expert during the clearing of hollow-bearing trees and integrate 17 nestboxes targeting birds and bats as part of the landscaping plan
- Relocation of fauna habitat features
- A constructed wetland and stormwater harvesting pond to treat runoff

The proposal does not intend to prepare an offset strategy. Instead the proposal seeks to have the ecosystem credits delivered via the landscaping works being undertaking on site. This approach is being taken as the proposal is not a “standard” development. Although the Major Projects Offset Policy currently do not allow for this approach, it is critical to note that this policy is currently in a transition phase. The Major Projects Offset Policy specifically notes (page 5, paragraph 7) that:

“During the transitional implementation period, application of the policy will be compulsory but a more flexible approach will be permitted to appropriately deal with any technical issues, practical implementation issues or potential perverse outcomes that may arise”

In this regard the proponent argues that:

- A total of 0.82 ha of native vegetation requires offsets according to the Framework for Biodiversity Assessment, but this vegetation is disturbed and of poor quality.

- The proposal retains significant areas of native vegetation with a total of 0.46 ha of Cumberland Plain Woodland, and 2.07 ha of River-flat Eucalypt Forest to be retained.
- The proposal will plant and maintain a larger amount of native vegetation than will be removed. A total of 1.74 ha of native vegetation will be planted versus 0.82 ha of native vegetation removed which requires ecological offsets. Currently, the proponent is not able to count the revegetation of land, as this is currently only allowed for mine site rehabilitation where a Mining Operations Plan is prepared.

The proposal was considered unlikely to have a significant impact on any Matters of NES and a referral is not required.

Biodiversity credit report



This report identifies the number and type of biodiversity credits required for a major project.

Date of report: 1/12/2015

Time: 7:07:08PM

Calculator version: v4.0

Major Project details

Proposal ID:	0039/2015/2167MP
Proposal name:	Bungarribee Zoo MP
Proposal address:	Great Western Highway Bungarribee NSW 2767
Proponent name:	Sydney Zoo
Proponent address:	3 Wills Avenue Waverley NSW 2041
Proponent phone:	0431473629
Assessor name:	Steven Ward
Assessor address:	Level 6 299 Sussex Street SYDNEY NSW 2000
Assessor phone:	9993 0566
Assessor accreditation:	0039

Summary of ecosystem credits required

Plant Community type	Area (ha)	Credits created
Forest Red Gum - Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney Basin Bioregion	0.82	23.00
Grey Box - Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin Bioregion	0.83	0.00
Total	1.65	23

Credit profiles

1. Forest Red Gum - Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney Basin Bioregion, (HN526)

Number of ecosystem credits created

23

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) 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

2. Grey Box - Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin Bioregion, (HN528)

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)	Cumberland - Hawkesbury/Nepean and any IBRA subregion that adjoins the IBRA subregion in which the development occurs

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Appendix A Likelihood of occurrence

Provided below are the likelihood tables for threatened species listed under the Commonwealth EPBC Act and NSW TSC Act. Species, populations and communities considered to have the potential, are likely or are known to occur but are ecosystem credit species are highlighted in purple. Those that have the potential to occur and are either species credit species or listed under the EPBC Act are highlighted blue and require impact assessment.

The analysis of the likelihood of occurrence table included findings from previous surveys conducted by Eco Logical Australia (ELA).

Key to the table:

- TSC Act = Listing under the NSW *Threatened Species Conservation Act 1995*
- EPBC Act = Listing under the *Environment Protection and Biodiversity Conservation Act 1999*
- CE = Critically Endangered
- E = Endangered (EPBC Act)
- E1 = Endangered (TSC Act)
- E2 = Endangered Population (TSC Act)
- E4 = Extinct (TSC Act)
- V = Vulnerable
- M = Migratory (EPBC Act)
- Mar = Marine (EPBC Act)

FLORA

Scientific Name	Common Name	TSC Act Status	EPBC Act Status	Distribution	Habitat	Distribution (yes/no)	Habitat quality (good marginal, none)	Species known to occur on site	Likelihood of occurrence	Habitat on site directly or indirectly impacted (Yes/No)	EPBC Significance Assessment Required
<i>Acacia pubescens</i>	Downy Wattle	V	V	Restricted to the Sydney region around the Bankstown-Fairfield-Rookwood and Pitt Town area, with outliers occurring at Barden Ridge, Oakdale and Mountain Lagoon.	Open woodland and forest, including Cooks River/Castlereagh Ironbark Forest, Shale/Gravel Transition Forest and Cumberland Plain Woodland. Occurs on alluviums, shales and at the intergrade between shales and sandstones.	Yes	Marginal	No	Unlikely	No	No
<i>Allocasuarina glareicola</i>		E1	E	Primarily restricted to the Richmond (NW Cumberland Plain) district, but with an outlier population found at Voyager Point, Liverpool.	Castlereagh woodland on lateritic soil. Found in open woodland with <i>Eucalyptus parramattensis</i> , <i>Eucalyptus fibrosa</i> , <i>Angophora bakeri</i> , <i>Eucalyptus sclerophylla</i> and <i>Melaleuca decora</i> .	Yes	Marginal	No	Unlikely	No	No
<i>Cynanchum elegans</i>	White-flowered Wax Plant	E1	E	Restricted to eastern NSW, from Brunswick Heads on the north coast to Gerroa in the Illawarra region, and as far west as Merriwa in the upper Hunter River valley.	Dry rainforest; littoral rainforest; <i>Leptospermum laevigatum</i> - <i>Banksia integrifolia</i> subsp. <i>integrifolia</i> (Coastal Tea-tree– Coastal Banksia) coastal scrub; <i>Eucalyptus tereticornis</i> (Forest Red Gum) or <i>Corymbia maculata</i> (Spotted Gum) open forest and woodland; and <i>Melaleuca armillaris</i> (Bracelet Honey myrtle) scrub.	Yes	Marginal	No	Unlikely	No	No
<i>Dillwynia tenuifolia</i>		V	-	Mainly on the Cumberland Plain, but also Bulga Mountains at Yengo in the north, and Kurrajong Heights and Woodford in the Lower Blue Mountains.	Scrubby/dry heath areas within Castlereagh Ironbark Forest and Shale Gravel Transition Forest, transitional areas where these communities adjoin Castlereagh Scribbly Gum Woodland, and disturbed escarpment woodland on Narrabeen sandstone.	Yes	None	No	Unlikely	No	No
<i>Genoplesium baueri</i>	Bauer's Midge Orchid	E1	E	Has been recorded from locations between Nowra and Pittwater and may occur as far north as Port Stephens.	Dry sclerophyll forest and moss gardens over sandstone.	Yes	None	No	No	No	No
<i>Grevillea juniperina</i> subsp. <i>juniperina</i>	Juniper-leaved Grevillea	V		Endemic to Western Sydney, centred on an area bounded by Blacktown, Erskine Park, Londonderry and Windsor with outlier populations at Kems Creek and Pitt Town.	Cumberland Plain Woodland, Castlereagh Ironbark Woodland, Castlereagh Scribbly Gum Woodland and Shale/Gravel Transition Forest, on reddish clay to sandy soils derived from Wianamatta Shale and Tertiary alluvium.	Yes	Good	No	Unlikely	No	No
<i>Haloragis exalata</i> subsp. <i>exalata</i>	Square Raspwort	V	V	Disjunct distribution in the Central Coast, South Coast and North Western Slopes botanical subdivisions of NSW.	Protected and shaded damp situations in riparian habitats.	No	Marginal	No	No	No	No
<i>Marsdenia viridiflora</i> subsp. <i>viridiflora</i>	<i>Marsdenia viridiflora</i> R. Br. subsp. <i>viridiflora</i> population in the Bankstown, Blacktown, Camden, Campbelltown, Fairfield, Holroyd, Liverpool and Penrith local government areas	E2		Razorback Range, also recorded at Prospect, Bankstown, Smithfield, Cabramatta Creek and St Marys.	Vine thickets and open shale woodland.	Yes	Marginal	No	Unlikely	No	No

Scientific Name	Common Name	TSC Act Status	EPBC Act Status	Distribution	Habitat	Distribution (yes/no)	Habitat quality (good marginal, none)	Species known to occur on site	Likelihood of occurrence	Habitat on site directly or indirectly impacted (Yes/No)	EPBC Significance Assessment Required
<i>Micromyrtus minutiflora</i>		E1	V	Restricted to the general area between Richmond and Penrith, western Sydney.	Castlereagh Scribbly Gum Woodland, Ironbark Forest, Shale/Gravel Transition Forest, open forest on tertiary alluvium and consolidated river sediments.	No	None	No	No	No	No
<i>Persoonia nutans</i>	Nodding Geebung	E1	E	Restricted to the Cumberland Plain in western Sydney, between Richmond in the north and Macquarie Fields in the south.	Northern populations: sclerophyll forest and woodland (Agnes Banks Woodland, Castlereagh Scribbly Gum Woodland and Cooks River / Castlereagh Ironbark Forest) on aeolian and alluvial sediments. Southern populations: tertiary alluvium, shale sandstone transition communities and Cooks River / Castlereagh Ironbark Forest.	Yes	None	No	No	No	No
<i>Pilularia novae-hollandiae</i>	Austral Pillwort	E1		In NSW, recorded from suburban Sydney, Khancoban, the Riverina between Albury and Urana, Oolambeyan National Park near Carathool and at Lake Cowal near West Wyalong.	Shallow swamps and waterways, roadside table drains, subalpine grassy plains.	Yes	Marginal	No	Unlikely	No	No
<i>Pimelea curviflora</i> var. <i>curviflora</i>		V	V	Confined to the coastal area of the Sydney and Illawarra regions between northern Sydney and Maroota in the north-west and Croom Reserve near Albion Park in the south.	Woodland, mostly on shaley/lateritic soils over sandstone and shale/sandstone transition soils on ridgetops and upper slopes.	Yes	None	No	No	No	No
<i>Pimelea spicata</i>	Spiked Rice-flower	E1	E	Two disjunct areas; the Cumberland Plain (Marayong and Prospect Reservoir south to Narellan and Douglas Park) and the Illawarra (Landsdowne to Shellharbour to northern Kiama).	Well-structured clay soils. <i>Eucalyptus moluccana</i> (Grey Box) communities and in areas of ironbark on the Cumberland Plain. Coast Banksia open woodland or coastal grassland in the Illawarra.	Yes	Good	No	Unlikely	No	No
<i>Pomaderris brunnea</i>	Brown Pomaderris	E	V	In NSW, found around the Colo, Nepean and Hawkesbury Rivers, including the Bargo area and near Camden. It also occurs near Walcha on the New England tablelands.	Moist woodland or forest on clay and alluvial soils of flood plains and creek lines.	Yes	Marginal	No	Unlikely	No	No
<i>Pterostylis gibbosa</i>	Illawarra Greenhood	E1	E	Known from a small number of populations in the Hunter region (Milbrodale), the Illawarra region (Albion Park and Yallah) and the Shoalhaven region (near Nowra).	Open forest or woodland, on flat or gently sloping land with poor drainage.	No	None	No	No	No	No
<i>Pterostylis saxicola</i>	Sydney Plains Greenhood	E1	E	Restricted to western Sydney between Freemans Reach in the north and Picton in the south.	Small pockets of shallow soil in depressions on sandstone rock shelves above cliff lines, adjacent to sclerophyll forest or woodland on shale/sandstone transition soils or shale soils.	Yes	None – database record near site is from 1804	No	Unlikely	No	No
<i>Pultenaea parviflora</i>		E1	V	Endemic to the Cumberland Plain. Mainly from Windsor to Penrith and east to Dean Park, with outlier populations at Kemps Creek and Wilberforce.	Dry sclerophyll forest, especially Castlereagh Ironbark Forest, Shale Gravel Transition Forest and transitional areas where these communities adjoin Castlereagh Scribbly Gum Woodland.	Yes	None	No	Unlikely	No	No
<i>Streblus pendulinus</i>	Siah's Backbone, Sia's	P	E	East coast south to Milton, south-east NSW, as well as Norfolk Island.	Warmer rainforests, chiefly along watercourses.	No	None	No	No	No	No

Scientific Name	Common Name	TSC Act Status	EPBC Act Status	Distribution	Habitat	Distribution (yes/no)	Habitat quality (good marginal, none)	Species known to occur on site	Likelihood of occurrence	Habitat on site directly or indirectly impacted (Yes/No)	EPBC Significance Assessment Required
	Backbone, Isaac Wood										
<i>Thesium australe</i>	Austral Toadflax	V	V	In eastern NSW it is found in very small populations scattered along the coast, and from the Northern to Southern Tablelands.	Grassland on coastal headlands or grassland and grassy woodland away from the coast.	Yes	Marginal	No	Unlikely	No	No

FAUNA

Scientific Name	Common Name	TSC Act Status	EPBC Act Status	Distribution	Habitat	Distribution (yes/no)	Habitat quality (good, moderate, marginal, none)	Species known to occur on site	Likelihood of occurrence	Habitat on site directly or indirectly impacted (Yes/No)	Impact Assessment Required
FISH											
<i>Macquarie australasica</i>	Macquarie Perch	E (under FM Act 1994)	E	Macquarie Perch are found in the Murray-Darling Basin (particularly upstream reaches) of the Lachlan, Murrumbidgee and Murray rivers, and parts of south-eastern coastal NSW, including the Hawkesbury/Nepean and Shoalhaven catchments. The conservation status of the different populations is not well known, but there have been long-term declines in their abundance (NSW DPI 2015).	Habitat for the Macquarie perch is bottom or mid-water in slow-flowing rivers with deep holes, typically in the upper reaches of forested catchments with intact riparian vegetation.	Yes	None	No	No	No	No
<i>Prototroctes maraena</i>	Australian Grayling	-	V	On mainland Australia, this species has been recorded from rivers flowing east and south of the main dividing ranges.	This species spends only part of its lifecycle in freshwater, mainly inhabiting clear, gravel-bottomed streams with alternating pools and riffles, and granite outcrops but has also been found in muddy-bottomed, heavily silted habitat.	Yes	None	No	No	No	No
AMPHIBIANS											
<i>Heleioporus australiacus</i>	Giant Burrowing Frog	V	V	South eastern NSW and Victoria, in two distinct populations: a northern population in the sandstone geology of the Sydney Basin as far south as Ulladulla, and a southern population occurring from north of Narooma through to Walhalla, Victoria.	Heath, woodland and open dry sclerophyll forest on a variety of soil types except those that are clay based.	Yes	None	No	No	No	No
<i>Litoria aurea</i>	Green and Golden Bell Frog	E1	V	Since 1990, recorded from ~50 scattered sites within its former range in NSW, from the north coast near Brunswick Heads, south along the coast to Victoria. Records exist west to Bathurst, Tumut and the ACT region.	Marshes, dams and stream-sides, particularly those containing <i>Typha</i> spp. (bullrushes) or <i>Eleocharis</i> spp. (spikerushes). Some populations occur in highly disturbed areas.	Yes	None	No	Unlikely	No	No
<i>Litoria raniformis</i>	Southern Bell Frog	E1	V	In NSW, only known to exist in isolated populations in the Coleambally Irrigation Area, the Lowbidgee floodplain and around Lake Victoria. A few recent unconfirmed records have also been made in the Murray Irrigation Area.	Permanent or ephemeral Black Box/Lignum/Nitre Goosefoot swamps, Lignum/Typha swamps and River Red Gum swamps or billabongs along floodplains and river valleys. Also found in irrigated rice crops.	Yes	None	No	No	No	No
REPTILES											
<i>Hoplocephalus bungaroides</i>	Broad-headed Snake	E1	V	Largely confined to Triassic and Permian sandstones within the coast and ranges in an area within approximately 250 km of Sydney.	Dry and wet sclerophyll forests, riverine forests, coastal heath swamps, rocky outcrops, heaths, grassy woodlands.	Yes	None	No	No	No	No
DIURNAL BIRDS											

Scientific Name	Common Name	TSC Act Status	EPBC Act Status	Distribution	Habitat	Distribution (yes/no)	Habitat quality (good, moderate, marginal, none)	Species known to occur on site	Likelihood of occurrence	Habitat on site directly or indirectly impacted (Yes/No)	Impact Assessment Required
<i>Anthochaera Phrygia</i>	Regent Honeyeater	CE	E	Inland slopes of south-east Australia, and less frequently in coastal areas. In NSW, most records are from the North-West Plains, North-West and South-West Slopes, Northern Tablelands, Central Tablelands and Southern Tablelands regions; also recorded in the Central Coast and Hunter Valley regions.	Eucalypt woodland and open forest, wooded farmland and urban areas with mature eucalypts, and riparian forests of <i>Casuarina cunninghamiana</i> (River Oak).	Yes	Marginal	No	Unlikely	No	No
<i>Botaurus poiciloptilus</i>	Australasian Bittern	E1	E	Found over most of NSW except for the far north-west.	Permanent freshwater wetlands with tall, dense vegetation, particularly <i>Typha</i> spp. (bullrushes) and <i>Eleocharis</i> spp. (spikerushes).	Yes	Marginal	No	Unlikely	No	No
<i>Chthonicola sagittata</i>	Speckled Warbler	V		From south-eastern Qld, the eastern half of NSW and into Victoria, as far west as the Grampians, mostly on hills and tablelands of the Great Dividing Range and rarely on coast.	<i>Eucalyptus</i> -dominated communities with a grassy understorey and sparse shrub layer, often on rocky ridges or in gullies.	Yes	None	No	No	No	No
<i>Daphoenositta chrysoptera</i>	Varied Sittella	V		Distribution in NSW is nearly continuous from the coast to the far west.	Inhabits eucalypt forests and woodlands, mallee and <i>Acacia</i> woodland.	Yes	Good	No	Potential	No (ecosystem credit species)	No (ecosystem credit species)
<i>Dasyornis brachypterus</i>	Eastern Bristlebird	E1	E	There are three main populations: Northern - southern Qld/northern NSW, Central - Barren Ground NR, Budderoo NR, Woronora Plateau, Jervis Bay NP, Booderee NP and Beecroft Peninsula and Southern - Nadgee NR and Croajingalong NP in the vicinity of the NSW/Victorian border.	Central and southern populations inhabit heath and open woodland with a heathy understorey. In northern NSW, habitat comprises open forest with dense tussocky grass understorey.	No	None	No	No	No	No
<i>Hieraaetus morphnoides</i>	Little Eagle	V		Throughout the Australian mainland, with the exception of the most densely-forested parts of the Dividing Range escarpment.	Open eucalypt forest, woodland or open woodland, including sheoak or <i>Acacia</i> woodlands and riparian woodlands of interior NSW.	Yes	Good	It has been recorded in the northern portion of the Bungarribee Precinct, but has not been recorded within the study site itself	Likely	Yes (although ecosystem credit species)	No
<i>Lathamus discolor</i>	Swift Parrot	E1	E	Migrates from Tasmania to mainland in Autumn-Winter. In NSW, the species mostly occurs on the coast and south west slopes.	Box-ironbark forests and woodlands.	Yes	Marginal	No	Unlikely	No	No
<i>Lophoictinia isura</i>	Square-tailed Kite	V		In NSW, it 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.	Timbered habitats including dry woodlands and open forests, particularly timbered watercourses.	Yes	Marginal	No	Unlikely	No	No

Scientific Name	Common Name	TSC Act Status	EPBC Act Status	Distribution	Habitat	Distribution (yes/no)	Habitat quality (good, moderate, marginal, none)	Species known to occur on site	Likelihood of occurrence	Habitat on site directly or indirectly impacted (Yes/No)	Impact Assessment Required
<i>Petroica boodang</i>	Scarlet Robin	V		In NSW, it occurs from the coast to the inland slopes.	Dry eucalypt forests and woodlands, and occasionally in mallee, wet forest, wetlands and tea-tree swamps.	Yes	None	No	Unlikely	No	No
<i>Petroica phoenicea</i>	Flame Robin	V		In NSW, breeds in upland areas, and in winter many birds move to the inland slopes and plains, or occasionally to coastal areas. Likely that there are two separate populations in NSW, one in the Northern Tablelands, and another ranging from the Central to Southern Tablelands.	Breeds in upland tall moist eucalypt forests and woodlands. In winter uses dry forests, open woodlands, heathlands, pastures and native grasslands. Occasionally occurs in temperate rainforest, herbfields, heathlands, shrublands and sedgeland areas at high altitudes.	Yes	Moderate	No - but record to the north of site in the Bungarribee Precinct	Potential	No (ecosystem credit species)	No

INVEREBRATES

<i>Meridolum corneovirens</i>	Cumberland Plain Land Snail	E1		Areas of 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.	Primarily inhabits Cumberland Plain Woodland. Also known from Shale Gravel Transition Forests, Castlereagh Swamp Woodlands and the margins of River-flat Eucalypt Forest.	Yes	Moderate	No	Unlikely	No	No
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MAMMALS (EXCLUDING BATS)

<i>Dasyurus maculatus</i>	Spotted-tailed Quoll	V	E	Found on the east coast of NSW, Tasmania, eastern Victoria and north-eastern Qld.	Rainforest, open forest, woodland, coastal heath and inland riparian forest, from the sub-alpine zone to the coastline.	Yes	None	No	No	No	No
<i>Phascolarctos cinereus</i>	Koala	V	V	The Koala has a fragmented distribution throughout eastern Australia. In NSW it mainly occurs on the central and north coasts with some populations in the west of the Great Dividing Range.	Inhabit eucalypt woodlands and forests.	Yes	Marginal	No	Unlikely	No	No
<i>Pseudomys novaehollandiae</i>	New Holland Mouse	-	V	Fragmented distribution across Tasmania, Victoria, New South Wales and Queensland.	Inhabits open heathlands, open woodlands with a heathland understorey and vegetated sand dunes.	Yes	None	No	Unlikely	No	No

MAMMALS

<i>Chalinolobus dwyeri</i>	Large-eared Pied Bat	V	V	Recorded from Rockhampton in Qld south to Ulladulla in NSW. Largest concentrations of populations occur in the sandstone escarpments of the Sydney basin and the NSW north-west slopes.	Wet and dry sclerophyll forests, Cyprus Pine dominated forest, woodland, sub-alpine woodland, edges of rainforests and sandstone outcrop country.	Yes	None	No	Unlikely	No	No
<i>Falsistrellus tasmaniensis</i>	Eastern False Pipistrelle	V		South-east coast and ranges of Australia, from southern Qld to Victoria and Tasmania. In NSW, records extend to the western slopes of the Great Dividing Range.	Tall (greater than 20m) moist habitats.	Yes	None	No	Unlikely	No	No
<i>Miniopterus australis</i>	Little Bentwing-bat	V	-	East coast and ranges of Australia from Cape York in Queensland to Wollongong in NSW.	Moist eucalypt forest, rainforest, vine thicket, wet and dry sclerophyll forest, Melaleuca swamps, dense coastal forests and banksia scrub. Generally found in well-timbered areas.	Yes	Marginal	No	Potential - no breeding habitat	No (ecosystem credit species)	No

Scientific Name	Common Name	TSC Act Status	EPBC Act Status	Distribution	Habitat	Distribution (yes/no)	Habitat quality (good, moderate, marginal, none)	Species known to occur on site	Likelihood of occurrence	Habitat on site directly or indirectly impacted (Yes/No)	Impact Assessment Required
<i>Miniopterus schreibersii oceanensis</i>	Eastern Bentwing-bat	V	-	In NSW it occurs on both sides of the Great Dividing Range, from the coast inland to Moree, Dubbo and Wagga Wagga.	Rainforest, wet and dry sclerophyll forest, monsoon forest, open woodland, paperbark forests and open grassland.	Yes	Moderate	No	Potential – no breeding habitat	Yes	No
<i>Mormopterus norfolkensis</i>	Eastern Freetail-bat	V		Found along the east coast from south Qld to southern NSW.	Dry sclerophyll forest, woodland, swamp forests and mangrove forests east of the Great Dividing Range.	Yes	Moderate	No	Potential - limited breeding habitat	Yes (although ecosystem credit species)	No
<i>Myotis macropus</i>	Southern Myotis	V		In NSW, found in the coastal band. It is rarely found more than 100 km inland, except along major rivers.	Foraging habitat is waterbodies (including streams, or lakes or reservoirs) and fringing areas of vegetation up to 20m.	Yes	Moderate	No	Potential – no breeding habitat	Yes (although ecosystem credit species for foraging habitat)	No
<i>Pteropus poliocephalus</i>	Grey-headed Flying-fox	V	V	Along the eastern coast of Australia, from Bundaberg in Qld to Melbourne in Victoria.	Subtropical and temperate rainforests, tall sclerophyll forests and woodlands, heaths and swamps as well as urban gardens and cultivated fruit crops.	Yes	Moderate	No	Likely	Yes (although ecosystem credit species)	Yes
<i>Scoteanax rueppellii</i>	Greater Broad-nosed Bat	V		Both sides of the great divide, from the Atherton Tableland in Qld to north-eastern Victoria, mainly along river systems and gullies. In NSW it is widespread on the New England Tablelands.	Woodland, moist and dry eucalypt forest and rainforest.	Yes	Moderate	No	Potential – limited breeding habitat	Yes (although ecosystem credit species)	No

NOCTURNAL BIRDS

<i>Tyto novaehollandiae</i>	Masked Owl	V		Recorded over approximately 90% of NSW, excluding the most arid north-western corner. Most abundant on the coast but extends to the western plains.	Dry eucalypt forests and woodlands from sea level to 1100 m.	Yes	Marginal	No	Potential foraging only	Yes although ecosystem credit species)	No
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MIGRATORY SPECIES

<i>Apus pacificus</i>	Fork-tailed Swift	P	C,J,K, Mar	Recorded in all regions of NSW.	Riparian woodland, swamps, low scrub, heathland, saltmarsh, grassland, Spinifex sandplains, open farmland and inland and coastal sand-dunes.	Yes	Moderate	Yes – 1983 record although accuracy 10,000 m	Yes	Yes	Yes
<i>Ardea alba</i>	Great Egret	P	C, J, Mar	Widespread, occurring across all states/territories. Also a vagrant on Lord Howe and Norfolk Island.	Swamps and marshes, grasslands, margins of rivers and lakes, salt pans, estuarine mudflats and other wetland habitats.	Yes	Marginal	No	Likely	Yes	Yes
<i>Ardea ibis</i>	Cattle Egret	P	C,J, Mar	Widespread and common across NSW.	Grasslands, wooded lands and terrestrial wetlands.	Yes	Moderate	No - but record to the north of site in the Bungarribee Precinct	Likely	Yes	Yes
<i>Gallinago hardwickii</i>	Latham's Snipe	P	C,J,R, Mar	Migrant to east coast of Australia, extending inland west of the Great Dividing Range in NSW.	Freshwater, saline or brackish wetlands up to 2000 m above sea-level; usually freshwater swamps, flooded grasslands or heathlands.	Yes	None	No	Unlikely	No	No

Scientific Name	Common Name	TSC Act Status	EPBC Act Status	Distribution	Habitat	Distribution (yes/no)	Habitat quality (good, moderate, marginal, none)	Species known to occur on site	Likelihood of occurrence	Habitat on site directly or indirectly impacted (Yes/No)	Impact Assessment Required
<i>Haliaeetus leucogaster</i>	White-bellied Sea-Eagle	P	C	Distributed along the coastline of mainland Australia and Tasmania, extending inland along some of the larger waterways, especially in eastern Australia.	Freshwater swamps, rivers, lakes, reservoirs, billabongs, saltmarsh and sewage ponds and coastal waters. Terrestrial habitats include coastal dunes, tidal flats, grassland, heathland, woodland, forest and urban areas.	Yes	None	No	Unlikely	No	No
<i>Hirundapus caudacutus</i>	White-throated Needle-tail	P	C,J,K	All coastal regions of NSW, inland to the western slopes and inland plains of the Great Divide.	Occur most often over open forest and rainforest, as well as heathland, and remnant vegetation in farmland.	Yes	Marginal	No	Unlikely	No	No
<i>Merops ornatus</i>	Rainbow Bee-eater	P	J	Distributed across much of mainland Australia, including NSW.	Open forests and woodlands, shrublands, farmland, areas of human habitation, inland and coastal sand dune systems, heathland, sedgeland, vine forest and vine thicket.	Yes	Marginal	No	Unlikely	No	No
<i>Monarcha melanopsis</i>	Black-faced Monarch	P	Bonn, Mar	In NSW, occurs around the eastern slopes and tablelands of the Great Divide, inland to Coutts Crossing, Armidale, Widden Valley, Wollemi National Park and Wombeyan Caves. It is rarely recorded farther inland.	Rainforest, open eucalypt forests, dry sclerophyll forests and woodlands, gullies in mountain areas or coastal foothills, Brigalow scrub, coastal scrub, mangroves, parks and gardens.	Yes	None	No	No	No	No
<i>Myiagra cyanoleuca</i>	Satin Flycatcher	P	Bonn, Mar	In NSW, widespread on and east of the Great Divide and sparsely scattered on the western slopes, with very occasional records on the western plains.	Eucalypt-dominated forests, especially near wetlands, watercourses, and heavily-vegetated gullies.	Yes	Marginal	No	Unlikely	No	No
<i>Pandion cristatus</i>	Eastern Osprey	V		Common around the northern NSW coast, and uncommon to rare from coast further south. Some records from inland areas.	Rocky shorelines, islands, reefs, mouths of large rivers, lagoons and lakes.	Yes	None	No	No	No	No
<i>Rhipidura rufifrons</i>	Rufous Fantail	P	Bonn, Mar	Coastal and near coastal districts of northern and eastern Australia, including on and east of the Great Divide in NSW.	Wet sclerophyll forests, subtropical and temperate rainforests. Sometimes drier sclerophyll forests and woodlands.	Yes	None	No	Unlikely	No	No
<i>Rostratula australis</i>	Australian Painted Snipe	E1	E, Mar	In NSW most records are from the Murray-Darling Basin. Other recent records include wetlands on the Hawkesbury River and the Clarence and lower Hunter Valleys.	Swamps, dams and nearby marshy areas.	Yes	None	No	Unlikely	No	No

Appendix B Plot and transect field data

Plots labelled from 1-3 were gathered during the May 2015, plots 4 – 8 during the July 2015 and plot 9 during the September 2015 survey period (**Figure 3**). However, not all plots were used to calculate the impacts (**see Table 7**). Those used in the impact assessment have been highlighted below and included plots representing the varying condition of the PCT across the study area.

Vegetation Zone 1

Vegetation Type: Grey Box – Forest Red Gum grassy woodland on flats of the Cumberland (HN528)

Condition: Moderate/Good (Medium)

Plot Name	NPS	NOS	NMS	NGC (G)	NGC (S)	NGC (O)	EPC	NTH	OR	FL	Easting	Northing	Zone
1	14	12	0	90	16	10	24	0	1	0	302469	6259088	56
5	6	11.5	2.4	22	0	2	76.2	0	0	0	302400	6259047	56
7	10	0	3.9	12	2	20	64	0	1	0	302501	6259119	56
8	10	0	0.5	12	2	6	80	0	0	0	302543	6259049	56
9	17	14.5	7	44	4	24	10	2	1	7	302698	6259091	56

Vegetation Zone 2*

Vegetation Type: Grey Box – Forest Red Gum grassy woodland on flats of the Cumberland (HN528)

Condition: Moderate/Good (Derived native grassland)

Plot Name	NPS	NOS	NMS	NGC (G)	NGC (S)	NGC (O)	EPC	NTH	OR	FL	Easting	Northing	Zone
2	8	0	0	96	0	0	44	0	0	0	302326	6259301	56

* The Site Value score for this vegetation zone was < 17.

Vegetation Zone 3

Vegetation Type: Forest Red Gum – Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney Basin Bioregion (HN526)

Condition: Moderate/Good (Medium)

Plot Name	NPS	NOS	NMS	NGC (G)	NGC (S)	NGC (O)	EPC	NTH	OR	FL	Easting	Northing	Zone
3	11	15	4	14	0	0	96	0	1	8.5	302145	6259196	56
4	13	3.5	9.2	34	2	0	64	0	1	0	302240	6259127	56

Additional Plot not associated with a Vegetation Zone

Vegetation Type: Exotic

Condition: Low

Plot Name	NPS	NOS	NMS	NGC (G)	NGC (S)	NGC (O)	EPC	NTH	OR	FL	Easting	Northing	Zone
6	7	0	0	4	0	4	92	0	0	0	302423	6259213	56

Appendix C Plot and transect field data sheets

Eco Logical Australia - Biobank plot data sheet	Site Sheet No.
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Ref Site ID	Bung 1	Recorders	KS AN	Date	29/5/15
Wapoint/ Plot ID	15+16	Easting *	St: 0302469 End: 0302431	Northing*	St: 6259088 End: 6259059
GPS datum	UTM	Photo no. (Camera)	St: 17 End: 18	Plot orient/ Slope/Aspect	-4° 1' 218°

* Record from Easting and Northing from both ends of the 50m transect

Slopes 4° to SSW

Vegetation Zone Identification

Biometric Vegetation Type (Create a standard short version)	CPW		
Ancillary Code (Usually condition description)			
Condition (Low or Mod-Good)	Moderate	Habitat Features	Poor

20 x 20m Quadrat	Number of native plant species	Use species list over page (full Id is not required)										14	(NPS)	
50m Transect - 10 Points	Native over- storey cover (%)	30	40	20	0	0	0	0	0	20	10	0	Sum / 10	13% (NOS)
	Native mid-storey cover (%)	0	0	0	0	0	0	0	0	0	0	0	Sum / 10	0% (NMS)
50m Transect - 50 Points	Native ground cover (hits/50 points) - Grasses	HH HH HH HH HH HH HH HH										Double score out of 50 to get %	90% (NGCG)	
	Native ground cover (hits/50 points) - Shrubs	HH HH										Double score out of 50 to get %	16% (NGCS)	
	Native ground cover (hits/50 points) - other	HH										Double score out of 50 to get %	10% (NGCO)	
50m Transect - 10 points + 50 points	Overstorey (10 points)											(a) Sum/10	Sum exotic cover (%) from	
	Midstorey (10 points)	0	0	0	0	0	0	0	0	0	0	(b) Sum/10	(a)+(b)+(c)	
	Ground (50 points)	HH HH HH										24 (c) Double score	24%	
20m x 50m Quadrat	Number of trees with hollows	0		Total length fallen logs >10cm width (m)		0								
Whole Veg. Zone	Over-storey regeneration	All canopy spp. in Veg Zone					Regen (Y/N) (indiv. <5cm?)		Proportion					
		Euc. mollucana					Y		1					
Strata	Form	Species					Height range		PFC					
Upper 1	Tree	E. mollucana					12-15m							
Upper 2														
Mid 1	Nothing													
Mid 2														
Lower 1	G	Microfaena stipoides					10cm							
Lower 2	G	Eragrostis curvula												

Form: (T) Tree; (M) Mallee tree; (S) Shrub; (G) Tussock Grass (Poa/Themeda); (d) Sod grass (Couch/Kikuyu); (L) Vine/climber/scrambler; (V) Sedge (Cyperoid); (R) Rush (Restioid, Juncaceae); (F) Forb; (E) Fern; (P) Palm; (A) Cycad

Plot#	Site Name	Date
1	Bungarbee South	29/5/15

Natives (20m Quadrat)		F	C	A	Exotics (20m Quadrat)		F	C	A
OVERSTOREY									
1	<i>Eucalyptus molluscana</i>								
2									
3									
4									
5									
6									
7									
8									
MIDSTOREY									
9	<i>E. molluscana</i>								
10	None								
11									
12									
13									
14									
15									
16									
17									
18									
19									
20									
21									
22									
GROUND COVER / other									
23	<i>Senecio hispidula</i>				Moth vine <i>Ajuga</i>				
24	<i>Microseris sphaeroides</i>				<i>Sida rhombifolia</i>				
25	<i>Orchardia repens</i>				<i>Cirsium vulgare</i>				
26	<i>Diarrhena sp.</i>				<i>Paspalum</i>				
27	<i>Glycine microphylla</i>				<i>Solanum sp.</i>				
28	<i>Lomandra filiformis</i>				<i>Pigea sp.</i>				
29	<i>Glycine fabacifolia</i>				<i>Senecio madagascariensis</i>				
30	<i>Thymus australis</i>				<i>M. setifolia</i>				
31	<i>Oxalis perfoliata</i>				<i>Tragopogon curvula</i>				
32	<i>Paspalum sp.</i>				<i>Compositae</i>				
33	<i>M. stila vagans</i>				<i>Plantago</i>				
34	<i>A. ramosa</i>								
35	<i>Juncus sp.</i>								
36									
37									
38									
39									
40									
41									
42									
43									
44									
45									

* Cover (C): Estimate of the appropriate cover measure for each recorded species; from 1-5 and then to the nearest 5%.

Abundance (A): A relative measure of the number of individuals or shoots of a species within the plot. Use the following intervals, 1,2,3,4,5,6,7,8,9,10,20,50,100,500,1000 or specify a number greater than 1000 if required.

Form: * (T) Tree; (M) Mallee tree; (S) Shrub; (G) Tussock Grass (Poa/Themeda); (d) Sod grass (Couch/Kikuyu); (L) Vine/climber/scrambler; (V) Sedge (Cyperoid); (R) Rush (Restioid, Juncaceae); (F) Forb; (E) Fern; (P) Palm; (A) Cycad

Braun-blanket: 1=<5% (rare, <3 individuals); 2=<5% (uncommon, scattered/localised); 3=<5% (common, consistent thru plot); 4a=<5% (very abundant, many individuals thru plot); 4b=5-25%; 5=25-50%; 6=50-75%; 7=75-100%

* Note: Cover and Abundance should be collected unless otherwise stated, as per Native Veg. Interim Type Standard (Sivertsen 2009)

Eco Logical Australia - Biobank plot data sheet	Site Sheet No.
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Ref Site ID	Bung 2	Recorders	KS AN	Date	29/5/15
Wapoint/ Plot ID	20.21	Easting *	St: 0202226 End: 0202370	Northing*	St: 6259301 End: 6259277
GPS datum	WGA	Photo no. (Camera)	St: 30 End: 31	Plot orient/ Slope/Aspect	+5° / 106°

* Record from Easting and Northing from both ends of the 50m transect

Vegetation Zone Identification

Biometric Vegetation Type (Create a standard short version)	CAW DNG		
Ancillary Code (Usually condition description)			
Condition (Low or Mod-Good)	mod	Habitat Features	Grassland

20 x 20m Quadrat	Number of native plant species	Use species list over page (full Id is not required)		8	(NPS)
50m Transect - 10 Points	Native over- storey cover (%)			Sum / 10	0% (NOS)
	Native mid-storey cover (%)			Sum / 10	0% (NMS)
50m Transect - 50 Points	Native ground cover (hits/50 points) - Grasses			Double score out of 50 to get %	96% (NGCG)
	Native ground cover (hits/50 points) - Shrubs			Double score out of 50 to get %	% (NGCS)
	Native ground cover (hits/50 points) - other			Double score out of 50 to get %	% (NGCO)
50m Transect - 10 points + 50 points	Overstorey (10 points)			(a) Sum/10	Sum exotic cover (%) from (a)+(b)+(c) 17%
	Midstorey (10 points)			(b) Sum/10	
	Ground (50 points)			(c) Double score	
20m x 50m Quadrat	Number of trees with hollows	0	Total length fallen logs >10cm width (m)	0	
Whole Veg. Zone	Over-storey regeneration	All canopy spp. in Veg Zone		Regen (Y/N) (indiv. <5cm?)	Proportion
		N/A			0
Strata	Form	Species		Height range	PFC
Upper 1					
Upper 2					
Mid 1					
Mid 2					
Lower 1					
Lower 2					

Form: (T) Tree; (M) Mailee tree; (S) Shrub; (G) Tussock Grass (Poa/Themeda); (d) Sod grass (Couch/Kikuyu); (L) Vine/climber/scrambler; (V) Sedge (Cyperoid); (R) Rush (Restioid, Juncaceae); (F) Forb; (E) Fern; (P) Palm; (A) Cycad

KAREN'S DNG PLOT

Plot#	Site Name	Date		
	Natives (20m Quadrat)	F	C	A
	Exotics (20m Quadrat)	F	C	A
OVERSTOREY				
1				
2				
3				
4				
5				
6				
7				
8				
MIDSTOREY				
9				
10				
11				
12				
13				
14				
15				
16				
17				
18				
19				
20				
21				
22				
GROUNDCOVER / other				
23	<i>Arctostaphylos</i>			
24	<i>Arctostaphylos</i>			
25	<i>Thymus</i>			
26	<i>Combretum</i>			
27	<i>Lomandra</i>			
28	<i>Dianella</i>			
29	<i>Hesperis</i>			
30	<i>Lomandra</i>			
31	<i>Lomandra</i>			
32				
33				
34				
35				
36	8 in csv file			
37	as original # from			
38	Karen's survey			
39				
40				
41				
42				
43				
44				
45				

* Cover (C): Estimate of the appropriate cover measure for each recorded species; from 1-5 and then to the nearest 5%.

Abundance (A): A relative measure of the number of individuals or shoots of a species within the plot. Use the following intervals, 1,2,3,4,5,6,7,8,9,10,20,50,100,500,1000 or specify a number greater than 1000 if required.

Form: * (T) Tree; (M) Mallee tree; (S) Shrub; (G) Tussock Grass (Poa/Themeda); (d) Sod grass (Couch/Kikuyu); (L) Vine/climber/scrambler; (V) Sedge (Cyperoid); (R) Rush (Restioid, Juncaceae); (F) Forb; (E) Fern; (P) Palm; (A) Cycad

Braun-blauquet: 1=<5% (rare, <3 individuals); 2=<5% (uncommon, scattered/localised); 3=<5% (common, consistent thru plot); 4a=<5% (very abundant, many individuals thru plot); 4b=5-25%; 5=25-50%; 6=50-75%; 7=75-100%

* Note: Cover and Abundance should be collected unless otherwise stated, as per Native Veg. Interim Type Standard (Sivertsen 2009)

Eco Logical Australia - Biobank plot data sheet	Site Sheet No.
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Ref Site ID	Bung 23	Recorders	KS AN	Date	29/5/15
Wapoint/ Plot ID	18, 19	Easting *	St: 0302145 End: 0302110	Northing*	St: 6259196 End: 6259232
GPS datum	UTM	Photo no. (Camera)	St: 22 End: 23	Plot orient/ Slope/Aspect	-1° 1' 208°

* Record from Easting and Northing from both ends of the 50m transect

Vegetation Zone Identification

Biometric Vegetation Type (Create a standard short version)	Replanted River-flat Eucalypt Forest		
Ancillary Code (Usually condition description)			
Condition (Low or Mod-Good)	Mod	Habitat Features	Some fallen trees in hollows or logs

20 x 20m Quadrat	Number of native plant species	Use species list over page (full id is not required)										6 11 (NPS)	
50m Transect - 10 Points	Native over- storey cover (%)	10	10	40	20	10	10	0	20	10	0	Sum / 10	15 % (NOS)
	Native mid-storey cover (%)	0	0	0	20	0	0	0	0	20	0	Sum / 10	4 % (NMS)
50m Transect - 50 Points	Native ground cover (hits/50 points) - Grasses	11 11										Double score out of 50 to get %	14 % (NGCG)
	Native ground cover (hits/50 points) - Shrubs											Double score out of 50 to get %	0 % (NGCS)
	Native ground cover (hits/50 points) - other											Double score out of 50 to get %	0 % (NGCO)
50m Transect - 10 points + 50 points	Overstorey (10 points)											0 (a) Sum/10	Sum exotic cover (%) from (a)+(b)+(c) 96 %
	Midstorey (10 points)	0 0 0 0 0 0 0 0 0 0 0										0 (b) Sum/10	
	Ground (50 points)	11 11 11 11 11 11 11 11 11 11										96 (c) Double score	
20m x 50m Quadrat	Number of trees with hollows	0										Total length fallen logs >10cm width (m)	8.5 m
Whole Veg. Zone	Over-storey regeneration	All canopy spp. in Veg Zone										Regen (Y/N) (indiv. <5cm?)	Proportion
		A. pergranulosa ✓										C. cunninghamiae ✓	1
		E. amygdaliolia ✓											
		A. decurrens ✓											
Strata	Form	Species										Height range	PFC
Upper 1													
Upper 2													
Mid 1													
Mid 2													
Lower 1													
Lower 2													

Form: (T) Tree; (M) Mallee tree; (S) Shrub; (G) Tussock Grass (Poa/Themeda); (d) Sod grass (Couch/Kikuyu); (L) Vine/climber/scrambler; (V) Sedge (Cyperoid); (R) Rush (Restioid, Juncaceae); (F) Forb; (E) Fern; (P) Palm; (A) Cycad

TPI DAS re-run of 20x20 to get CIA

8/9/15

Plot#	Block	Site Name	Date
	2	Bungaroo bush	29/5/15

Natives (20m Quadrat)		F	C	A	Exotics (20m Quadrat)		F	C	A
OVERSTOREY									
1	<i>Eucalyptus amplifolia</i> ✓	1	5	2					
2	<i>Acacia decurrens</i> ✓	1	15	2					
3	<i>Le. Acacia parvomitensis</i>	1	3	1					
4	<i>Casuarina cunninghamiana</i>	1	5	4					
5									
6									
7									
8									
MIDSTOREY									
9	<i>E. amplifolia</i>	T	1	2					
10	<i>C. cunninghamiana</i> glauc	T	5	20					
11	<i>A. parvomitensis</i> ✓	S	5	20					
12	<i>Dill sick</i>	S	1	1					
13	<i>Burs. sp. n. s.</i>	S	1	1					
14	<i>Acacia tin</i>	S							
15	<i>Acacia (opulenta) (F)</i>	S	5	1					
16	<i>A. elong (S) (yellow)</i>	S	1	4					
17	<i>Acacia wic</i>	S	1	1					
18									
19									
20									
21									
22									
GROUND COVER / other									
23	<i>Lomandra longifolia</i> ✓		3	4	Small-leaf Privet	S	1	4	
24	<i>Microlaena stip</i> ✓		15	100	Comm. ✓	D	70	50	
25	<i>Acacia parvomitensis</i>				Moth vine	V	1	1	
26	<i>A. decurrens</i> ✓				<i>Paspalum</i>	G	1	20	
27					<i>Fragaria vesicaria</i> ✓	G	5	20	
28					Carpet grass ✓	G	2	20	
29					<i>Hypochaeris radiata</i>	F	1	10	
30					<i>Plantago lanc</i>	F	1	3	
31					<i>Rumex</i>	G	1	50	
32					<i>Verbena bon</i>	F	1	2	
33					<i>Croton</i>	F	1	1	
34					<i>Briar subsp.</i>	G	15	100	
35					<i>Rumex sp</i>	F	1	1	
36									
37									
38									
39									
40									
41									
42									
43									
44									
45									

* Cover (C): Estimate of the appropriate cover measure for each recorded species; from 1-5 and then to the nearest 5%.

Abundance (A): A relative measure of the number of individuals or shoots of a species within the plot. Use the following intervals, 1,2,3,4,5,6,7,8,9,10,20,50,100,500,1000 or specify a number greater than 1000 if required.

Form: * (T) Tree; (M) Mallee tree; (S) Shrub; (G) Tussock Grass (Poa/Themeda); (d) Sod grass (Couch/Kikuyu); (L) Vine/climber/scrambler; (V) Sedge (Cyperoid); (R) Rush (Restioid, Juncaceae); (F) Forb; (E) Fern; (P) Palm; (A) Cycad

Braun-blauquet: 1=<5% (rare, <3 individuals); 2=<5% (uncommon, scattered/localised); 3=<5% (common, consistent thru plot); 4a=<5% (very abundant, many individuals thru plot); 4b=5-25%; 5=25-50%; 6=50-75%; 7=75-100%

* Note: Cover and Abundance should be collected unless otherwise stated, as per Native Veg. Interim Type Standard (Sivertsen 2009)

Eco Logical Australia – BioBanking / BioCertification plot data sheet

Site Sheet No.

Plot Information

Site	004 RFF	Recorders	TP / DAB	Date	03/07/15
Waypoint (GPS datum)	WP 24 / 31	Easting*	0302240	Northing*	6259127
		B	0302189	B	6259129
		Photo No.	0051	Orientation	270°
		B	0050	Slope	Flat

* Record Easting and Northing from the end of the 50m transect at the start of the 20m quadrat. B- end of 50m transect

Vegetation Zone Identification

Biometric Vegetation Type (Create a standard short version)	
Ancillary Code (Usually condition description)	
Condition (Low or Mod-Good)	Habitat Features (rocks etc)
Comments	Grassy

20m x 20m Quadrat	Number of native plant species	Use species list over page (full id is not required) Write no. natives here:											
50m Transect – 10 Points	Native over-storey cover (%)	0	20	0	5	0	0	0	0	0	0	350	Sum / 10
	Native mid-storey cover (%)	5	0	0	10	2	0	10	20	20	5	92	Sum / 10
50m Transect – 50 Points	Native ground cover (hits/50 pts) – shrubs	1											Double score out of 50 to get %
	Native ground cover (hits/50 pts) – grasses												Double score out of 50 to get %
	Native ground cover (hits/50 pts) – other												Double score out of 50 to get %
Exotic: 50m Transect – 10 pts	Overstorey (10 points)	0	0	0	0	0	0	0	0	0	0	(a) Sum/10	Sum exotic cover (%)
	Midstorey (10 points)	0	0	0	0	0	0	0	0	0	0	(b) Sum/10	From (a)=(b)=(c)
Exotic: 50m Transect – 50 pts	Ground (50 points)											(c) Double score	64 %
20m x 50m Quadrat	Number of trees with hollows	0										Total length fallen logs >10cm width (m)	0
Whole Veg. Zone	Over-storey regeneration	Over-storey Species										Regenerating (<5cm)	Proportion
		E. amplif											1 as predicted as not written in field
		amng.											
Stratum	Growth form	Species name										Height Range	PFC (Projected Foliage Cover %)
Upper													
Upper													
Mid													
Mid													
Ground													
Ground													

Growth form: T = tree, S = shrub, G = grass, V = vine, (H) Herb, E = exotic

Cover: <1, 1,2,3,4,5, 15,20,25,30,35 etc foliage cover %

3-7-15

TP

GAREF

	Natives (20m Quadrat)	C	A	Exotics (20m quadrat)	C	A
1	<i>E. amplifolia</i>	3	5			
2						
3	<i>Acacia decurrens</i>	10	6			
4	<i>Juv stringybark(?)</i>	3	4			
5						
6						
7						
8						
9						
10						
11						
12						
13						
14						
15						
16	SHRUBS					
17	<i>Melaleuca styph</i>	3	8			
18	<i>Acacia decurrens</i>	2	30			
19	<i>Acacia paria</i>	1	1			
20						
21						
22						
23						
24						
25						
26						
27						
28						
29	GROUND					
30	<i>Microlaena stipoides</i>	5	50	<i>Cyniza sp</i>	1	20
31	<i>Themeda aus</i>	5	10	<i>Myrsophyllum zeyl</i>	1	1
32	<i>Anetha vagans</i>	15	100	<i>Setaria gracilis</i>	5	50
33	<i>Lomandra longifolia</i>	1	1	<i>Senecio madecar</i>	1	10
34	<i>Lomandra multi</i>	1	3	<i>Axonopus Assi</i>	10	100
35	<i>Lomandra filii subsp. filii</i>	1	2	<i>Cynodon dactylon</i>	20	500
36	<i>Panicum dthys</i>	1	1	<i>Piza subaristata(?)</i>	30	500
37	<i>Dichroa repens</i>	1	6	<i>Paspalum distatum</i>	5	30
38	Folded leaf grass (Boca?)			<i>Formulca</i>		50
39				<i>Hypericum</i>	1	1
40				<i>Cirsium vulgare</i>	1	2
41				<i>Plantago lance</i>	1	3
42				<i>Viola (C. modica) (s)</i>	1	2
43				<u>E. nit id</u>		
44						
45						
46						
47						
48						
49						
50						

Braun-Blanquet scale: 1: <5% - rare, <3 individuals, 2: <5% - uncommon, >3 individuals, 3: <5% - common, scattered or locally common, 4a: <5% - very abundant, 4b: 5-25%, 5: 25-50%, 6: 50-75%, 7: 75-100% (C & A not required for Biobanking)

Eco Logical Australia – BioBanking / BioCertification plot data sheet

Site Sheet No.

Plot Information

Site	007	Recorders	TP/DAB	Date	03/07/15
Waypoint (GPS datum)	37 / 36	Easting *	0302501	Northing*	6259114
		B	0302545	B	6259147
		Photo No.	56	Orientation	
		B	57	Slope	

* Record Easting and Northing from the end of the 50m transect at the start of the 20m quadrat. B- end of 50m transect

Vegetation Zone Identification

Biometric Vegetation Type (Create a standard short version)	
Ancillary Code (Usually condition description)	
Condition (Low or Mod-Good)	Habitat Features (rocks etc)
Comments	grassland

20m x 20m Quadrat	Number of native plant species	Use species list over page (full Id is <u>not</u> required) Write no. natives here:												
50m Transect - 10 Points	Native over-storey cover (%)	0	0	0	0	0	0	0	0	0	0	Sum / 10	(NOS)	%
	Native mid-storey cover (%)	18	1	5	2	0	2	1	10	0	0	39	Sum / 10	(NMS)
50m Transect - 50 Points	Native ground cover (hits/50 pts) - shrubs	1										Double score out of 50 to get %	2	%
	Native ground cover (hits/50 pts) - grasses	1111										Double score out of 50 to get %	12	%
	Native ground cover (hits/50 pts) - other	1111111111										Double score out of 50 to get %	20	%
Exotic: 50m Transect - 10 pts	Overstorey (10 points)	0										(a) Sum/10	Sum exotic cover (%) From (a)=(b)=(c)	
	Midstorey (10 points)	0										(b) Sum/10		
Exotic: 50m Transect - 50 pts	Ground (50 points)	11111111111111111111										(c) Double score		
20m x 50m Quadrat	Number of trees with hollows	0					Total length fallen logs >10cm width (m)					0		
Whole Veg. Zone	Over-storey regeneration	Over-storey Species										Regenerating (<5cm)		Proportion
		Enc. melu...										Yes		
Stratum	Growth form	Species name										Height Range		PFC (Projected Foliage Cover %)
Upper		Enc. melu...										16-16		5%
Upper		shrub Danesia spiky flt G.2										0.5		5%
Mid		Bursaria										0.5-3		3%
Mid		Enc. melu...										2-3		5%
Ground		Couch / Paspalum												20/20
Ground		Digitaria Avicennia Fossi												20%

Growth form: T = tree, S = shrub, G = grass, V = vine, (H) Herb, E = exotic

Cover: <1, 1,2,3,4,5, 15,20,25,30,35 etc foliage cover %

3-7-15
Q7 AREA E

	Natives (20m Quadrat)	C	A	Exotics (20m quadrat)	C	A
1	CANOPY					
2	E. mol	10	1			
3						
4						
5						
6						
7						
8						
9						
10						
11	SHRUB					
12	E. mol	10	8			
13	Bursaria spinosa	5	10			
14						
15						
16						
17						
18						
19						
20						
21	GROUND					
22	Dichondra repens	5	100	Quercus dactylon	40	
23	Dianella	2	20	Pasp dilatat	2	
24	Microlaena stip	2	20	Cirsium vulg	1	1
25	Anetha vagans	10	50	Senecio madagas	1	10
26	Bathia macra	1	2	Sida rhomb	2	30
27	Lomandra fil	3	30	Sporobolus	1	2
28	Cymbopogon refractus	1	1	Plantago lanc	1	3
29	Themeda triandra	1	1	Galium or Asperula (as per prev)	1	2
30	Austrodanth (S) COLESP	1	1	Setaria gracilis	5	50
31				Sporobolus creber	1	2
32				Coniza hor	1	3
33				Axonopus Axi	20	
34				Chloris gayana	4	13
35				Poa suberistata	10	30
36				Hypochaeris rad	1	1
37						
38						
39						
40						
41						
42						
43						
44						
45						
46						
47						
48						
49						
50						

Braun-Blanquet scale: 1: <5% - rare, <3 individuals, 2: <5% - uncommon, >3 individuals, 3: <5% - common, scattered or locally common, 4a: <5% - very abundant, 4b: 5-25%, 5: 25-50%, 6: 50-75%, 7: 75-100% (C & A not required for Biobanking)

Eco Logical Australia - Biobank plot data sheet	Site Sheet No.
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Ref Site ID	CPW 4 Q9 EBC	Recorders	TP 5 DAB	Date	03/09/15
Wapoint/ Plot ID	005 006	Easting *	St: 0302698 End: 6259091	Northing*	St: 0302657 End: 6259074
GPS datum		Photo no. (Camera)	St: 708 End: 709	Plot orient/ Slope/Aspect	SW Flat 1

* Record from Easting and Northing from both ends of the 50m transect

Vegetation Zone Identification

Biometric Vegetation Type (Create a standard short version)			
Ancillary Code (Usually condition description)	Good		
Condition (Low or Mod-Good)	Mod-Good	Habitat Features	lot little re

20 x 20m Quadrat	Number of native plant species	Use species list over page (full id is not required)										(NPS)	
50m Transect - 10 Points	Native over- storey cover (%)	0	0	40	30	0	60	15	40	0	0	Sum / 145	4.5 % (NOS)
	Native mid-storey cover (%)	0	60	0	0	0	0	0	100	10	0	Sum / 70	7 % (NMS)
50m Transect - 50 Points	Native ground cover (hits/50 points) - Grasses	(22)										Double score out of 50 to get %	44 % (NGCG)
	Native ground cover (hits/50 points) - Shrubs	(2)										Double score out of 50 to get %	4 % (NGCS)
	Native ground cover (hits/50 points) - other	(12)										Double score out of 50 to get %	24 % (NGCO)
50m Transect - 10 points + 50 points	Overstorey (10 points)	0	0	0	0	6	0	0	0	0	0	(a) Sum/10	Sum exotic cover (%) from (a)+(b)+(c) 10 %
	Midstorey (10 points)	0	0	0	0	0	0	0	0	0	0	(b) Sum/10	
	Ground (50 points)	(10)										(c) Double score	

Grass suspected
hit 111

20m x 50m Quadrat	Number of trees with hollows	1 very small 1 hollow snag	Total length fallen logs >10cm width (m)	4m + 1 = 7m
Whole Veg. Zone	Over-storey regeneration	All canopy spp. in Veg Zone		Regen (Y/N) (indiv. <5cm?)
	Acacia seedling	Euc mel		Y
		Euc leuc		Y
		Angophora - flc		Y
Strata	Form	Species	Height range	PFC
Upper 1	Tree	Eucalyptus mel	1-14	100%
Upper 2	Tree	Euc leuc	1-10	10%
Mid 1	Shrub	Bursaria spin	0.2-2.2	10
Mid 2		Drosera ulicifolia	0.1-0.5	<5%
Lower 1		Themeda	0-1	25-30% range
Lower 2		Anthurus	0-1	25-30%

Form: (T) Tree; (M) Mallee tree; (S) Shrub; (G) Tussock Grass (Poa/Themeda); (d) Sod grass (Couch/Kikuyu); (L) Vine/climber/scrambler; (V) Sedge (Cyperoid); (R) Rush (Restioid, Juncaceae); (F) Forb; (E) Fern; (P) Palm; (A) Cycad

CLS
habitat

Plot# CPW4 29 Site Name Bung Zoo Date 3-9-15
EPBC

Natives (20m Quadrat)		F	C	A	Exotics (20m Quadrat)		F	C	A
OVERSTOREY									
1	E. teret	T	20	20					
2	Ang. flor	T	1	1					
3	E. mol	T	5	2					
4									
5									
6									
7									
8									
MIDSTOREY									
9	Bursaria sp.	S	10	20					
10	Acacia falc.	S	1	20					
11	Danessa ulic.	S	3	50					
12									
13									
14									
15									
16									
17									
18									
19									
20									
21									
22									
GROUND COVER / other									
23	Dicksonia repens	F	1	500	Hyperbaena rad. +	F	1	20	
24	Aristida vagans	G	40	100	Chenopodium HT HT +	V	1	20	
25	Bulbine bulbosa	F	1	10	Sedum m. III	F	2	20	
26	Cyperus sp. HT HT (S)	V	1	10					
27	Lomandra fil. subsp. nov.	S	5	500	Awnopus Her	G	5	50	
28	Goodenia hederacea	F	1	10	Oxalis (S) III	F	1	3	
29	Microbena stip	G	20	100	Anagallis aenease I	F	1	1	
30	Lomandra multi HT	V	2	10	Coryza gl	F	1	1	
31	Argophora seedling	T	1	3	Hypochaeris HT	F	1	5	
32	Themeda triandra HT HT	G	20	100	Taxodium sp	F	1	1	
33	Dianella (?) longifolia	V	1	3	Braea (?) subarist	G	3	10	
34	Glycine	L	1	3	Galium (?) apocine	F	1	10	
35									
36									
37									
38									
39	CLS habitat although								
40	none found								
41	0.5% search								
42									
43									
44									
45									

BFCShire

* Cover (C): Estimate of the appropriate cover measure for each recorded species; from 1-5 and then to the nearest 5%.

Abundance (A): A relative measure of the number of individuals or shoots of a species within the plot. Use the following intervals, 1,2,3,4,5,6,7,8,9,10,20,50,100,500,1000 or specify a number greater than 1000 if required.

Form: * (T) Tree; (M) Mallee tree; (S) Shrub; (G) Tussock Grass (Poa/Themeda); (d) Sod grass (Couch/Kikuyu); (L) Vine/climber/scrambler; (V) Sedge (Cyperoid); (R) Rush (Restioid, Juncaceae); (F) Forb; (E) Fern; (P) Palm; (A) Cycad

Braun-blauquet: 1=<5% (rare, <3 individuals); 2=<5% (uncommon, scattered/localised); 3=<5% (common, consistent thru plot); 4a=<5% (very abundant, many individuals thru plot); 4b=5-25%; 5=25-50%; 6=50-75%; 7=75-100%

* Note: Cover and Abundance should be collected unless otherwise stated, as per Native Veg. Interim Type Standard (Sivertsen 2009)

Appendix D Flora species recorded

The flora lists include species recorded from biometric plots although not all plots were used for the calculation of credits.

Table 15: Flora species recorded within study area

Scientific Name	Common Name	Native / Exotic / Planted	Noxious Weeds	WoNS	Growth Form	1	2	3		4		5		6		7		8		9	
								C	A	C	A	C	A	C	A	C	A	C	A	C	A
<i>Acacia decurrens</i>	Black Wattle	N			S			15	2	10	6										
<i>Acacia</i> sp.2		N			S			1	4												
<i>Acacia falcata</i>		N			S															1	20
<i>Acacia parramattensis</i>	Parramatta Wattle	N			T			3	1	3	1										
<i>Acacia parramattensis</i>	shrub layer	N			S					5	20										
<i>Acacia</i> sp.		N			S			5	1												
<i>Acacia ulicifolia</i>	Prickly Moses	N			S			1	1												
<i>Anagallis arvensis</i>	Scarlet Pimpernel	E			F															1	1
<i>Angophora floribunda</i>		N			T															1	1
<i>Angophora</i> sp.	seedling	N			T															1	3
<i>Araujia sericifera</i>	Moth Vine	E			L	x		1	1												
<i>Aristida ramosa</i>	Purple Wiregrass	N			G	x	x														
<i>Aristida vagans</i>	Threeawn Speargrass	N			G	x	x			15	100	1	10	15	500	10	50	5		40	100
<i>Asparagus asparagoides</i>	Bridal Creeper	E	Class 4	Y	V					1	1										
<i>Axonopus fissifolius</i>	Narrow-leaved Carpet Grass	E			G	x		2	20	10	100					20		15	500	5	50
<i>Bothriochloa macra</i>		N			G											1	2				
<i>Briza subaristata</i>		E			G			15	100	30	500	5	100	20	500	10	30	10	500	3	10
<i>Bulbine bulbosa</i>	Native Leek	N			F															1	10
<i>Bursaria spinosa</i>	Blackthorn	N			S			1	1					1	1	5	10	5	8	10	20
<i>Casuarina glauca</i>	Swamp Oak	N			T			5	4												
<i>Chloris gayana</i>	Rhodes Grass	E			G		x									4	13	2	6		
<i>Cirsium vulgare</i>	Spear Thistle	E			F	x				1	2			1		1	1	1	2		
<i>Conyza bonariensis</i>	Flaxleaf Fleabane	E			F		x					1	10			1	3	1	3		
<i>Conyza</i> sp.		E			F			1	1	1	30									1	1
<i>Cymbopogon refractus</i>	Barbed Wire Grass	N			G		x							1	2	1	1				
<i>Cynodon dactylon</i>	Couch	E			G			1	4	20	500	40	1000	40	1000	40		40	1000		
<i>Cyperus</i> sp.		N			V															1	10
<i>Daviesia ulicifolia</i>	Gorse Bitter Pea	N			S															3	50
<i>Dianella longifolia</i>	Blueberry Lily	N			V															1	3
<i>Dianella</i> sp.		N			V	x	x							1	1	2	20				
<i>Dichondra repens</i>	Kidney Weed	N			F	x				1	6					5	100			1	500
<i>Digitaria</i> sp.		N			G							25	500								
<i>Dillwynia sieberi</i>		N			S			1	1												
<i>Einadia hastata</i>	Berry Saltbush	N			F													1	1		
<i>Eragrostis curvula</i>	African Lovegrass	E			G	x		5	20												

Scientific Name	Common Name	Native / Exotic / Planted	Noxious Weeds	WoNS	Growth Form	1	2	3		4		5		6		7		8		9	
								C	A	C	A	C	A	C	A	C	A	C	A	C	A
<i>Eucalyptus amplifolia</i>	Cabbage Gum	N			T			5	2	3	5										
<i>Eucalyptus amplifolia</i>	seedling	N			T			1	2												
<i>Eucalyptus moluccana</i>	Grey Box	N			T	x						2	2			10	1	5	1	5	2
<i>Eucalyptus tereticornis</i>	Forest Red Gum	N			T															20	20
<i>Eucalyptus</i> sp.	Juvenile stringybark	N			T					3	4										
<i>Galium aparine</i>	Goosegrass	E			F							1	5	1	10	1	2			1	10
<i>Glycine microphylla</i>	Small-leaf glycine	N			L	x															
<i>Glycine</i> sp.		N			L															1	3
<i>Glycine tabacina</i>		N			L	x															
<i>Goodenia hederacea</i>	Forest Goodenia	N			F															1	10
<i>Goodenia paniculata</i>	Branched Goodenia	N			F													1	1		
<i>Gomphocarpus</i> sp.		E			S	x															
<i>Hakea sericea</i>	Needlebush	N			S		x					2	50								
<i>Hypericum perforatum</i>	St. Johns Wort	E	Class 4		F					1	1	1	5							1	5
<i>Hypochaeris radicata</i>	Catsear	E			F			1	10							1	1			1	20
<i>Juncus</i> sp.		N			V	x															
<i>Ligustrum sinense</i>	Small-leaved Privet	E	Class 4		S			1	4												
<i>Lomandra filiformis</i> subsp. <i>filiformis</i>	Wattle Mat-rush	N			V	x	x			1	2	1	1			3	30	1	10	5	500
<i>Lomandra longifolia</i>		N			V			3	4	1	1							1	1		
<i>Lomandra multiflora</i>		N			V					1	3									2	10
<i>Lomandra</i> sp.		N			V		x					2	20	2	20						
<i>Melaleuca styphelioides</i>	Prickly-leaved Tea Tree	N			T					3	8										
<i>Microlaena stipoides</i>	Weeping Grass	N			G	x		15	100	5	50	5	100			2	20	5	50	20	100
<i>Opuntia stricta</i>	Prickly Pear	E	Class 4	Y	F															1	3
<i>Oxalis perennans</i>		N			F	x															
<i>Panicum effusum</i>	Hairy Panic	N			G					1	1										
<i>Paspalidium</i> sp.		N			G	x															
<i>Paspalum dilatatum</i>	Paspalum	E			G	x	x	1	20	5	30	5	50	5	50	2		15	100		
<i>Plantago lanceolata</i>	Lamb's Tongues	E			F	x		1	3	1	5					1	3				
<i>Romulea</i> sp.		E			G			1	50	1	50			1				1	10	1	20
<i>Rytidosperma</i> sp.		N			G											1	1				
<i>Senecio hispidulus</i>	Hill Fireweed	N			F	x															
<i>Rumex</i> sp.		E			F			1	1												
<i>Senecio madagascariensis</i>	Fireweed	E	Class 4	Y	F	x	x			1	10	1	5	2	100	1	10	2	50	2	20
<i>Senecio</i> sp.		N																1	1		
<i>Setaria parviflora</i>		E			G	x	x			5	50	20	500	20	500	5	50	10	500		
<i>Sida rhombifolia</i>	Paddy's Lucerne	E			F	x										2	30				
<i>Solanum nigrum</i>	Black-berry Nightshade	E			F													1	2		
<i>Solanum</i> sp.		E			F	x						1	2					1	1		
<i>Sporobolus creber</i>	Western Rat-tail Grass	N			G									1	1	1	2				
<i>Sporobolus</i> sp.		E			G											1	2				
<i>Themeda triandra</i>	Kanagaroo Grass	N			G	x	x			5	10			1	1	1	1	1	2	20	100

Scientific Name	Common Name	Native / Exotic / Planted	Noxious Weeds	WoNS	Growth Form	1	2	3		4		5		6		7		8		9	
								C	A	C	A	C	A	C	A	C	A	C	A	C	A
<i>Trifolium</i> sp.		E			F															1	1
<i>Verbena bonariensis</i>	Purpletop	E			F		x	1	2												
<i>Verbena</i> sp.		E			F													2	30		

Appendix E Fauna species recorded

The fauna list includes species recorded from opportunistic surveys and Anabat survey.

Table 16: Fauna species list recorded during the field survey

	Common Name	Scientific Name	Observation Type
AVES			
1	Common Myna	<i>Acridotheres tristis*</i>	O
2	Yellow-tailed Black-Cockatoo	<i>Calyptorhynchus funereus</i>	O
3	Black-faced Cuckoo-shrike	<i>Coracina novaehollandiae</i>	O
4	Australian Raven	<i>Corvus coronoides</i>	O
5	Australian Magpie	<i>Cracticus tibicen</i>	O
6	White-faced Heron	<i>Egretta novaehollandiae</i>	O
7	Superb Fairy-wren	<i>Malurus cyaneus</i>	O
8	Noisy Miner	<i>Manorina melanocephala</i>	O
9	Golden Whistler	<i>Pachycephala pectoralis</i>	O, W
10	Willie Wagtail	<i>Rhipidura leucophrys</i>	O
AMPHIBIAN			
11	Common Eastern Froglet	<i>Crinia signifera</i>	W

O denotes observed, W denotes heard.

Appendix F Study area description

Description	The site consists of the southern portion of Western Sydney Parklands Bungarribee Precinct. The Bungarribee precinct has been subject to an extensive history of intense grazing and vegetation clearance. Remnant vegetation occurs as scattered trees and along Eastern Creek. Systematic planting has extended vegetation coverage within the riparian corridor and the species diversity within the study area. The following vegetation communities were identified occurring in the site: 1. Cumberland Plain Woodland 2. Derived Native Grassland 3. River-flat Eucalypt Forest 4. Exotic Grassland
Condition	Overall the majority of the site is poor to moderate condition as the site has been subjected to historical clearing and grazing. The majority of the site is regrowth or planted vegetation. The only good condition vegetation occurs in the east of the site and is part of a larger stand of vegetation to the north of the site.
Threatened species of plant?	No threatened plant species were found at this site and potential habitat is primarily limited to the vegetation on the eastern boundary of the site.
Threatened community?	This site contains two threatened communities Cumberland Plain Woodland and River-flat Eucalypt Forest. Cumberland Plain Woodland exists as single remnant trees and intact woodland in the east of the study area. The NSW Scientific Committee's final determination for CPW has identified that a significant proportion of the remaining CPW in western Sydney has been substantially modified and fragmented. Under the TSC Act, remnant trees that represent diagnostic canopy species which may or may not contain a native ground cover or shrub layer, constitute the CPW vegetation community listed under the TSC Act (NSW Scientific Committee 2009). Derived Native Grassland' (DNG) is also a component of the CPW. It is acknowledged that DNG forms part of CPW woodlands. Due to anthropogenic disturbances the canopy and shrub layer have been cleared leaving predominantly native grassland. DNG is listed under the TSC Act as a component of CPW. It is not, however, recognised as a sub-community of CPW under the EPBC Act. DNG is represented where native perennial grasses occur at higher densities than exotic grasses. Remnant River-flat Eucalypt Forest was recorded on either side of Eastern Creek. The vegetation is generally in moderate condition. Planted RFEF is located within the floodplain which represents the natural distribution of this community prior to vegetation clearance. The plantings are consistent to the RFEF species assemblage; however, has not achieved the habitat complexity which can be found within remnant RFEF.

Photos



Cumberland Plain Woodland (May 2015). Note mixture of native and exotic ground layer with absent shrub layer.



Derived Native Grassland



River-flat Eucalypt Forest



Planted River-flat Eucalypt Forest



Exotic Grassland

Appendix G EPBC Act Significant Impact Criteria

The proposed construction footprint of the project supports areas of native vegetation and potential and habitat for four threatened fauna species. A full list of species and threatened communities recorded within a five kilometre radius of the construction footprint is found in **Appendix A**. However, not all of these communities, species or their habitats are likely to be impacted by the project. Potentially impacted species and communities are listed below. Each has been assessed for potential impacts that may result from the project.

Threatened Ecological Communities

- Cumberland Plain Shale Woodlands and Shale-Gravel Transition Forest (CPW)

Threatened Fauna

- *Pteropus poliocephalus* (Grey-headed Flying-fox)
- *Apus pacificus* (Fork-tailed Swift)
- *Ardea alba* (Great Egret)
- *Ardea ibis* (Cattle Egret)

THREATENED ECOLOGICAL COMMUNITIES

Cumberland Plain Woodland (Shale Plains Woodland)

The Cumberland Plain Woodland is listed under the EPBC Act as a Critically Endangered Ecological Community.

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

a) reduce the extent of an ecological community

The proposed zoo and associated infrastructure (i.e. car park and roads) will remove 0.08 ha of CPW listed under the EPBC Act. This includes removal of native canopy, shrubs and ground layer species. This represents 41 % of the total CPW listed under the EPBC Act within the study area. The removal of 0.07 ha of CPW will be subject to an offset agreement. Additional CPW planted species will be conducted to increase the extent of CPW and connectivity within the study area.

b) fragment or increase fragmentation of an ecological community, for example by clearing vegetation for roads or transmission lines

There are several small patches of CPW mapped within the study area. These patches are currently isolated from each other and separated by a matrix of exotic grasses.

The proposed zoo layout has tried to avoid impacts to the majority of the CPW mapped within the study area. Where possible, the larger patches of CPW will be retained. Under the proposed works approximately 0.08 ha of CPW which satisfies the criteria for listing under the EPBC Act will be permanently removed. The remaining 0.09 ha of CPW will be retained within the study area and incorporated into the zoo's landscaping. Given that the CPW is already fragmented it is unlikely that the proposed zoo will further increase the risk of fragmentation within the study area.

Furthermore, in the broader locality a substantial amount of CPW has been conserved within the Bungarribee Precinct located directly north and east of the study area. Therefore, the proposed zoo will not fragment or increase fragmentation of CPW with the broader locality.

c) adversely affect habitat critical to the survival of an ecological community

No critical habitat has been identified under the EPBC Act for CPW. However, for the long-term survival of this ecological community, it is important to maintain species diversity, connectivity and reduce weed invasion of CPW retained within the study area.

The remaining patches of CPW to be retained within the study area contain moderate native species diversity. These patches of CPW will be incorporated into the animal enclosures. Consideration has been made into the selected species which will reduce impacts to the CPW. The proposed works are unlikely to result in a loss of species diversity within the study area.

Connectivity between CPW patches within the study area is poor. It is unlikely that the proposed zoo will further reduce connectivity as supplementary CPW plantings has been considered within the Masterplan. Management of weeds requires trained bush regenerators to implement and a NSW Scientific License.

d) modify, 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

There is potential that the construction of pathways and the car park may result in minor alteration of surface water drainage patterns across the study area. This may result in an increase in nutrient and sediment flow into the remaining CPW. During construction a sediment and erosion control plan will be implemented to reduce impacts on CPW. Following the construction phase the pathways and car park are unlikely to have a significant impact on the factors necessary for the long-term survival of CPW within the study area, as it will not significantly impact on the groundwater levels or substantially alter the surface water drainage patterns.

- e) 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 and fauna harvesting.**

The proposed works will remove a small extent (0.08 ha) of CPW listed under the EPBC Act. This consists of several isolated patches of CPW. The remaining 0.09 ha will be retained in two larger patches within the study area. The patches contain moderate native species diversity which will be retained as part of the proposed zoo enclosures. Consideration has been given into the type of fauna species to be housed within CPW to limit impacts of grazing or ring-barking of trees. The proposed works are unlikely to substantially change the species composition within the CPW to be retained. The CPW patches do not represent significant species and no burning or harvesting will be conducted as part of the proposed works.

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

- I. assisting invasive species, that are harmful to the listed ecological community, to become established, or**
- II. causing regular mobilisation of fertilisers, herbicides or other chemicals or pollutants into the ecological community which kill or inhibit the growth of species in the ecological community, or**

The local occurrence of CPW in this situation is defined as the entire CPW mapped within the study area. Although the CPW listed under the EPBC Act contains reasonable native species diversity, the vegetation is fragmented within a disturbed environment.

Invasive species which have potential to reduce the quality or integrity include noxious and Weeds of National Significance (WoNS). These weeds were widely distributed in the study area. The proposed zoo will ensure the removal of all noxious weeds and WoNS. Additionally, given that the proposed works will involve the housing of animals it is unlikely that excessive use of harmful chemicals will occur within the study area.

- g) Criterion g: interfere with the recovery of an ecological community.**

There is no recovery plan for CPW under the EPBC Act. However, the Cumberland Plain Recovery Plan under the TSC Act (DECCW 2011) should be used in the recovery process of this species. The NSW Recovery Plan has the overall objective of providing for the long-term survival and protection of the threatened biodiversity of the Cumberland Plain. The works do not conflict with the objectives set out in the draft plan.

Conclusion

Based on the above criteria, it is unlikely that the proposed works will lead to a significant impact on EPBC Act listed CPW, and therefore, a referral to the Commonwealth is not required.

THREATENED FAUNA

Pteropus poliocephalus (Grey-headed Flying-fox)

1. Lead to a long-term decrease in the size of an important population of the species

Foraging for the Grey-headed Flying-fox populations occurs within a 50 km radius around known camp sites. Available foraging resources include: street trees, urban bushland and conservation reserves. The proposed works are unlikely to impact on the long-term population such that the size of the population would be decreased as no known camps exist within or adjacent the study area.

Under the proposed works a small amount of habitat will be removed including canopy trees. These trees may be used for the Grey-headed Flying-fox as foraging habitat and occasionally roosting habitat. The amount of habitat to be affected is small given the amount of vegetation available in the local area. No individuals or camps of Grey-headed Flying-fox were recorded in the impact area and the site would only be used on occasion as foraging or roosting habitat. The proposed works will not impact on any part of a known camp.

Given that foraging habitat exists in the surrounding landscape, and that this species is wide-ranging (traveling up to 50 km in one night), the proposed works are unlikely to affect any populations of this species that would lead to a long-term decrease in the size of an important population of this species.

2. Reduce the area of occupancy of an important population

A number of camps in the Sydney Basin support important populations. The area of occupancy for these populations is dynamic with individuals moving between bat camps throughout Sydney. Additionally, during foraging, individuals may travel up to 50 km a night. This species is highly mobile and populations at each camp may change during seasonal fluctuations.

Under the proposal the amount of clearing is restricted to groundcover, shrub layer and some canopy trees which represent potential foraging resources. However, these impacts are unlikely to reduce the area of occupancy for these populations given the availability of foraging and roosting habitat present in adjacent areas and the highly mobile nature of this species.

3. Fragment an existing important population into two or more populations

Grey-headed Flying-fox populations in the Sydney Basin are highly dynamic with individuals moving between permanent camps to utilise foraging resources, although they will return to traditional camps to rear offspring. Individuals are highly mobile and populations are not static.

No known camps or an important population will not be fragmented under the proposed actions. Trees will be retained within the study area. Furthermore proposed planting will increase the amount of potential foraging habitat in the study area. Therefore the proposed actions are unlikely to fragment any existing important population into two or more populations.

4. Adversely affect habitat critical to the survival of a species

As the proposed works would not disrupt any known camp, it would be unlikely to create a barrier to movement, and would only result in removing a small amount of foraging habitat (0.83 ha) relative to the availability of foraging habitat in the study area (3.29 ha). Therefore, it is unlikely that habitat critical to the survival of this species would be adversely affected.

5. Disrupt the breeding cycle of an important population

As no roosting habitat would be removed or disturbed as part of the works, it is unlikely that the breeding cycle of an important population that roosts at any of the Sydney camps will be impacted.

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

As no campsites would be removed or disturbed, and extensive foraging habitat exists outside of the site, the proposed works would be unlikely to modify, destroy, remove, or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.

7. Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat

The proposal would not result in invasive species, such as weeds, that would be harmful to Grey-headed Flying Fox. It is unlikely that the proposed works will result in an increased number of weeds due to the current disturbed nature of the site and the recommended mitigation measures.

8. Introduce disease that may cause the species to decline, or

Grey-headed Flying-foxes are reservoirs for the Australian bat lyssavirus (ABL) and can cause clinical disease and mortality in GHFF (DECCW 2009). The proposed works is unlikely to present a significant ecological stress on known individuals or camps utilizing the subject site and therefore unlikely to affect this species. The proposed work would be unlikely to introduce a disease that may cause this species to decline.

9. Interfere substantially with the recovery of the species.

A Draft National Recovery Plan for the Grey-headed Flying-fox was developed in 2009. As no maternity camps would be removed and that the proposed works will only result in the removal of a small amount of potential foraging habitat relative to the surrounding landscape, it is considered unlikely that the proposed works will interfere with the recovery of this species.

Is a significant impact on the species likely to result?

The proposal will not affect known breeding habitat and will only impact on a relatively small amount of potential foraging for this species. No important populations would be isolated or fragmented and the life cycle of this species is not likely to be affected.

Therefore, the proposal is no likely to have a significant impact on this species and a Referral is not required.

Apus pacificus (Fork-tailed Swift)

The Fork-tailed Swift is listed as a migratory marine species under the EPBC Act, and is included in the Japan-Australia Migratory Bird Agreement (JAMBA), the China-Australia Migratory Bird Agreement (CAMBA), and the Republic of Korea-Australia Migratory Bird Agreement (ROKAMBA) (DotE 2015).

In Australia, they mostly occur over inland plains but sometimes above foothills or in coastal areas. They often occur over cliffs and beaches and also over islands and sometimes well out to sea. They also occur over settled areas, including towns, urban areas and cities. They mostly occur over dry or open habitats, including riparian woodland and tea-tree swamps, low scrub, heathland or saltmarsh. They are also found at treeless grassland and sandplains covered with spinifex, open farmland and inland and coastal sand-dunes. They sometimes occur above rainforests, wet sclerophyll forest or open forest or plantations of pines.

In NSW, the Fork-tailed Swift is recorded in all regions. Many records occur east of the Great Divide, however, a few populations have been found west of the Great Divide. These are widespread but scattered further west of the line joining Bourke and Dareton. Sightings have been recorded at Milparinka, the Bulloo River and Thurloo Downs. The species has been recorded as occasionally travelling with Needletails (e.g. *Hirundapus caudacutus*).

They forage aerially, up to hundreds of metres above ground, but also less than 1 m above open areas or over water. The species food items within Australia are not well known, however, the Fork-tailed Swift is known to be insectivorous. Studies have recorded the Swift eating small bees, wasps, termites and moths (DotE 2015).

The Fork-tailed Swift does not breed in Australia, they breed in Siberia from August to September. They migrate to Australia following breeding and are commonly seen in NSW between October and March (DotE, 2015).

An action is likely to have a significant impact on a migratory species if there is a real chance or possibility that it will meet any of the following criteria:

- 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;**

It should be noted that according to the MNES assessment an “area of important habitat for a 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; and/or*
- *Habitat that is of critical importance to the species at particular life-cycle stages; and/or*
- *Habitat utilised by a migratory species which is at the limit of the species’ range; and/or*
- *Habitat within an area where the species is declining.*

The Forked-tailed Swift may utilise the vegetative and open grasslands within the study area as potential foraging habitat. This species may also forage over the adjacent Bungarribee Precinct located outside the study area. The proposal would result in the removal of foraging habitat for the species including up to 13.06 ha of grassland and 0.82 ha of vegetative areas. The remaining 2.47 ha vegetative areas and 0.15 ha open grasslands will be retained within the study area. This is unlikely to substantially modify

destroy or isolate an area of important habitat for a migratory species as the study area does not represent important habitat for this species for the following reasons:

- this species is an occasional visit and last recorded in 1983 within the locality and is not considered an ecologically significant proportion of its population
- this species is a non-breeding visitor so no impact will occur to its life-cycle
- this species is located throughout NSW and therefore it is not located at the limit of its range
- there is no evidence that this species is declining within this area

The removal of vegetation would not represent a substantial loss and / or fragmentation of foraging habitat for the species, with the species unlikely to be reliant on the resources present in the study area and able to use other areas due to its highly mobile nature.

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;

The proposal is unlikely to result in the establishment of an invasive species that is harmful to Fork-tailed Swift. Mitigation measures have been provided to prevent the spread of or introduction of new weed propagules into adjacent areas, such as sediment fencing.

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

The proposal is unlikely to seriously disrupt the lifecycle of an ecologically significant proportion of the population of Fork-tailed Swift. The Fork-tailed Swift is a non-breeding migrant to Australia. Breeding occurs in Siberia.

This species is an aerial forager and even roosts aerially. Therefore, the removal of vegetation within the study area will not impact on foraging or resting behaviour. Furthermore, due to its aerial nature and the proposed zoo and associated car parking facilities will not impact on migration patterns of this species.

Therefore, the proposed works should not disrupt the lifecycle of the Forked-tailed Swift. As such, a referral is not required for this species.

Ardea alba* (Great Egret)*1. Substantially modify (including by fragmenting, altering fire regimes, altering nutrient cycles or altering hydrological cycles), destroy or isolate an area of important habitat for a migratory species;**

The Great Egret is not susceptible to fragmentation of habitats as this species is highly mobile and will utilise urban environments (outside breeding season). Other disturbances include loss of foraging habitat and alteration of water flow. Under the proposal 13.64 ha of potential foraging habitat within a mixture of exotic and native grassland will be removed to accommodate infrastructure for the proposed Zoo and associated infrastructure such as car parking. The proposed works will result in a temporary disturbance to this species during the construction of the Zoo and ongoing human disturbance. However extensive areas of habitat for this species will remain within the remaining Bungarribee Precinct, 2.22 ha of which will remain within the study area and will provide potential foraging habitat for this highly mobile and wide ranging species.

2. 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

Introduced fauna and exotic weeds have been identified within the study area. It is unlikely that the proposed works will result in an increase of invasive species becoming established in the locality. Mitigation measures have been provided to prevent the spread of or introduction of new weed propagules into adjacent areas, such as sediment fencing.

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

The Great Egret forms large breeding colonies, the largest known colony occurs in Northern Territory. Other minor breeding colonies are known in north-eastern NSW and other states. Non-breeding individuals have been recorded over most of mainland Australia. Breeding habitats include mangroves and swamps. One record of breeding of individuals was noted at Shortland in NSW. However, this is generally a rare occurrence.

No potential breeding habitat was identified within the study area. The study area does provide suitable foraging and roosting habitat for this species. These actions are unlikely to seriously disrupt the lifecycle of this species. As such referral is not recommended for this species.

***Ardea ibis* (Cattle Egret)**

Ardea ibis (Cattle Egret) is listed as a migratory species under the EPBC Act.

The Cattle Egret is widespread in Australia, though a relatively recent migrant to Australia. The Cattle Egret occurs in tropical and temperate grasslands, wooded lands and terrestrial wetlands. It has occasionally been seen in arid and semi-arid regions however this is extremely rare. High numbers have been observed in moist, low-lying poorly drained pastures with an abundance of high grass; it avoids low grass pastures. The Cattle Egret has a diverse diet, which includes fish, macroinvertebrates, frogs, lizards, snakes and small birds and mammals (DotE 2015).

An action is likely to have a significant impact on a migratory species if there is a real chance or possibility that it will meet any of the following criteria:

- 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;**

Cattle Egret has not been previously recorded within the study area. This species is known to occupy disturbed habitats including agricultural grazing lands and urban landscapes. Therefore, grasslands and fringing riparian vegetation within the study area has been identified as potential foraging habitat for this species.

It is unlikely that the removal of 13.06 ha of grasslands (native and exotic) will substantially modify, destroy or isolate an area of important habitat for this species for the following reasons:

- no important habitat has been identified for this species within the study area (i.e. no breeding habitat)
- this species is highly mobile and capable of utilising urban and disturbed environments
- vegetation within the adjacent Bungarribee Precinct contains suitable habitat for this species and will not be impacted under the proposed works.

Therefore, the action is unlikely to significant impact this 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;**

Introduced fauna and exotic weeds have been identified within the study area. It is unlikely that the proposed works will result in an increase of invasive species becoming established in the locality. Mitigation measures have been provided to prevent the spread of or introduction of new weed propagules into adjacent areas, such as sediment fencing.

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

The Cattle Egret is widely distributed across Australia. It forms breeding colonies with other Cattle Egrets or similar species such as herons. Breeding sites have been located from Newcastle to Bundaberg in Mangroves or Melaleuca Swamps. No breeding habitat has been recorded within the study area or in the broader locality nor will be impacted by the proposed works.

Foraging occurs in tall grass on poorly drained soils which includes 0.83 ha of native grasslands (DNG) and 12.22 ha of exotic grasslands which will be removed under the proposed works. A small proportion

of the grasslands will be retained (0.06 ha) within the study area. Additionally, Bungaribee Precinct to the north of the study area contains large areas of suitable foraging habitat for this species. Therefore, foraging habitat will not be substantially reduced in the locality for the Cattle Egret.

This species is also highly mobile and is likely to forage in adjacent habitats. The removal of vegetation within the study area will not impact on this species ability to migrate to new habitats.

Therefore, the proposed works should not disrupt the lifecycle of the Cattle Egret. As such, a referral is not required for this species.

Appendix H FBA Methodology and where addressed in document

Table 17: Location of FBA methodology requirements for a 'Biodiversity Assessment Report' and where these are addressed in this report

Report section	Information	Maps & data	FBA reference	Section in this Report
Introduction	Introduction to the biodiversity assessment including: • identification of development site footprint, including: ◦ operational footprint ◦ construction footprint indicating clearing associated with temporary construction facilities and infrastructure • general description of development site • sources of information used in the assessment, including reports and spatial data.	• Site Map (as described in Section 3.2) • Location Map (as described in Section 3.2) • Digital shape files for all maps and spatial data	Chapter 3 and Section 3.2	Chapter 1 – Introduction and Chapter 2 Methodology Appendix F -study area description with photographs.

Report section	Information	Maps & data	FBA reference	Section in this Report
Landscape features	Identification of landscape features at the development site, including: • IBRA bioregions and subregions, NSW landscape region and area (ha) • native vegetation extent in the outer assessment circle or buffer area • cleared areas • evidence to support differences between mapped vegetation extent and aerial imagery • rivers and streams classified according to stream order • wetlands within, adjacent to and downstream of development site • landscape value score components, including: ○ identification of method applied (i.e. linear or site-based) ○ percent native vegetation cover in the landscape ○ connectivity value ○ patch size ○ area to perimeter ration • landscape value score.	• IBRA bioregions and subregions (as described in Paragraphs 4.1.1.3–4) • NSW landscape regions (as described in Paragraphs 4.1.1.5–6) • Rivers and streams (as described in Paragraphs 4.1.1.8–10) • Wetlands (as described in Paragraphs 4.1.1.11–13) • Other landscape features (as required by SEARs) • Native vegetation extent (as described in Paragraphs 4.1.1.12–15) • State, regional and local biodiversity links (as described in Paragraphs 4.1.1.16–17) • Regional vegetation used to calculate patch size	Section 4.1, Appendix 4 and Appendix 5	Chapter 3 – Landscape features

Report section	Information	Maps & data	FBA reference	Section in this Report
Native vegetation	Identify native vegetation extent within the development site, including cleared areas and evidence to support differences between mapped vegetation extent and aerial imagery. Describe PCTs within the development site, including: • vegetation class • vegetation type • area (ha) for each vegetation type • species relied upon for identification of vegetation type and relative abundance • justification of evidence used to identify a PCT (as outlined in Paragraph 5.2.1.8) • EEC status (as outlined in Subsection 5.2.1) • estimate of percent cleared value of PCT. Describe vegetation zones within the development site, including: • condition class and subcategory (where relevant) • area (ha) for each vegetation zone • survey effort as described in Paragraphs 5.2.1.5–7 (number of plots/transects). Where use of local data is proposed: • identify relevant vegetation type • identify source of information for local benchmark data • justify use of local data in preference to database values.	• Map of native vegetation extent within the development site (as described in Section 5.1) • Map of PCTs within the development site • Map of condition class and subcategory (where relevant) • Map of plot and transect locations relative to PCTs and condition class • Map of EECs • Plot and transect field data (MS Excel format) • Plot and transect field data sheets • Table of current site value scores for each vegetation zone within the development site • Map of vegetation zones with a current site value score of <17.	Chapter 5	Chapter 2 – Methodology for details on methods, Appendix B, C, D and E for details on species data and plot sheets. Chapter 4 – Native vegetation

Report section	Information	Maps & data	FBA reference	Section in this Report
Threatened species	Identify ecosystem credit species associated with PCTs on the development site as outlined in Section 6.3, including: • list of species derived • justification for exclusion of any ecosystem credit species predicted above. Identify species credit species on the development site as outlined in Sections 6.5 and 6.6, including: • list of candidate species • justification for inclusions and exclusions based on habitat features • indication of presence based on targeted survey or expert report • details of targeted survey technique, effort, timing and weather • species polygons • species that cannot withstand a further loss. Where use of local data is proposed: • identify relevant species or population • identify aspect of species/population data • identify source of information for local data • justify use of local data in preference to database values. Where expert reports are used in place of targeted survey: • identify the relevant species or population • justify the use of an expert report • indicate and justify the likelihood of presence of the species or population and information considered in making this assessment • estimate the number of individuals or area of habitat (whichever unit of measurement applies to the species/individual) for the development site, including a description of how the estimate was made • identify the expert and provide evidence of their expert credentials.	• Table of vegetation zones and landscape Tg values, particularly indicating where these have changed due to species exclusion • Targeted survey locations • Table detailing the list of species credit species and presence status on site as determined by targeted survey, indicating also where presence was assumed and/or where presence was determined by expert report • Species credit species polygons (as described in Paragraph 6.5.1.19) • Table detailing species and habitat feature/component associated with species and its abundance on site (as described in Paragraph 6.5.1.19) • Species polygons for species that cannot withstand a loss	Chapter 6	Chapter 2 – methodology for survey details Chapter 5 – Threatened Species Appendix A likelihood of occurrence for EPBC Act species.

Report section	Information	Maps & data	FBA reference	Section in this Report
Avoid and minimise impacts	Demonstration of efforts to avoid and minimise impact on biodiversity values in accordance with Section 8.3. Identification of final project footprint during construction and operation in accordance with Subsection 8.3.3. Assessment of direct and indirect impacts unable to be avoided at the development site in accordance with Sections 8.3 and 8.4. The assessment would include but not be limited to: type, frequency, intensity, duration and consequence of impact. Statement of onsite measures proposed to avoid and minimise direct and indirect impacts of the Major Project.	• Table of measures to be implemented before, during and after construction to avoid and minimise the impacts of the project, including action, outcome, timing and responsibility • Map of final project footprint, including construction and operation • Maps demonstrating indirect impact zones where applicable	Chapter 8	Chapter 6 – Avoidance and mitigation measures Chapter 7 – Assessment of impacts

Report section	Information	Maps & data	FBA reference	Section in this Report
Impact summary	Identification of areas not requiring assessment in accordance with Section 9.5. Identification of areas not requiring offset in accordance with Section 9.4. Identification of PCTs and species polygons requiring offset in accordance with Section 9.3. Identification of impacts that require further consideration in accordance with Section 9.2, including: • the entity and/or impact for which further consideration is necessary • supporting information relevant to the impact, as outlined in Subsection 9.2.2. Ecosystem credits and species credits that measure the impact of the Major Project on biodiversity values at the development site, including: • future site value score for each vegetation zone at the development site • change in landscape value score • number of required ecosystem credits for the impact of development on each vegetation zone at the development site • number of required species credits for the impact of development on each threatened species that occurs on the development site.	• Map of areas not requiring assessment • Map of PCTs and species polygons not requiring offset • Map of PCTs and species polygons requiring offset • Map of the occurrence of the entity or impact that requires further consideration • Table of PCTs requiring offset and the number of ecosystem credits required • Table of species and populations requiring offset and the number of species credits required • Full biodiversity Credit Calculator output • Submitted proposal in the Credit Calculator	Chapter 9 Subsections 10.4.3 and 10.4.4	Chapter 8 – Impact summary and offsets
Biodiversity credit report	Credit profiles for ecosystem credits and species credits at the development site.	• Table of credit type and matching credit profile • Biodiversity credit report from the Credit Calculator	Subsection 10.4.5	Chapter 9 – Summary and biodiversity credit report

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