OAKDALE WEST ESTATE STATE SIGNIFICANT DEVELOPMENT

Biodiversity Assessment Report

For:

Goodman Property Services (Aust) Pty Ltd

March 2017

Final Report

cumberland ecology

PO Box 2474
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Report No. 15122RP1

The preparation of this report has been in accordance with the brief provided by the Client and has relied upon the data and results collected at or under the times and conditions specified in the report. All findings, conclusions or recommendations contained within the report are based only on the aforementioned circumstances. The report has been prepared for use by the Client and no responsibility for its use by other parties is accepted by Cumberland Ecology.

Version	Date Issued	Amended by	Details
001	15/02/2016	LH	First Draft
002	15/04/2016	LH	Second Draft
003	02/06/2016	GK	Final Draft
004	22/09/2016	GK	Draft – peer review comments
005	25/10/2016	GK	Final draft
006	5/11/2016	GK	Final – updated masterplan amendments
007	1/12/2016	GK	Final draft: Fitzpatrick land amendments
008	5/12/2016	GK	Final: Fitzpatrick land amendments
009		GK	Final draft: Western Boundary amendments
010	31/03/2017	VO	Final – Peer Review Amendments

Approved by: David Robertson

Position: Director

Signed: David Robertson

Date: *31 March, 2017*

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Glossary of Terms

BAR	Biodiversity Assessment Report
BBAM	BioBanking Assessment Methodology
BBCC	BioBanking Credit Calculator
BOS	Biodiversity Offset Strategy
CEEC	Critically Endangered Ecological Community
DoE	Commonwealth Department of the Environment
DP&E	NSW Department of Planning and Environment
EEC	Endangered Ecological Community
EIS	Environmental Impact Statement
EP&A Act	NSW *Environmental Planning and Assessment Act 1979*
EPBC Act	Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*
FBA	Framework for Biodiversity Assessment
FM Act	NSW *Fisheries Management Act 1994*
GDE	Groundwater Dependent Ecosystem
GIS	Geographic Information System
GPS	Global Positioning System
LGA	Local Government Area
MNES	Matters of National Environmental Significance
NSW	New South Wales
OEH	NSW Office of Environment and Heritage
PCT	Plant Community Type
Penrith DCP 2014	Penrith Development Control Plan 2014
the Project	The staged development of a warehouse and distribution complex within the Oakdale West precinct of the broader Oakdale Estate which is located within the Western Sydney Employment Area
SEARs	Secretary's Environmental Assessment Requirements
SSD	State Significant Development
SSDA	State Significant Development Application
TEC	Threatened Ecological Community
TSC Act	NSW *Threatened Species Conservation Act 1995*
WSEA SEPP	NSW *State Environmental Planning Policy (Western Sydney Employment Area) 2009*

Executive Summary

S1 Introduction

Cumberland Ecology was commissioned by Goodman Property Services (Aust) Pty Ltd (Goodman) to prepare a Biodiversity Assessment Report (BAR) for Oakdale West Estate State Significant Development (the 'Project') Masterplan. The Project involves the staged development of a warehouse and distribution complex. This BAR, in conjunction with the Biodiversity Offset Strategy (BOS) will form part of the Environmental Impact Statement (EIS) being prepared for Goodman to support an application for State Significant Development Consent under Division 4.1 of Part 4 of the New South Wales (NSW) *Environmental Planning and Assessment Act 1979* (EP&A Act).

The purpose of this BAR is to assess the potential impacts of the proposed development on flora and fauna. This BAR has been prepared in accordance with the New South Wales (NSW) *Framework for Biodiversity Assessment* (NSW Government, 2014a) and responds to the Secretary's Environmental Assessment Requirements (SEARs) as they relate to flora and fauna.

S2 Project Description

The Project is located within the Oakdale West precinct of the broader Oakdale Estate which is located within the Western Sydney Employment Area as identified under the NSW *State Environmental Planning Policy (Western Sydney Employment Area) 2009* (WSEA SEPP). The project is located within Penrith Local Government Area (LGA) and the nearest town centres are Erskine Park and Horsley Park which are both approximately 6 km west and east respectively from the Project.

The Project seeks to facilitate the development of the Oakdale West precinct and represents the third stage of development of the broader Oakdale Estate into a regional warehousing and distribution hub. The Project also involves the construction of a North/South Link Road between the proposed Oakdale West Warehouse hub and the Erskine Park East-West Link Road as identified in the WSEA SEPP.

The Project comprises a State Significant Development (SSD) and has been assessed in accordance with the requirements of the *NSW Biodiversity Offsets Policy for Major Projects* and associated Framework for Biodiversity Assessment (FBA).

The main warehouse hub of the Oakdale West development is located on land owned by Goodman while the North/South Link Road runs through lands to the north of the Goodman land. The majority of the North/South Link Road passes though land owned by Fitzpatrick Investments Pty Ltd (Fitzpatrick) which forms part of the Erskine Park Employment Area. As the Fitzpatrick land has previously been assessed for ecological impacts and has received

approval for development subject to the creation of a conservation zone, the area of the SSD Application that lies within the Fitzpatrick lands is not considered as part of the development site in this BAR.

S3 Summary of Impacts of the Project

The development site is largely located within grassland used for cattle grazing so as to minimise environmental impacts to vegetation. Approximately 95% of the vegetation within the development area comprises low diversity/exotic grassland or planted native vegetation that does not meet the determination of a native Plant Community Type (PCT) with the remaining 5% comprising Critically Endangered and Endangered Ecological Communities (C/EECs). These C/EECs consist of remnant patches of fragmented, degraded and isolated vegetation. As such; it is unlikely that such small areas of C/EECs are viable in the future if left in their current state.

The proposal will unavoidably remove 4.93 ha of native vegetation and 111.31 ha of immature planted vegetation and exotic vegetation from the development site. The native vegetation conforms to four PCTs that are threatened ecological communities listed under the *NSW Threatened Species Conservation Act 1995* (TSC Act) and *Commonwealth Environmental Protection and Biodiversity Conservation Act 1999* (EPBC Act):

- HN526 Forest Red Gum - Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney Basin (TSC Act EEC);
- HN528 Grey Box - Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin (TSC Act CEEC and EPBC Act CEEC);
- HN529 Grey Box - Forest Red Gum grassy woodland on shale of the southern Cumberland Plain, Sydney Basin Bioregion (TSC Act CEEC and EPBC Act CEEC); and
- HN594 Swamp Oak swamp forest fringing estuaries, Sydney Basin Bioregion and South East Corner Bioregion (TSC Act EEC).

A total of 24 *Grevillea juniperina* subsp. *juniperina* (Juniper-leaved Grevillea) individuals, listed as vulnerable under the TSC Act, were located within the Link Road footprint on Fitzpatrick land. The offsetting for the removal of these individuals forms part of the approvals for the development of the Fitzpatrick land and further offsetting of these individuals is not considered in this BAR.

The impacts of the Project on CEECs and EECs are to be offset by a combination of establishment of a Biobank site and purchase and retirement of credits not generated at the Biobank site. These measures are detailed in the BOS for the Project (Cumberland Ecology, 2017)

Chapter 1

Introduction

Cumberland Ecology was commissioned by Goodman Property Services (Goodman) to prepare a Biodiversity Assessment Report (BAR) of the Masterplan of the Oakdale West Estate Project (the 'Project').

1.1 Purpose

This BAR has been prepared to inform a State Significant Development (SSD) Application for the staged development of the Project. The aim of the BAR is to assess the potential impacts of the proposed development on flora and fauna and has been prepared in accordance with the New South Wales (NSW) *Framework for Biodiversity Assessment* (NSW Government, 2014a). The report responds to the Secretary's Environmental Assessment Requirements (SEARs) as they relate to flora and fauna. The SEARs relevant to this SSD have been considered and are addressed in this report are shown in **Table 1.1**.

This report supports an Environmental Impact Statement (EIS) prepared for the Project and should be read in conjunction with the EIS and development plans submitted with the SSDA.

Table 1.1 Relevant SEARS addressed in the BAR

Relevant SEARS	Response
Details of the quantity and type of any vegetation to be cleared	This report includes identification and description of plant community types that exist within the Project detailed in Section 4.4 and 4.5.
An assessment of impacts (direct or indirect) on threatened species, populations, ecological communities (including groundwater dependent ecosystems) and their habitat, critical habitat (including riparian habitat) and native vegetation in accordance with the Framework for Biodiversity Assessment (Oct 2014)	An assessment of impacts on threatened species, populations, ecological communities and their habitat in accordance with the Framework for Biodiversity Assessment has been undertaken and are included in Chapter 5.
Proposed measures to avoid, mitigate or offset any significant impacts in accordance with the NSW Biodiversity Offset Policy for Major Projects	Proposed measures to avoid, mitigate or offset any significant impacts in accordance with the NSW Biodiversity Offset Policy for Major Projects is provided in Chapter 6.

1.2 Project Description

1.2.1 Location

The Project is located within the Oakdale West precinct of the broader Oakdale Estate which is located within the Western Sydney Employment Area as identified under the NSW *State Environmental Planning Policy (Western Sydney Employment Area) 2009* (WSEA SEPP). The project is located within Penrith Local Government Area (LGA) and the nearest town centres are Erskine Park and Horsley Park which are both approximately 6 km west and east respectively from the Project. The Project is accessed currently via Bakers Lane and is proposed to be accessed via the proposed Western North-South Link Road that is a part of this development application. There are several other developments adjoining the Project within a broader industrial precinct.

The Project comprises the staged construction of a warehousing hub as well as a North/South Link Road between the proposed Oakdale West Warehouse hub and the Erskine Park East-West Link Road as identified in the WSEA SEPP.

The development footprint assessed in the BAR covers approximately 117.82 ha on Lot 11 DP1178389 and an additional 0.94 ha of land which passes from south to north through Lot 3 DP85393, Lot 2 DP84578, Lot 6 DP229784 and Lot 2 DP1215268 (which will facilitate future access to the proposed Western North South Road Link (WNSRL)).

The proposed WNSLR will connect in the north-eastern part of the site, providing a link north to Lenore Drive and the broader external road network. Construction of the WNSLR between the site and Lenore Drive forms part of the proposed Stage 1 works.

Most of the WNSLR link north to Lenore Drive is located on Lot 2 DP1215268, which is owned by Fitzpatrick Investments Pty Ltd (Fitzpatrick) and forms part of the Erskine Park Employment Area.

The Fitzpatrick land has already been assessed for ecological impacts and has received approval for development subject to the creation of a conservation zone (KMA, 2016), the area of the SSD Application that lies within the Fitzpatrick lands is not considered as part of the development site in this BAR.

The location of the various components of the SSD Application area – namely the development site and the link road are shown in **Figure 1.1** and **Figure 1.2**.

1.2.2 Overview

The Project represents the third stage of development within the broader Oakdale Estate. The land within the Oakdale West Estate is owned by a Goodman to develop the Oakdale Estate into a regional warehousing and distribution hub. Goodman is the applicant for the Project. The Project seeks to facilitate the development of the Oakdale West precinct. The Project itself is being assessed as a staged development under Division 2A of the EP&A Act.

The SSD Application for the Project seeks approval for:

- An overarching planning framework to guide the staged development of the Project including:
  - An Indicative Master Plan and Structure Plan;
  - Development Controls for the Project;
  - Western North/South Link Road;
  - A Biodiversity Offset Strategy.
- Stage 1 Development of the Estate including:
  - A package of estate-wide site preparation works to be implemented in stages including:
    - Subdivision;
    - Bulk earthworks (including construction of detention basins); and
    - Construction of retaining walls, road and utility infrastructure/services.
    - Environmental management measures and protocols for the site.
  - Development for the purposes of warehousing and distribution including:
    - The construction of warehouse buildings in Precincts 1, 2, 3, 4 and 5;
    - The construction of hardstand, loading, car parking and landscaping in Precincts 1, 4 and 5;
  - The fit out and use of buildings in Precincts 1, 2, 3, 4 and 5 for generic warehousing and distribution uses.

A detailed description of the Project components is provided within the EIS. The conceptual layout of the Project is shown in **Figure 1.3**.

1.2.3 Identification of Development Site Footprint

The extent of the construction and operational footprints are shown in **Figure 1.3**. The construction footprint of the Project will encompass all works associated with the Project and is wholly contained within the development site. The construction footprint includes all roads, precincts, earthworks, set down areas, bio-retention basins, access tracks and temporary fencing. The operational footprint of the Project for this assessment will include Precinct 1, 2, 3, 4 and 5, the Services Lot, and all earthworks, roadways, utility infrastructure, batters, and bio-retention basins.

1.3 General Description of Development Site

i. Landform, Geology and Soils

Landform at the development site is relatively uniform, with undulating rises and alluvial flats bisected by narrow ridge running from the south west to the north east of the development site. The topography does not have any large variances like mountains or cliff lines, with high elevations within the development site of 88m above sea level and the lowest point of the development site being approximately 50m above sea level.

Underlying geology of the site is best described as an alluvial plain with high clay content on shaly soils. The soil landscape is described as Cumberland Plain (DECCW, 2008) which is present on low rolling hills and valleys in a rain shadow area between the Blue Mountains and the coast on horizontal Triassic shales and lithic sandstones forming a down-warped block on the coastal side of the Lapstone monocline (DECCW, 2008).

ii. Vegetation

Native vegetation comprises approximately 5% of the vegetated cover of the development site. The majority of the development site is cleared for agriculture and is dominated by exotic pasture grasses. Native vegetation within the development site is primarily limited to small remnant patches and sparsely scattered trees through the paddocks. There are also areas of regenerating woodland that connect to larger patches of woodland to the west and south of the development site. These regenerating areas largely comprise of juvenile, regenerating *E. tereticornis* but the understorey in these patches is largely absent due to heavy grazing by cattle and Eastern Grey Kangaroo. The condition of vegetation across the whole development site is degraded due to persistent impacts from grazing even within areas of native vegetation, the ground layer is frequently dominated by exotic species, and the shrub layer is almost absent.

One small patch of planted native vegetation exists within parts of the proposed North South Link Road contained within the development site and continues northwards into Fitzpatrick lands. This vegetation has been planted as tubestock and comprises immature vegetation dominated by juvenile trees.

iii. Hydrology

The development site occurs within the Hawkesbury-Nepean Catchment. The development site occurs at the headwaters of the alluvial plain and is bisected by a number of depressions that drain into Ropes Creek, a third order stream, which flows into South/Wianamatta Creek approximately 13 km north of the development site. The drainage system within the development site (i.e. the depressions) is in relatively poor condition, due to erosion and trampling by cattle.

iv. Land Uses

The development site has previously been utilised for the purpose of cattle grazing. This land use has resulted in the majority of the development site being extensively cleared of

vegetation which has resulted in a significant loss of flora and fauna habitats. Land surrounding the development site has also historically been utilised for agricultural purposes.

The development site and adjoining land is zoned IN1 – General Industrial and E2 – Environmental Conservation under the WSEA SEPP. The objective of the IN1 - General Industrial zoning is to facilitate a wide range of employment-generating development including industrial, manufacturing, warehousing, storage and research uses and ancillary office space. The objectives of E2 – Environmental Conservation are to protect, manage and restore areas of high ecological, scientific, cultural or aesthetic values; and to prevent development that could destroy, damage or otherwise have an adverse effect on those values.

Two converging power easements meet in the south east of the development site and run through the eastern portion of the lot and Sydney Water Mains Pipelines run immediately to the north of the development site. Other nearby land uses includes industrial buildings within Oakdale Central, brick and roofing quarry and rural living.

The land to the north of the development site that North South Link Road will run through is owned by Fitzpatrick Investments Pty Ltd and has concept plan approval (Application Number: MP 06_0166) for the Link Road. This area is predominantly cleared for the purpose of cattle grazing but has a conservation corridor that runs along the southern boundary of the site that has been revegetated by Greening Australia. The conservation corridor through the Fitzpatrick land is contained within parts of the Cumberland Conservation Corridor shown in **Figure 1.2**. The specifics of the conservation corridor through Fitzpatrick land are outlined in the ecological documentation for the Erskine Park Erskine Park Employment Area.

1.4 Information Sources

1.4.1 Database Analysis

A number of databases were utilised as part of this assessment, including:

- Atlas of NSW Wildlife;
- Threatened Species Profile Database;
- VIS Classification Database;
- Department of Primary Industries Threatened and protected species - records viewer; and
- BoM Atlas of Groundwater Dependent Ecosystems.

1.4.2 Literature Review

A review of ecological literature relevant to the development site was undertaken as part of this assessment to evaluate the biodiversity values associated with the development site. Key documents reviewed for this BAR include:

- Oakdale South Estate Biodiversity Assessment Report (Cumberland Ecology, 2016);
- Ecological Assessment - Oakdale Concept Plan (Cumberland Ecology, 2007);
- Cumberland Plain Vegetation Mapping (DECCW, 2007);
- Erskine Park Link Road Network Concept Plan (NSW Department of Planning, 2009); and
- Revised Biodiversity Management Plan Erskine Park Employment Area: 2007 (HLA-Envirosciences, 2007).

1.4.3 Aerial Photography

The aerial imagery used was taken from Nearmap. This aerial is dated 11-02-2017. SIXmaps imagery managed by the Department of Lands was also utilised. The SIXmaps aerial was dated 4-01-2014.

Coordinate System: MGA Zone 56 (GDA 94)

Grid North

Lot 3031
DP1168407

Lot 6 DP229784

Lot 2 DP84578

Lot 3 DP85393

Lot 11 DP1178389

Ropes Creek

Legend

- Development Site
- SSD Application Area
- Additional North-South Link Road Area
- Cadastral boundaries
- Native vegetation extent

Rivers and Streams

- 1st Order Stream
- 3rd Order Stream
- Riparian Buffer Areas

IBRA Bioregion

- Sydney Basin

IBRA Subregion

- Cumberland

Mitchell Landscapes

- Cumberland Plain
- Sydney Basin Diatremes

Scale: 1:9,130 @ A3 page
Date prepared: 31/03/2017

Image Source:
Image © Nearmap
(dated 11-02-2017)

Data Source:
Remnant Vegetation of the western Cumberland subregion, 2013 Update. VIS_ID 4207, OEH 2013.
Change in the distribution of Cumberland Plain Woodland VIS_ID 3785. DECCW 2008.
Interim Biogeographic Regionalisation for Australia (IBRA) version 7, 2012;
DECC (2008), Landscapes (Mitchell) of NSW - Version 3;

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I:\...\15122\Figures\RP1_BAR\20170331\Figure 1.1. Site Map

100 0 100 200 300 400 m

Figure 1.1. Site map

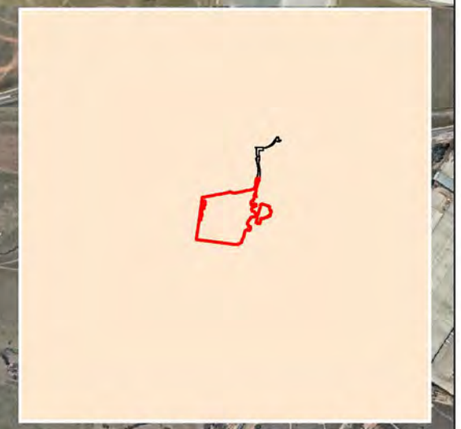
Coordinate System: MGA Zone 56 (GDA 94)

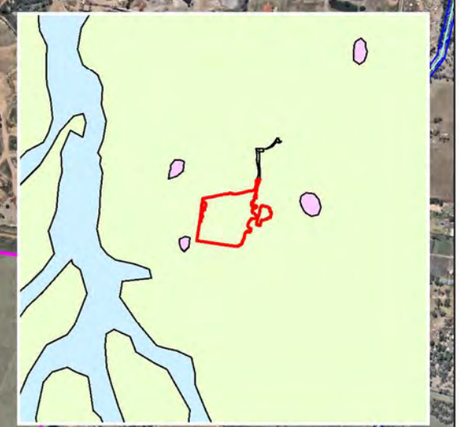
BLACKTOWN

FAIRFIELD

PENRITH

Roper





Legend

- Development Site
- Additional North-South Link Road Area
- Inner Assessment Circle (100 ha)
- Outer Assessment Circle (1000 ha)
- Native vegetation extent
- Local Government Area

Connectivity

- Biodiversity Link
- Most limiting width

Regional Biodiversity Link

- Cumberland Conservation Corridor

Rivers and Streams

- 1st Order Stream
- 3rd Order Stream

IBRA Bioregion

- Sydney Basin

IBRA Subregion

- Cumberland

Mitchell Landscapes

- Cumberland Plain
- Sydney Basin Diatremes
- Hawkesbury - Nepean Channel and Floodplains

Grid North

Scale : 1:15,534 @ A3 page
Date prepared: 31/03/2017

Image Source:
Image © Nearmap
(dated 11-02-2017)

Data Source:
Remnant Vegetation of the western Cumberland subregion, 2013 Update. VIS_ID 4207, OEH 2013.
Change in the distribution of Cumberland Plain Woodland VIS_ID 3785. DECCW 2008.
Interim Biogeographic Regionalisation for Australia (IBRA) version 7, 2012;
DECC (2008), Landscapes (Mitchell) of NSW - Version 3;

LPI (2001). New South Wales DCDB Local Governement Area Boundaries.

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I:\...\15122\Figures\RP1_BAR\20170331\Figure 1.2. Location Map

Figure 1.2. Location map

250 0 250 500 750 1000 m

Coordinate System: MGA Zone 56 (GDA 94)

Grid North

Legend

- Development Site
- Operational Footprint
- Construction Footprint

Development Layout

- Services Lot (Substation)
- Precinct
- Bio-retention Basin
- Road
- Batter

Precinct 1
Precinct 2
Precinct 2
Precinct 3
Precinct 4
Precinct 5

Scale: 1:8,980 @ A3 page
Date prepared: 31/03/2017

Image Source:
Image © Nearmap
(dated 11/02/2017)

Data Source:
Image © 2015
NSW Land and Property
Management Authority,
SIX Viewer

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I:\...\15122\Figures\RP1_BAR\20170331\Figure 1.3. Indicative Layout_Development Site

Figure 1.3. Indicative layout of the development site

100 0 100 200 300 400 m

Chapter 2

Legislation and Policies

2.1 Commonwealth

2.1.1 Environment Protection and Biodiversity Conservation Act 1999

The *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) is the Australian Government's principal piece of environmental legislation and is administered by the Commonwealth Department of the Environment and Energy (DoEE). It is designed to protect national environmental assets, known as Matters of National Environmental Significance (MNES), which include threatened species of flora and fauna, endangered ecological communities, migratory species as well as other protected matters. Among other things, it defines the categories of threat for threatened flora and fauna, identifies key threatening processes and provides for the preparation of recovery plans for threatened flora, fauna and communities.

Under the EPBC Act, any action (which includes a development, project or activity) that is considered likely to have a significant impact on MNES must be referred to the Commonwealth Minister for the Environment. The following MNES were identified within the development site at the time of survey:

- Cumberland Plain Woodland – Critically Endangered Ecological Community (CEEC); and
- Cattle Egret (*Ardea ibis*) – Migratory.

A preliminary assessment of the MNES present within the development site indicated that there is an impact on remnant Cumberland Plain Woodland CEEC and, as such, a referral to DoEE was required for further consideration. It is noted that the Cattle Egret has been delisted effective 9 June 2016 but has been retained in the referral assessment due to this species being listed at the time of survey.

A referral to DoEE has been prepared and is to be submitted following the submission of the DA. It is recommended that the impacted CEEC's are low quality remnant patches that would likely not survive in the long-term; therefore, in the presence of on-site vegetation enhancement and biodiversity offsets, the Project should not be considered a controlled action.

2.1.2 Environmental Protection and Biodiversity Conservation Act 1999 Environmental Offsets Policy

Under the *Environmental Protection and Biodiversity Conservation Act 1999 Environmental Offsets Policy*, environmental offsets are actions taken to counterbalance significant residual impacts on MNES. Offsets are used as a last resort in instances where an action will give rise to residual impacts, even after the application of management measures.

The policy came into force in October 2012 and provides guidance on the role of offsets in environmental impact assessments and how DoEE considers the suitability of a proposed offset package (SEWPaC, 2012). According to the policy, an offsets package is a "*suite of actions that a proponent undertakes in order to compensate for the residual significant impact of a project"* (SEWPaC, 2012b). It can comprise a combination of direct offsets and other compensatory measures.

A preliminary assessment of the MNES present within the development site indicated that there is an impact on remnant Cumberland Plain Woodland CEEC and, as such, a referral to DOEE was required for further consideration.

A referral to DOEE has been prepared and is to be submitted following the submission of the DA. The referral recommends that in the presence of existing offset requirements under the *NSW Biodiversity Offsets Policy for Major Projects* no further biodiversity offsets should be required under the *Environmental Protection and Biodiversity Conservation Act 1999 Environmental Offsets Policy*.

2.2 New South Wales

2.2.1 Environmental Planning and Assessment Act 1979

The *Environmental Planning and Assessment Act 1979* (EP&A Act) is the overarching planning legislation in NSW that provides for the creation of planning instruments that guide land use. The EP&A Act also provides for the protection of the environment, including the protection and conservation of native animals and plants. This includes threatened species, populations and ecological communities, and their habitats of biodiversity values, as listed in the NSW *Threatened Species Conservation Act 1995* (TSC Act) and NSW *Fisheries Management Act 1994* (FM Act). The protection of the environment is addressed in Section 5A of the EP&A Act - Significant effect on species, populations or ecological communities or their habitats.

The applicant is seeking State Significant Development (SSD) Consent under Division 4.1 of Part 4 of the EP&A Act. The Project is to be a staged development made under Clause 83B, Division 2A of Part 4 of the EP&A Act. A SSD can be declared under the *State Environmental Planning Policy (State and Regional Development) 2011* or by the Minister for Planning. The Development Application submitted for the SSD must be accompanied by an EIS, which is to be prepared in accordance with the SEARs.

The SEARs for the Project were issued by the NSW Department of Planning and Environment (DP&E) on 26 November 2015. The provisions that are relevant to this BAR are reproduced below.

The EIS must address the following specific matters that relate to the Masterplan and Stage 1 works:

- *Flora and fauna – including:*
  - *details of the quantity and type of any vegetation to be cleared;*
  - *an assessment of impacts (direct or indirect) on threatened species, populations, ecological communities (including groundwater dependant ecosystems) and their habitat, critical habitat (including riparian habitat) and native vegetation in accordance with the Framework for Biodiversity Assessment (Oct 2014); and*
  - *proposed measures to avoid, mitigate or offset any significant impacts in accordance with the draft Biodiversity Offset Policy for Major Projects.*

An assessment of the quantum and type of impacts resulting from the Project on biodiversity values and measures to avoid and mitigate these impacts is presented within this BAR. A separate Biodiversity Offset Strategy (BOS) to address offset measures has been prepared for the Project and is provided as part of the EIS documentation.

2.2.2 Threatened Species Conservation Act 1995

The *Threatened Species Conservation Act 1995* (TSC Act) is the key piece of legislation in NSW relating to the protection and management of biodiversity and threatened species. The TSC Act aims to protect and encourage the recovery of threatened species, populations and communities that are listed under the Act through threat abatement and species recovery programs. The TSC Act requires consideration of whether a development (Part 4) or an activity (Part 5) is likely to significantly impact threatened species, populations, communities or their habitat. The potential impacts of any developments, land use changes or activities do not need to undergo an "Assessment of Significance" under Section 5A of the EP&A Act as the Project has been declared a SSD. The impacts of the Project are therefore assessed within this BAR.

2.2.3 Fisheries Management Act 1994

The FM Act provides for the protection, conservation and recovery of fish stocks, key fish habitats, threatened species, populations and ecological communities of fish and marine vegetation as well as management of threats to threatened species, populations and ecological communities defined under the Act. In particular, the FM Act has mechanisms for the protection of fish, fish habitats, mangroves, seagrasses and seaweeds on public water land and foreshores.

2.2.4 NSW Biodiversity Offsets Policy for Major Projects

The *NSW Biodiversity Offsets Policy for Major Projects* was adopted in September 2014 and applies to SSD and State Significant Infrastructure designated under the EP&A Act. The policy provides a standard method for assessing impacts of major projects on biodiversity and determining offsetting requirements (NSW Government, 2014b). The policy is underpinned by six principles, which must be considered when assessing offsets for major projects.

The Framework for Biodiversity Assessment (FBA) has been developed in conjunction with the policy to provide a method for determining the quantum of impacts. The FBA provides rules and software for calculating 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. "Credits" are the currency used within FBA and they are not specifically area measurements. Rather, they are a measure of the current quality of habitat. Where a proponent is proposing to establish an offset site as part of the BOS, the BioBanking Assessment Methodology (BBAM) must be used to assess the biodiversity values of the offset site and to identify the number and type of credits that may be created on the offset site (NSW Government, 2014a).

The FBA requires the preparation of the following documents:

- Biodiversity Assessment Report: To describe the biodiversity values present within the development site and the impact of the project on these values; and
- Biodiversity Offset Strategy: To outline how the proponent intends to offset the impacts of the project.

These reports are required to be submitted as part of the EIS.

As the FBA applies predominantly to terrestrial biodiversity, the *NSW Offsets Policy for Major Projects* and FBA refers to the NSW Department of Primary Industries *Policy and Guidelines for Fish Habitat Conservation and Management (Update 2013)* for guidance on assessing and offsetting aquatic impacts. Offsets for identified key fish habitats are required once avoidance and mitigation measures have been implemented. No key fish habitats have been identified within the Penrith LGA. The development site does not include any streams or waterbodies that are considered fish habitat.

2.2.5 State Environmental Planning Policy (Western Sydney Employment Area) 2009

The development site is located within Precinct 8 (South of Sydney Catchment Authority Warragamba Pipelines) of the Western Sydney Employment Area designated under the WSEA SEPP. The development site is located within the Oakdale West sub-precinct of the Oakdale Estate within Precinct 8. The WSEA SEPP requires that a consent authority must not grant consent to development unless a development control plan has been prepared for that land. The *Penrith Development Control Plan 2014* (Penrith DCP 2014) applies to the land within the development site. However, pursuant to Clause 11 of the NSW *State*

Environmental Planning Policy (State and Regional Development) 2011, development control plans do not apply to SSDs. As such, the provisions of the Penrith DCP 2014 are not relevant to the Project; however, development controls for the Project will form part of the masterplan and will be ultimately incorporated into the Penrith DCP 2014.

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Chapter 3

Landscape Features

3.1 Landscape Features

As the Project is being assessed as a site based assessment, assessment circles were established to identify landscape features associated with the Project. For the purposes of this BAR a 100 ha inner assessment circle and 1,000 ha outer assessment circle have been utilised for this assessment and the locations are shown in **Figure 1.2**. A 1,000 ha outer assessment circle was selected as it was the minimum size to encompass the entire extent of the development site. The 100 ha inner assessment circle is centred on the portion of the development site that contains the highest percent native vegetation cover impacted by the Project.

3.1.1 IBRA Bioregions and IBRA Subregions

i. Bioregions

Development site: Sydney Basin Bioregion (118.78 ha)

Outer assessment circle: Sydney Basin Bioregion (1,000 ha)

The development site and outer assessment circle are wholly contained within the Sydney Basin Bioregion. This bioregion occupies approximately 3.6 million hectares (approximately 4.5% of NSW) and extends from just north of Batemans Bay to Nelson Bay on the central coast, and almost as far west as Mudgee (NSW NPWS, 2003). The Sydney Basin Bioregion is one of the most species diverse in Australia, which is the result of the variety of rock types, topography and climates in the bioregion (NSW NPWS, 2003). This bioregion contains significant flora, fauna and wetlands.

The extent of the Sydney Basin bioregion within the development site is shown in **Figure 1.1**. The extent of the bioregion within the outer assessment circle is shown in **Figure 1.2**.

ii. Subregions

Development site: Cumberland Subregion (118.78 ha)

Outer assessment circle: Cumberland Subregion (1,000 ha)

The development site and outer assessment circle are wholly contained within the Cumberland Subregion. This subregion is typified by low rolling hills and wide valleys in the rain shadow below the Blue Mountains (NSW NPWS, 2003). The underlying geology of this

subregion predominately comprises Triassic Wianamatta group shales and sandstones (NSW NPWS, 2003). Vegetation communities of this subregion that occur in the vicinity of the development site include: Grey Box, Forest Red Gum, Narrow-leaved Ironbark woodland with some Spotted Gum on the shale hills; and Broad-leaved Apple, Cabbage Gum and Forest Red Gum with abundant Swamp Oak on river flats (NSW NPWS, 2003).

The extent of the Cumberland subregion within the development site is shown in **Figure 1.1**. The extent of the subregion within the outer assessment circle is shown in **Figure 1.2**.

3.1.2 Mitchell Landscapes

Development site: Cumberland Plain (118.78 ha)

Outer assessment circle: Cumberland Plain (1,000 ha)

The extent of the Cumberland Plain Mitchell Landscape within the development site is shown in **Figure 1.1**. The extent of the Mitchell Landscapes within the outer assessment circle is shown in **Figure 1.2**.

The development site is wholly contained within the Cumberland Plain Mitchell Landscape. This landscape is characterised by low rolling hills and valleys in a rain shadow area between the Blue Mountains and the coast on horizontal Triassic shales and lithic sandstones (DECC, 2002). There are some occurrences of volcanic vents and is partly covered by Tertiary river gravels and sands with main streams containing quaternary alluvium. The general elevation of this Mitchell Landscape is between 30 and 120 m. Woodlands and open forest consist of *Eucalyptus moluccana* (Grey Box), *Eucalyptus tereticornis* (Forest Red Gum), *Eucalyptus crebra* (Narrow-leaved Ironbark), *Eucalyptus eugenioides* (Thin-leaved Stringybark), *Eucalyptus amplifolia* (Cabbage Gum) *and Angophora subvelutina* (Broad-leaved Apple) (DECC, 2002). This vegetation has grassy to shrubby understorey often dominated by *Bursaria spinosa* (Australian Boxthorn), poorly drained valley floors, often salt affected with *Casuarina glauca* (Swamp Oak) *and Melaleuca sp.* (DECC, 2002).

3.1.3 Rivers and Streams

The development site and outer assessment circle occurs within the Hawkesbury-Nepean Catchment. No rivers or streams are present within the development site. One first order stream, Ropes Creek Tributary, and one third order stream, Ropes Creek, have been identified within the outer assessment circle, only. Stream data was obtained from Geoscience Australia, with stream orders defined using the Strahler stream ordering system. A buffer of 10 m and 30 m either side of the waterway were applied to first and third order streams, respectively. Ropes Creek Tributary is located in the Oakdale South Estate and flows west through the estate into Ropes Creek, which flows north, eventually reaching South/Wianamatta Creek which is located 13 km north of the development site. Ropes Creek had a small amount of flowing water (<10cm) at the time of survey.

The extent of the streams and their associated buffers within the inner and outer assessment circle is shown in **Figure 1.2**.

3.1.4 Wetlands

No important or local wetlands occur within the development site or outer assessment circle. The closest wetlands to the development site are located more than 19 km to the north near Windsor Downs, where South/Wianamatta Creek and Eastern Creek merge.

3.1.5 Native Vegetation Extent

The outer assessment circle, which is 1,000 ha in size, occurs within an area in which a number of broad-scale vegetation mapping projects have been undertaken. To map the extent of native vegetation within the outer assessment circle, 2013 update to the vegetation mapping of the Cumberland Plain (DECCW, 2007) was overlain on a 2014 aerial available through the Department of Lands SIXmaps application.

The extent of native vegetation cover was then revised through aerial photographic interpretation and surveys of the development site. Amendments to the extent of native vegetation were made using a Geographic Information System (GIS), MapInfo Professional 12.5. Additional mapping updates were done during a peer review process, using ArcGIS v10.5 and 2017 aerial photography, and further ground truthing of boundaries, undertaken in March 2017.

The boundaries of native vegetation were reduced in areas that have been cleared since the previous vegetation mapping was prepared and the boundaries were extended in areas where the previous vegetation mapping did not have mapped vegetation that are now subsequently mapped or can be predicted to contain native vegetation using aerial imagery.

Native vegetation occurring in the outer assessment circle is shown in **Figure 1.2**. Native vegetation occupies approximately 165.61 ha, which represents approximately 16% of the outer assessment circle. Native vegetation within the outer assessment circle is predominately confined to riparian corridors and a large patch of native woodland to the north west of the development site. The remaining land within the outer assessment circle comprises cleared land and built environments. It is considered that there are no significant differences between the mapped vegetation extent and aerial imagery utilised by this assessment.

3.1.6 State or Regionally Significant Biodiversity Links

No state or regionally significant biodiversity links occur within the development site or inner assessment circle. Cumberland Conservation Corridor occurs within the outer assessment circle, directly to the north of the development site and is shown on **Figure 1.2**. The Cumberland Conservation Corridor links Priority Conservation Sites identified within the Approved Cumberland Plain Recovery Plan (DECCW, 2011).

3.1.7 Other Landscape Features

No other landscape features within the development site, inner assessment circle or outer assessment circle were identified in the SEARs.

3.2 Landscape Value Score

3.2.1 Attributes

i. Percent Native Vegetation Cover

The current and future percentage of native vegetation cover within the inner and outer assessment circles was determined in increments of 5% using GIS. These calculations utilised the native vegetation extent identified in ***Section 3.1.5*** and considered the condition of the vegetation. The Project will result in the loss of 4.89 ha of native vegetation within the development site. A summary of the current and future percentage of native vegetation cover in the inner and outer assessment circles is provided in **Table 3.1**. Based on these values, the Project has a native vegetation cover score of 0.75.

Table 3.1 Current and future native vegetation cover within the assessment circles

Assessment Circle	Current Extent of Native Vegetation		Future Extent of Native Vegetation	
	Area (ha)	% Cover Class	Area (ha)	% Cover Class
Inner assessment circle	22.86	21-25	19.41	16-20
Outer assessment circle	165.61	16-20	160.40	16-20

ii. Connectivity Value

The one connecting link has been identified within the development site running from the southern boundary, through the south west of the development site eventually connecting to Ropes Creek to the north of the development site. The following connecting link conditions have been identified:

- Linkage width class: Narrow (>5-30m);
- Over-storey condition: % foliage cover within benchmark; and
- Mid-storey or groundcover condition: % foliage cover of mid-storey or ground cover within benchmark.

Figure 1.2 shows the location of the connecting link within the development site. The vegetation within these corridors is in moderate to good condition, has a patch size of greater than one hectare, is separated by less than 100 m and is not separated by a hostile link. All vegetation within the identified connecting link has been assessed as having overstorey and midstorey or groundcover percent foliage cover within benchmark. A summary of the current and future width class and condition class values of the only connecting link within the development site is shown in **Table 3.2**. The final connectivity score for the Project is 0.

Table 3.2 Current and future connecting links within the assessment circles

Connecting Link	Linkage Width Class			Linkage Condition Class			Connectivity Value
	Current	Future	Classes Crossed	Current	Future	Classes Crossed	
1	Narrow (>5-30m)	Narrow (>5-30m)	0	3	3	0	0

iii. Patch Size

As the Project is a site-based development, patch size has been determined in accordance with Appendix 4 of the FBA. The development site occurs within the Cumberland Plain Mitchell Landscape which has a cleared native vegetation value of 91%. The native vegetation within the development site and assessment circles has been identified in ***Section 3.1.5***. Of this vegetation, the largest patch of native vegetation, of which a portion occurs within the development site, is 224.15 ha in size. Based on these variables, the patch size class is categorised as 'Extra large' which has a corresponding patch size score of 12.

3.2.2 Score

Using the results from the assessment of landscape attributes in ***Section 3.2.1*** and Equation 4 in Appendix 1 of the FBA, the landscape value score for the development site is 12.80.

cumberland ecology

Chapter **4**

Native Vegetation

4.1 Review of Existing Data

The following primary sources of information were consulted as part of a desktop assessment of the native vegetation within the development site:

- VIS Classification Database;
- Cumberland Plain Vegetation Mapping (DECCW, 2007), including 2013 updates;
- Ecological Assessment – Oakdale Concept Plan (Cumberland Ecology, 2007); and
- Oakdale South Estate Biodiversity Assessment Report (Cumberland Ecology, 2015).
- Oakdale South Biodiversity Assessment Report – Section 96 (Cumberland Ecology, 2016)

Information obtained during the review of existing data was utilised in conjunction with field data collected by Cumberland Ecology to assess native vegetation within the development site.

4.2 Surveys

4.2.1 Overview

Surveys of the vegetation within the development site and adjoining land were conducted on 12 October 2015, 15 – 20 October 2015 and 8 April 2016. The first round of survey was conducted to obtain an overview of the nature and extent of vegetation not just within the development site but also within adjacent lands owned by the proponent, as well as mapping of vegetation communities and establishing the required number of floristic plots required. Once the likely Plant Community Types (PCTs) were identified, full floristic plots and plot and transect surveys were conducted to verify the PCTs and collect site value data from the identified vegetation zones. As the development site contains a number of scattered trees, for the purposes of this assessment, only patches that contained greater than three mature trees, were assigned to a vegetation community and subsequent PCT.

These surveys were undertaken following the SSD determination and were designed to meet the requirements of the FBA. Areas of native vegetation were generally delineated using a

handheld Global Positioning System (GPS) unit, aerial photograph interpretation and site notes.

For the purposes of assigning PCTs to native vegetation communities, plot based full floristic survey was undertaken in accordance with Table 1 of the FBA at 13 sites across the development site. This number of sites was required to ensure the appropriate assessment of observed environmental variation was completed and to fill gaps in previous mapping.

Vegetation of the same PCT and broad condition state was initially classified as one vegetation zone in accordance with the rules of FBA and surveyed for the required number of plots/transect for the particular vegetation zone.

Due to the fragmented nature of the development site and the distance between vegetation patches, for the purposes of this assessment the initial vegetation zones for each PCT were subsequently split into multiple vegetation zones based on distance of the more isolated patches (>100m from another patch of native vegetation) for the purpose of filtering predicted ecosystem credit species, given that patch size influences predicted ecosystem credits. This resulted in the creation of nine vegetation zones as summarised in **Table 4.1**.

As the different vegetation zones for each PCT occur in the same broad condition and zonation was based on the level of fragmentation rather than vegetation being in different conditions, the same sites were used for plot and transect surveys across the vegetation zones for each PCT.

4.2.2 Plot-based Full Floristic Survey

Thirteen full floristic plots surveyed within the development site on 15 – 20 October 2015 have been utilised in this assessment. The following information was collected at each of the thirteen 20 x 20 m full floristic plots in accordance with Table 1 of the FBA:

- Stratum (and layer): stratum and layer in which each species occurs;
- Growth form: growth form for each recorded species;
- Species name: scientific name and common name;
- Cover: a measure or estimate of the appropriate cover measure for each recorded species; recorded from 1–5% and then to the nearest 5%. If the cover of a species is less than 1% and the species is considered important, then the estimated cover should be entered (e.g. 0.4); and
- Abundance rating: a relative measure of the number of individuals or shoots of a species within the plot. Use the following intervals; numbers above about 20 are estimates only: 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 20, 50, 100, 500, or 1,000, or specify a number greater than 1,000 if required.

The locations of these plots are shown in **Figure 4.1**. The locations of the full floristic plots were determined by randomly marking a point within each observable PCT within adjoining

land to the development site that would enable an appropriate assessment of expected environmental variation.

4.2.3 Plot and Transect Surveys

Thirteen plot and transect sites surveyed within the development site on 15-20 October 2015. The additional two plot and transect sites surveyed on 8 April 2016 have not been utilised in this assessment as these largely occur within the Fitzpatrick land that does not form part of this BAR. The following information was collected at each of the 20 x 50 m plot and transect sites in accordance with Section 5.3.2 of the FBA:

- Native species richness recorded within each stratum of a 20 m x 20 m sub-plot;
- Native overstorey cover recorded at 10 points along a 50 m transect;
- Native midstorey cover recorded at 10 points along a 50 m transect;
- Native ground cover recorded at 50 points along a 50 m transect for three life forms (shrubs, grasses and other);
- Exotic plant cover expressed as a total percent cover across all strata (each strata measured using the same method for native overstorey, midstorey and ground cover);
- Number of trees with hollows visible from the ground within the 20 m x 50 m plot;
- The total length of fallen logs >10 cm in diameter within the 20 m x 50 m plot; and
- The proportion of regenerating overstorey species within the vegetation zone.

The locations of the plot and transect sites are shown in **Figure 4.1**. The locations of the plot and transect sites were determined by randomly marking a point within each observable PCT within the development site.

Table 4.1 summarises the plot and transect survey effort undertaken for the Project. The minimum number of plot and transect surveys have been conducted for the initial vegetation zones (based on the broad-condition/PCT) and have been utilised for the assessment of the refined vegetation zones. Data collected from all plot and transect sites was utilised to determine the site value score for each vegetation zone.

Table 4.1 Plot and transect survey effort

Vegetation Zone	PCT Code	Condition*	Area (ha)	Minimum Plot and Transect Sites Required	Number of Plot and Transect Sites Sampled
1	HN526	Moderate/Good	0.57	1	1

Table 4.1 Plot and transect survey effort

Vegetation Zone	PCT Code	Condition*	Area (ha)	Minimum Plot and Transect Sites Required	Number of Plot and Transect Sites Sampled
2	HN526	Moderate/Good_High	0.22	1	1
3	HN526	Moderate/Good_Medium	0.32	1	1
4	HN528	Moderate/Good	0.89	1	2
5	HN528	Moderate/Good_High	0.05	1	2
6	HN528	Moderate/Good_Medium	0.10	1	2
7	HN529	Moderate/Good	1.07	1	3
8	HN529	Moderate/Good_High	0.10	1	3
9	HN594	Moderate/Good	1.62	1	3

** Condition names reflect options available within the BioBanking Credit Calculator rather than on-ground condition.*

4.3 Native Vegetation Extent

The development site is 118.78 ha in size which includes 4.93 ha of remnant native vegetation, 0.51 ha of planted native revegetation, 110.80 ha of exotic vegetation and 2.54 ha of cleared/developed areas. The extent of native vegetation extent within the development site is shown in **Figure 1.1**. This extent has been determined through aerial photograph interpretation and field surveys. It is considered that there are no significant differences between the mapped vegetation extent and aerial imagery utilised by this assessment.

The 0.51 ha revegetation area within the North/South Link Road alignment of the development site lies either side of the Warragamba Pipeline. This vegetation does not comprise a naturally occurring PCT but has been included within the mapped native vegetation extent for the purposes of landscape value as it comprises native Australian plant species. However, as it cannot be assessed against benchmark data for a PCT, it has been excluded from the patch size calculations for the identified vegetation zones. The quadrat data from this patch (Q14) has also not been utilised for any of the vegetation zones.

The remaining areas of the development site comprise cleared land, which include exotic grassland (see ***Section 4.5.3***) and dams. In accordance with Section 5.1.1.3 of the FBA, these areas of revegetation and cleared land do not require further assessment unless they provide habitat for species credit species.

4.4 Identification of Plant Community Types

Identification of the PCTs occurring within the development site was guided by the results of the review of existing data (see ***Section 4.1***) and surveys of the development site (see

Section 4.2). The data collected during surveys of the development site was analysed in conjunction with a review of the PCTs held within the VIS Classification Database. Consideration was given to the following:

- Occurrence within the Cumberland IBRA subregion;
- Vegetation formation;
- Landscape position;
- Dominant upper, mid and ground strata species.

The analysis determined that the vegetation within the development site aligned with four PCTs held within the VIS Classification Database. **Table 4.2** lists the PCTs that have been identified within the development site and the justification for their selection.

Table 4.2 Justification for selection of PCTs within the development site

PCT Code	PCT Name	Evidence Used for Identification	Species Relied upon for Identification
HN526	Forest Red Gum - Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney Basin	**IBRA Subregion:** Occurs within the Cumberland IBRA subregion	**Upper stratum species**: *Eucalyptus tereticornis , Eucalyptus amplifolia subsp. amplifolia,*
		Vegetation formation: Coastal Valley Grassy Woodlands	**Mid stratum species**: *Acacia parramattensis, Bursaria spinosa*
		Landscape position: Occurs on stream banks and alluvial flats on the Cumberland Plain	**Ground stratum species**: *Dichondra repens, Echinopogon ovatus, Entolasia marginata, Microlaena stipoides, Solanum prinophyllum, Veronica plebeia*
HN528	Grey Box - Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin	**IBRA Subregion:** Occurs within the Cumberland IBRA subregion	**Upper stratum species**: *Eucalyptus tereticornis, Eucalyptus moluccana, Eucalyptus eugenioides*
		Vegetation formation: Coastal Valley Grassy Woodlands	**Mid stratum species**: *Bursaria spinosa*
		Landscape position: Occurs on clay/loam soils derived from Wianamatta Shales on the Cumberland Plain at low altitudes (mainly below 150m).	**Ground stratum species**: *Cheilanthes sieberi, Dichelachne micrantha, Dichondra repens, Eragrostis leptostachya, Lomandra filiformis, Microlaena stipoides, Paspalidium distans*
HN529	Grey Box - Forest Red Gum grassy woodland on shale of the southern Cumberland Plain, Sydney Basin Bioregion	**IBRA Subregion:** Occurs within the Cumberland IBRA subregion	**Upper stratum species**: *Acacia implexa, Eucalyptus moluccana, Eucalyptus tereticornis*
		Vegetation formation: Coastal Valley Grassy Woodlands	**Mid stratum species**: *Bursaria spinosa, Rubus parvifolius*
		Landscape position: Occurs on clay soils with iron-indurated gravel derived from Tertiary alluvium or shale in the Castlereagh-Holsworthy area.	**Ground stratum species**: *Dichondra repens, Brunoniella australis, Desmodium gunni, Aristida ramosa, Microlaena stipoides, Carex inversa, Themeda australis, Cyperus gracilis, Dichelachne micrantha, Asperula conferta, Oxalis perennans, Cheilanthes sieberi, Desmodium brachypodum, Sporobolus creber, Wahlenbergia gracilis*

Table 4.2 Justification for selection of PCTs within the development site

PCT Code	PCT Name	Evidence Used for Identification	Species Relied upon for Identification
HN594	Swamp Oak swamp forest fringing estuaries, Sydney Basin Bioregion and South East Corner Bioregion	**IBRA Subregion:** Occurs within the Cumberland IBRA subregion **Vegetation formation:** Coastal Floodplain Wetlands **Landscape position:** Occurs on sandy saline sediments fringing the high tide mark in coastal estuaries below 5m.	**Upper stratum species**: *Casuarina glauca* **Mid stratum species**: *Melaleuca styphelioides* **Ground stratum species**: *Microlaena stipoides, Centella asiatica*

4.5 Description of Plant Community Types

4.5.1 Overview

Table 4.3 provides a summary of the PCTs occurring within the development site, including vegetation formation, percent cleared within the Hawkesbury/Nepean catchment and extent within the development site. The distribution of these PCTs within the development site is shown in **Figure 4.2**.

Table 4.3 Summary of PCTs occurring within the development site

PCT Code	PCT Name	Vegetation Formation	Vegetation Class	% Cleared within Catchment	Area within Development Site (ha)
HN526	Forest Red Gum - Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney Basin	Grassy Woodlands	Coastal Valley Grassy Woodlands	95	1.11
HN528	Grey Box - Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin	Grassy Woodlands	Coastal Valley Grassy Woodlands	95	1.03
HN529	Grey Box - Forest Red Gum grassy woodland on shale of the southern Cumberland Plain, Sydney Basin Bioregion	Grassy Woodlands	Coastal Valley Grassy Woodlands	90	1.17
HN594	Swamp Oak swamp forest fringing estuaries, Sydney Basin Bioregion and South East Corner Bioregion	Forested Wetlands	Coastal Floodplain Wetlands	95	1.62

4.5.2 Threatened Ecological Communities

All PCTs identified within the development site are associated with a Threatened Ecological Community (TEC) according to the VIS Classification Database. As shown in **Table 4.4**, HN526, HN528 and HN529 are associated with only one TEC, whilst HN594 is associated with three. Assessment of HN594 within the development site has indicated that the PCT comprises Swamp Oak Floodplain Forest of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions. The distribution of TECs within the development site is shown in **Figure 4.3**.

Table 4.4 TECs associated with PCTs occurring within the development site

PCT Code	PCT Name	TEC Name	TEC Status	Assessed as Associated TEC?
HN526	Forest Red Gum - Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney Basin	River-Flat Eucalypt Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions	Endangered	Yes
HN528	Grey Box - Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin	Cumberland Plain Woodland in the Sydney Basin Bioregion	Critically Endangered	Yes
HN529	Grey Box - Forest Red Gum grassy woodland on shale of the southern Cumberland Plain, Sydney Basin Bioregion	Cumberland Plain Woodland in the Sydney Basin Bioregion	Critically Endangered	Yes
HN594	Swamp Oak swamp forest fringing estuaries, Sydney Basin Bioregion and South East Corner Bioregion	Swamp Oak Floodplain Forest of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions	Endangered	Yes
		Swamp Sclerophyll Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions	Endangered	No
		River-Flat Eucalypt Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions (Part)	Endangered	No

The vegetation condition of HN528 and HN529 at the development site was assessed against the listing advice for Cumberland Plain Shale Woodland and Shale-Gravel Transition Forest, which is listed as a CEEC under the EPBC Act. Only parts of vegetation zone 4 of HN528 (see **Table 4.5**) and vegetation zone 7 of HN529 (see **Table 4.6**) within the development site were determined as conforming to this CEEC as listed under the EPBC Act as vegetation zones 5, 6 and 8 and an isolated patch of zone 4 near the eastern boundary of the development all have patch sizes of less than 0.5 ha. The extent of the EPBC Act listed CEEC is shown in **Figure 4.4**. A referral has been prepared for submission to DoEE which includes consideration of this CEEC.

Table 4.5 Evaluation of Vegetation Zone 4 (HN528) at development site against EPBC Act listing advice thresholds

Category and Rationale	Threshold	Development site details
Core thresholds that apply under most circumstances: patches with an understorey dominated by natives and consistent with the minimum mapping unit size applied in NSW.	Minimum patch size is ≥ 0.5 ha; AND ≥ 50% of the perennial understorey vegetation cover is made up of native species	The patch size at the development site is 0.80 ha with understorey vegetation is approximately 50% native. Patches within the development site are connected to a wider 224 ha patch of native vegetation with a separation of <100m.
OR		
Larger patches which are inherently valuable due to their rarity.	The patch size is ≥ 5 ha; AND ≥ 30% of the perennial understorey vegetation cover is made up of native species.	
OR		
Patches with connectivity to other larger native vegetation remnants in the landscape.	The patch size is ≥ 0.5 ha; AND ≥ 30% of the perennial understorey vegetation cover is made up of native species; AND The patch is contiguous with a native vegetation remnant (any native vegetation where cover in each layer present is dominated by native species) that is ≥ 5ha in area.	
OR		
Patches that have large mature trees or trees with hollows (habitat) that are very scarce on the Cumberland Plain.	The patch size is ≥ 0.5 ha in size; AND ≥ 30% of the perennial understorey vegetation cover is made up of native species; AND The patch has at least one tree with hollows per hectare or at least one large tree (≥80 cm dbh) per hectare from the upper tree layer species outlined in the Description and Appendix A (of the EPBC listing advice:	

Table 4.5 Evaluation of Vegetation Zone 4 (HN528) at development site against EPBC Act listing advice thresholds

Category and Rationale	Threshold	Development site details
	Threatened Species Scientific Committee, 2008)	

Table 4.6 Evaluation of Vegetation Zone 7 (HN529) at development site against EPBC Act listing advice thresholds

Category and Rationale	Threshold	Development site details
Core thresholds that apply under most circumstances: patches with an understorey dominated by natives and consistent with the minimum mapping unit size applied in NSW.	Minimum patch size is ≥ 0.5 ha; AND ≥ 50% of the perennial understorey vegetation cover is made up of native species	The patch size at the development site is 1.07 ha with understorey vegetation is approximately 50% native exotic. Patches within the development site are connected to a wider 224 ha patch of native vegetation with a separation of <100m.
OR		
Larger patches which are inherently valuable due to their rarity.	The patch size is ≥ 5 ha; AND ≥ 30% of the perennial understorey vegetation cover is made up of native species.	
OR		
Patches with connectivity to other larger native vegetation remnants in the landscape.	The patch size is ≥ 0.5 ha; AND ≥ 30% of the perennial understorey vegetation cover is made up of native species; AND The patch is contiguous with a native vegetation remnant (any native vegetation where cover in each layer present is dominated by native species) that is ≥ 5ha in area.	
OR		
Patches that have large	The patch size is ≥ 0.5 ha in size;	

Table 4.6 Evaluation of Vegetation Zone 7 (HN529) at development site against EPBC Act listing advice thresholds

Category and Rationale	Threshold	Development site details
mature trees or trees with hollows (habitat) that are very scarce on the Cumberland Plain.	AND ≥ 30% of the perennial understorey vegetation cover is made up of native species; AND The patch has at least one tree with hollows per hectare or at least one large tree (≥80 cm dbh) per hectare from the upper tree layer species outlined in the Description and Appendix A (of the EPBC listing advice: Threatened Species Scientific Committee, 2008)	

4.5.3 Description of Plant Community Types within the Development Site

i. HN526: Forest Red Gum - Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney Basin

HN526 occurs in the central area of the development site as small, degraded patches associated with drainage lines, and moist areas surrounding a large dam. A representative photograph of this PCT is included as **Photograph 4.1**.

The upper stratum consists predominately of scattered *Eucalyptus crebra* (Narrow-leaved Ironbark) individuals, and to a lesser extent, occurrences of *Eucalyptus tereticornis* (Forest Red Gum). A mid-storey consisting of a small tree layer of *Melaleuca decora* and some regrowth occurrences of the canopy species is present. The shrub layer is mostly absent, with the only shrubs recorded within the community regrowth individuals of *Eucalyptus crebra* (Narrow-leaved Ironbark).

The ground layer is dominated by exotic species, the most prevalent being the exotic grass *Cynodon dactylon* (Couch), which made up over half of the ground layer at the time of the site survey. Other exotic grasses present include *Bromus catharticus* (Prairie Grass), *Chloris gayana* (Rhodes Grass), and *Paspalum dilatatum* (Paspalum). Exotic forbs are common in the ground layer, and species recorded include *Senecio madagascariensis* (Fireweed), *Lactuca saligna* (Willow-leaved Lettuce), *Cirsium vulgare* (Spear Thistle) and *Cotula coronopifolia* (Water Buttons).

The most common native species present in the ground layer is *Microlaena stipoides* (Weeping Grass) which is dominant in some small patches within the ground layer, and *Lachnagrostis filiformis* is present in smaller numbers. No other native grasses were recorded in a 20 x 20 m quadrat within the community. Diversity of native forbs is similarly

lacking, due to the dominance of suppressive exotic weed species, and historical cattle grazing. Species recorded include *Cotula australis* (Annual Buttonweed), *Plantago debilis*, and *Rumex brownii* (Swamp Dock).

Photograph 4.1 HN526 within the development site

ii. HN528: Grey Box - Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin

HN528 occurs as a small number of scattered patches in the eastern half of the development site, and along the southern boundary. The patches are degraded, with significant coverage of exotic species in the shrub and ground layer, however retain some diversity of native herbs, and the ground layer is dominated by a native grass. A representative photograph of this PCT is included as **Photograph 4.2**.

The upper stratum consists of remnant trees of *Eucalyptus crebra* (Narrow-leaved Ironbark), *Eucalyptus eugenioides* (Thin-leaved Stringybark), and *Eucalyptus tereticornis* (Forest Red Gum). *Eucalyptus moluccana* (Grey Box) is also present within the community, though is not common. The small tree layer is mostly absent, with the exception of a small number of regrowth individuals of the canopy species. The shrub layer consists of sparse occurrences of *Bursaria spinosa* (Blackthorn), and exotic species such as *Cestrum parqui* (Green Cestrum) and *Lycium ferocissimum* (African Boxthorn).

The ground layer is dominated by the native grass *Microlaena stipoides* (Weeping Grass). Other native grasses including *Aristida ramosa* (Purple Wiregrass), *Eragrostis leptostachya*

(Paddock Lovegrass) and *Chloris ventricosa* (Plump Windmill Grass) occur in lesser abundances. Native herbs present include *Einadia trigonos* (Fishweed), *Geranium solanderi* (Native Geranium), *Tricoryne elatior* (Yellow Autumn-lily) and *Poranthera microphylla*.

Exotic grasses and forbs are common in the ground layer. Grasses include *Briza subaristata* (Chilean Quaking Grass), *Axonopus fissifolius* (Carpet Grass), *Paspalum dilatatum* (Paspalum) and *Bromus catharticus* (Prairie Grass). Forbs include *Senecio madagascariensis* (Fireweed), *Sida rhombifolia* (Paddy's Lucerne) and *Modiola caroliniana* (Red-flowered Mallow).

Photograph 4.2 HN528 within the development site

iii. HN529 Grey Box - Forest Red Gum grassy woodland on shale of the southern Cumberland Plain, Sydney Basin Bioregion

HN529 is present within the development site as woodland patches along the western edge of the site and in the south-eastern corner. Some patches of the community have moderate levels of weed invasion in the ground layer, however this layer is reasonably intact across the site. A representative photograph of this PCT is included as **Photograph 4.3**.

The dominant tree species in the community across the site is *Eucalyptus tereticornis* (Forest Red Gum). *Eucalyptus moluccana* (Grey Box) and *Eucalyptus eugenioides* (Thin-leaved Stringybark), are also present, though not common. A small tree layer is present, comprised predominately of regrowth individuals of the canopy species, with isolated instances of *Acacia parramattensis* (Sydney Green Wattle).

The shrub layer across the site is comprised predominately of *Bursaria spinosa* (Blackthorn). The species occurs in some areas as scattered individuals, and in other areas in high densities in the understorey. Native shrub species that occur less frequently include *Ozothamnus diosmifolius* (Rice Flower) and *Dillwynia sieberi* (Prickly Parrot Pea), and regrowth individuals of the canopy species. The exotic shrub *Lycium ferocissimum* (African Boxthorn) is present within the community, and within the southernmost patch along the western boundary of the site, the exotic shrub *Dovyalis caffra* (Kei-apple) is common.

The native grass *Microlaena stipoides* (Weeping Grass) is dominant in the ground layer of all patches of the woodland on the site. Other native grasses present include *Aristida ramosa*, *Dichelachne micrantha* (Shorthair Plumegrass), *Paspalidium distans* and *Bothriochloa macra* (Red-leg Grass). Native forbs present include *Solanum prinophyllum* (Forest Nightshade), *Brunoniella australis* (Blue Trumpet), *Lomandra multiflora* (Many-flowered Mat-rush) and *Arthropodium sp B.* The presence of dense *Bursaria spinosa* (Blackthorn) in some areas provides shelter for the native sub-shrubs *Hibbertia diffusa* (Wedge Guinea Flower) and *Bossiaea prostrata,* which are not present in areas with an open understorey.

Exotic species make up a significant proportion of the ground layer within the community in most areas, though are not dominant. Exotic grasses present within the community include *Cynodon dactylon* (Couch), *Paspalum dilatatum* (Paspalum), *Ehrharta erecta* (Panic Veldtgrass) and *Briza subaristata*. Forbs include *Linum trigynum* (French Flax), *Cirsium vulgare* (Spear Thistle), *Hypochaeris radicata* (Catsear) and *Bidens pilosa* (Cobbler's Pegs).

Photograph 4.3 HN529 within the development site

iv. HN594: Swamp Oak swamp forest fringing estuaries, Sydney Basin Bioregion and South East Corner Bioregion

HN594 is associated with lower lying areas of the development site associated with drainage lines, and Ropes Creek. It occurs as a single patch in the west of the site, which is highly degraded, and as patches along the eastern boundary of the site. A representative photograph of this PCT is included as **Photograph 4.4**.

The canopy of the community across the development site is dominated by *Casuarina glauca* (Swamp Oak). A small tree layer of younger individuals of this species is present across the site, and *Melaleuca styphelioides* (Prickly-leaved Paperbark) also occurs in the small tree layer in the eastern patches.

The shrub stratum in the western patch of the site contains common occurrences of the exotic *Dovyalis caffra* (Kei-apple). Other exotic shrubs species within the community include *Lycium ferocissimum*, *Rosa rubiginosa* (Sweet Briar), and *Cestrum parqui* (Green Cestrum). Native shrubs recorded include juveniles of the tree and small tree layer species, along with *Bursaria spinosa* (Blackthorn), *Acacia parramattensis* (Sydney Green Wattle) and *Melaleuca linariifolia* (Flax-leaved Paperbark).

The ground layer is dominated in all patches by the native grass *Microlaena stipoides* (Weeping Grass). Other native grasses such as *Oplismenus aemulus* (Basket Grass), *Lachnagrostis filiformis*, and *Bothriochloa macra* (Red-leg Grass) are present in lesser abundances. Native forbs occurring within the community include *Einadia nutans* subsp. *linifolia* (Climbing Saltbush), *Plantago debilis*, *Carex inversa*, *Galium leptogonium, Scutellaria humilis* (Dwarf Skullcap) and *Plectranthus parviflorus* (Cockspur Flower).

Exotic species are common in the ground layer. Exotic sedges and grasses present within the community include *Juncus acutus* (Spiny Rush), *Cyperus eragrostis* (Umbrella Sedge), *Cynodon dactylon* (Couch), *Setaria parviflora* (Pigeon Grass) and *Paspalum dilatatum* (Paspalum). Exotic herbs such as *Solanum pseudocapsicum* (Jerusalem Cherry), *Sherardia arvensis* (Field Madder), *Rumex crispus* (Curled Dock) and *Plantago lanceolata* (Lamb's Tongues) are also present.

Photograph 4.4 HN594 within the development site

v. *Other Vegetation*

a. Native Revegetation Area

This section forms part of the proposed North South Link Road alignment that extends northwards into Fitzpatrick lands and historically is part of a revegetation area planted out by Greening Australia. Part of the community is present within the development site with a further patch is located within the Additional North South Link Road area on Fitzpatrick lands.

As it is an area of planted native vegetation within the development site, it does not conform to a PCT and, as such, does not require further assessment under the FBA.

The landform is a large mound, likely to have been created during construction of the adjacent pipelines that disect the proposed link road alignment. The vegetation on the top of the mound is dominated by a small tree layer of *Casuarina glauca* (Swamp Oak), and scattered individuals of *Acacia decurrens* (Black Wattle) occur in this area. The *Casuarina glauca* in this area may be growth from seed of individuals from Swamp Oak Forest which may have occurred at lower elevations to the south where the pipelines are currently situated, which were excavated, and seed along with soil piled up during construction works. Swamp Oak Forest does not naturally occur at this elevation (90 m ASL).

Further downslope of the revegetation area heading north along the link road alignment are several small tree-sized *Eucalyptus tereticornis* (Forest Red Gum), and a lesser number of *Eucalyptus amplifolia* (Cabbage Gum) which have been planted.

Shrub species present include juvenile *Casuarina glauca*, which is dominant, and *Eucalyptus tereticornis*. Other species present include *Callistemon salignus* (Willow Bottlebrush), *Acacia falcata* (Sickle Wattle), and *Dillwynia sieberi*.

The ground layer is dominated in the upper areas by native grasses, though exotic species are present in significant numbers, and exotic grass species increase in prevalence downslope to the north. Native species include *Eragrostis brownii* (Brown's Lovegrass), *Microlaena stipoides* (Weeping Grass), *Aristida ramosa* (Purple Wiregrass), and *Bothriochloa decipiens* (Pitted Bluegrass). Dominant exotic species include *Chloris gayana* (Rhodes Grass), *Eragrostis curvula* (African Lovegrass), and *Cynodon dactylon* (Couch).

Native forbs are uncommon with species recorded including *Fimbristylis dichotoma* (Common Fringe-sedge), *Lomandra longifolia* (Spiny Mat-rush), *Vittadinia cuneata* (Fuzzweed), and *Oxalis perennans*. Exotic forb species such as *Conyza sumatrensis* (Tall Fleabane), *Bidens subaristata* (Greater Beggar's Ticks), *Senecio madagascariensis* (Fireweed), and *Solanum sisymbriifolium* (Red Buffalo-bur), and *Cirsium vulgare* (Spear Thistle) are prevalent in the ground layer.

Photograph 4.5 *Casuarina glauca* dominating the mound top of revegetation area

Photograph 4.6 *Eucalyptus tereticornis* below mound top to the north

b. Exotic Grassland and Shrubby Regrowth

The majority of the proposed Western North/South Link Road alignment consists of exotic grassland, with occurrences of scattered, shrubby regrowth. Grassland areas are dominated by exotic species such as *Axonopus fissifolius* (Carpet Grass), *Cynodon dactylon*, and *Eragrostis curvula*. Native grass species are scattered throughout the area and include *Eragrostis brownii*, *Bothriochloa macra* (Redleg Grass), *Microlaena stipoides*, and *Sporobolus creber* (Rat's Tail Grass). Common exotic forb species include *Hypochaeris radicata* (Catsear), *Gamochaeta americanum* (Cudweed), *Conyza sumatrensis*, and *Hypochaeris microcephala* (White Flatweed). Native forbs occur less commonly and include *Fimbristylis dichotoma*, *Carex inversa,* and *Juncus usitatus*.

Shrubby regrowth growing throughout the exotic grassland consists of native species, likely to be regrowth occurrences of species present prior to historical clearing of the land. The dominant species is *Melaleuca nodosa* (Prickly-leaved Paperbark), and other shrubs such as *Callistemon pinifolius* (Pine-leaved Bottlebrush), *Melaleuca erubescens,* and the vulnerable species *Grevillea juniperina* subsp. *juniperina* occur less frequently.

Photograph 4.7 Exotic Grassland and Shrubby Regrowth within the proposed Western North/South Link Road Alignment

c. Exotic Grassland

The remaining vegetation within the wider Oakdale West development site is non-native and requires no further assessment unless it provides habitat for species credit species. The non-native vegetation within the development site comprises exotic grassland and does not conform to the determination for the derived native grassland component of Cumberland Plain Woodland CEEC due to its high percentage of exotic species cover and lack of native species present in the ground storey. The vegetation condition is a result of historic degradation due to past and present grazing of the development site and pasture improvement. A representative photograph of exotic grassland is shown in **Photograph 4.5.**

Exotic grasses are dominant in all areas, although some native grass species are present. Dominant exotic grasses include *Cynodon dactylon* (Couch), *Axonopus fissifolius* (Carpet Grass), *Briza subaristata* (Chilean Quaking Grass) and *Paspalum dilatatum* (Paspalum), with *Vulpia bromoides* (Squirrel Tail Fescue) and *Chloris gayana* (Shivery Grass) occurring less frequently. The most commonly occurring native grass is *Aristida ramosa*. Other native grasses present include *Dichelachne micrantha* (Shorthair Plume Grass), *Bothriochloa macra* (Red-leg Grass), *Lachnagrostis filiformis* and *Sporobolus creber* (Slender Rat's Tail Grass). Common exotic herbs include *Senecio madagascariensis* (Fireweed), *Hypochaeris radicata* (Catsear), *Lotus uliginosus* (Greater Birds-foot Trefoil) and *Anagallis arvensis* (Scarlet Pimpernel). Native herbs recorded in grassland areas include *Asperula conferta* (Common Woodruff), *Wahlenbergia gracilis* (Native Bluebell), *Juncus usitatus* and *Oxalis*

perennans (Wood Sorrel).Scattered trees are present within the grassland, which are representative of the PCTs that are may have historically occurred across the development site prior to grassland improvement. Scattered tree species include *Eucalyptus fibrosa* (Red Ironbark), *Eucalyptus moluccana* (Grey Box) and *Eucalyptus tereticornis* (Forest Red Gum).

Photograph 4.8 Exotic Grassland at the Oakdale West Estate development site

4.6 Vegetation Zones

All PCTs identified within the development site were assessed as being in moderate-good condition. Each of the four PCTs was assessed as being within one broad condition state and was initially assessed as a single vegetation zone. Each of these initial vegetation zones was assessed using plot and transect surveys to determine the site value score. Plot and transect data collected from the vegetation zones are provided in **Appendix A.**

Due to the fragmented nature of the development site and the distance between vegetation patches, for the purposes of this assessment, each PCT was subsequently split into multiple vegetation zones based on the connectivity of the patches. This was where the more isolated patches within the development site were a distance >100m from another patch of native vegetation. This was for the purpose of filtering predicted ecosystem credit species, resulting in the creation of nine vegetation zones.

As the different vegetation zones for each PCT occur in the same broad condition and zonation was based on the level of fragmentation rather than vegetation being in different conditions, the quadrat data collected for each PCT (based on the initial vegetation zones) were used to calculate the site value score for each of the vegetation zones for that PCT.

A summary of the vegetation zones and their calculated site value score within the development site is provided in **Table 4.7** and their distribution is shown in **Figure 4.5**. All of the vegetation zones within the development site have a site value score of ≥17 and therefore, must be further assessed.

Table 4.7 Vegetation zones within the development site

Vegetation Zone	PCT	Condition*	Area (ha)	Site Value Score	Patch Size (ha)
1	HN526: Forest Red Gum - Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney Basin Bioregion	Moderate/Good	0.57	28.65	224
2	HN526: Forest Red Gum - Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney Basin Bioregion	Moderate/Good_High	0.23	28.65	1
3	HN526: Forest Red Gum - Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney Basin Bioregion	Moderate/Good_Medium	0.32	28.65	1
4	HN528: Grey Box - Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin Bioregion	Moderate/Good	0.89	53.86	224
5	HN528: Grey Box - Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin Bioregion	Moderate/Good_High	0.05	53.86	1
6	HN528: Grey Box - Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin Bioregion	Moderate/Good_Medium	0.10	53.86	1
7	HN529: Grey Box - Forest Red Gum grassy woodland on shale of the southern Cumberland Plain, Sydney Basin Bioregion	Moderate/Good	1.07	39.86	224
8	HN529: Grey Box - Forest Red Gum grassy woodland on shale of the southern Cumberland Plain, Sydney Basin Bioregion	Moderate/Good_High	0.10	39.86	1
9	HN594: Swamp Oak floodplain swamp forest, Sydney Basin Bioregion and South East Corner Bioregion	Moderate/Good	1.62	65.22	224

** Condition names reflect options available within the BioBanking Credit Calculator rather than on-ground condition.*

4.7 Groundwater Dependent Ecosystems

Groundwater dependent ecosystems (GDEs) were initially assessed by reviewing the Groundwater Dependent Ecosystem Atlas (BOM, 2015) for the development site.

One GDE was identified within the development site as Cumberland River Flat Forest, which corresponds to the PCT HN526: Forest Red Gum - Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney Basin and HN594: Swamp Oak swamp forest fringing estuaries, Sydney Basin Bioregion and South East Corner Bioregion previously identified within ***Section 4.6***. The impacts to both PCTs that are identified as GDEs within the development site will be assessed in **Chapter 7**. A figure showing the location of all GDEs identified within the development site is shown in **Figure 4.6**.

Coordinate System: MGA Zone 56 (GDA 94)

Legend

- Development Site
- Additional North-South Link Road Area
- Lot Boundary
- Flora Plot Location

Grid North

Scale: 1:9,847 @ A3 page
Date prepared: 31/03/2017

Image Source:
Image © Nearmap
(dated 11/02/2017)

Data Source:
Image © 2015
NSW Land and Property
Management Authority,
SIX Viewer

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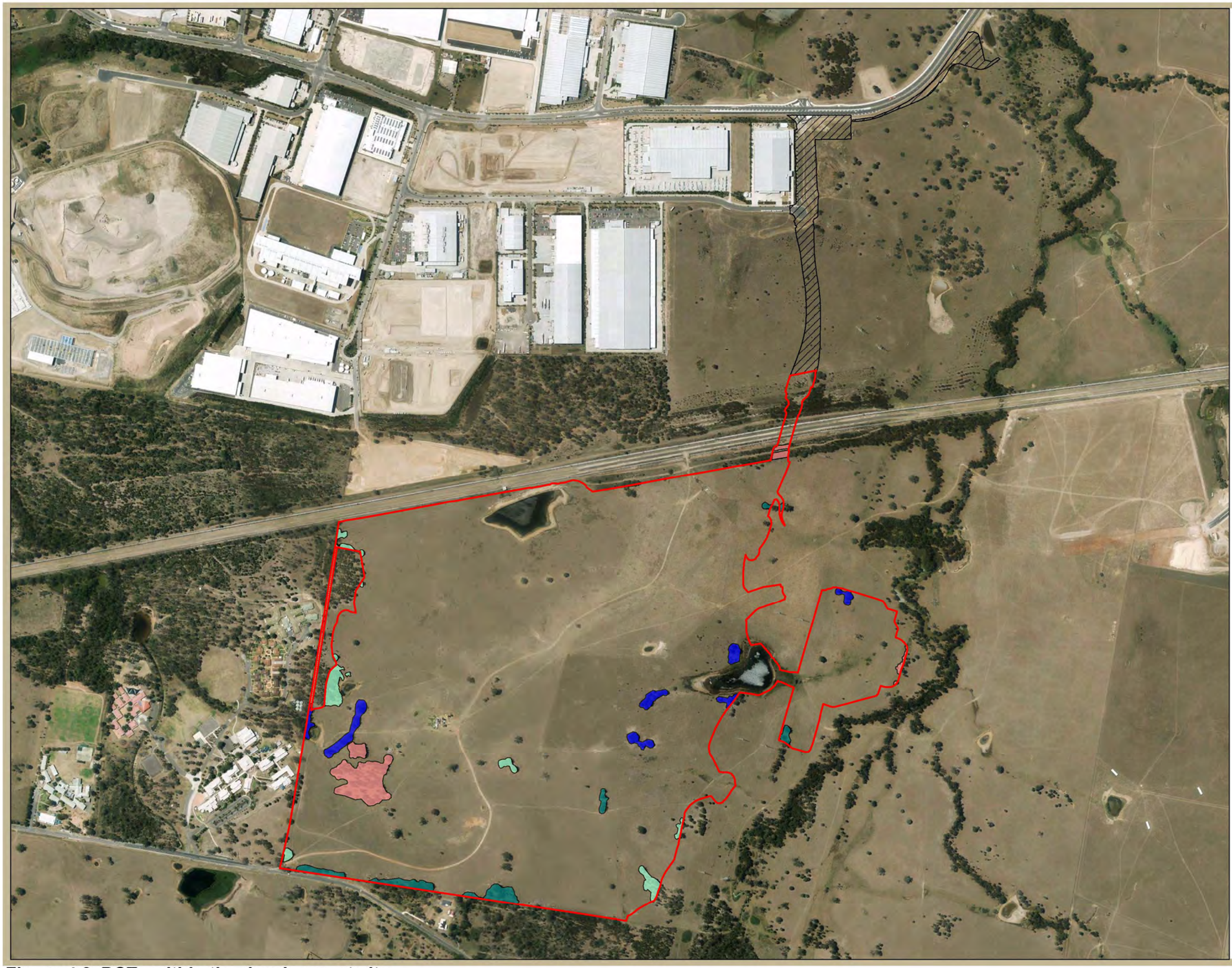
I:\...\15122\Figures\RP1_BAR\20170331\Figure 4.1. Floristic Plot Survey Sites

Figure 4.1. Plot-based full floristic survey and plot and transect survey sites

100 0 100 200 300 400 m

Coordinate System: MGA Zone 56 (GDA 94)



Legend

Development Site

Additional North-South Link Road Area

PCT

- 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 shale of the southern Cumberland Plain, Sydney Basin Bioregion (HN529)
- Grey Box - Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin Bioregion (HN528)
- Swamp Oak floodplain swamp forest, Sydney Basin Bioregion and South East Corner Bioregion (HN594)

N

Grid North

Scale: 1:9,339 @ A3 page
Date prepared: 31/03/2017

Image Source:
Image © Nearmap
(dated 11/02/2017)

Data Source:
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NSW Land and Property Management Authority,
SIX Viewer

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100 0 100 200 300 400 m

I:\...\15122\Figures\RP1_BAR\20170331\Figure 4.2. PCTs_Development Site

Figure 4.2. PCTs within the development site

Coordinate System: MGA Zone 56 (GDA 94)

Legend

Development Site

Additional North-South Link Road Area

TEC (TSC Act)

Cumberland Plain Woodland in the Sydney Basin Bioregion

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

Swamp Oak Floodplain Forest of the NSW North Coast, Sydney Basin and South East Corner Bioregions

N

Grid North

Scale: 1:9,339 @ A3 page
Date prepared: 31/03/2017

Image Source:
Image © Nearmap
(dated 11/02/2017)

Data Source:
Image © 2015
NSW Land and Property Management Authority,
SIX Viewer

cumberland ecology

I:\...\15122\Figures\RP1_BAR\20170331\Figure 4.3. TSC Act TECs_Development Site

Figure 4.3. TSC Act TECs within the development site

100 0 100 200 300 400 m

Coordinate System: MGA Zone 56 (GDA 94)

Legend

Development Site

Additional North-South Link Road Area

TEC (EPBC Act)

Cumberland Plain Shale Woodlands and Shale-Gravel Transition Forest

Grid North

Scale: 1:9,339 @ A3 page
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I:\...\15122\Figures\RP1_BAR\20170331\Figure 4.4. EPBC Act TECs_Development Site

Figure 4.4. EPBC Act TECs within the development site

100 0 100 200 300 400 m

Coordinate System: MGA Zone 56 (GDA 94)

Legend

- Development Site
- Additional North-South Link Road Area

Vegetation Zone

- Zone 1: HN526 (Mod/Good)
- Zone 2: HN526 (Mod/Good_High)
- Zone 3: HN526 (Mod/Good_Medium)
- Zone 4: HN528 (Mod/Good)
- Zone 5: HN528 (Mod/Good_High)
- Zone 6: HN528 (Mod/Good_Medium)
- Zone 7: HN529 (Mod/Good)
- Zone 8: HN529 (Mod/Good_High)
- Zone 9: HN594 (Mod/Good)

N
Grid North

Scale: 1:9,339 @ A3 page
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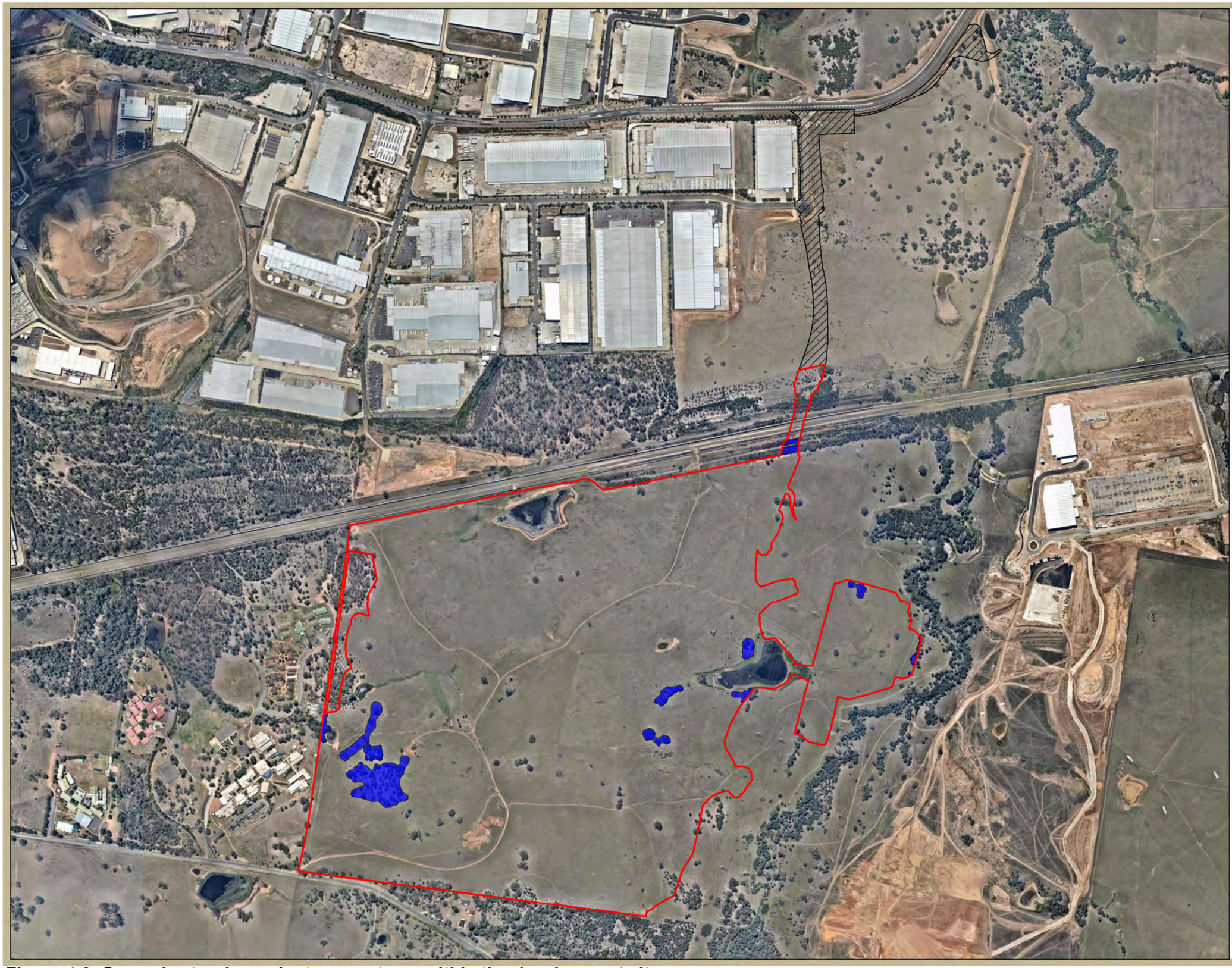
I:\...\15122\Figures\RP1_BAR\20170331\Figure 4.5. Vegetation Zones_Development Site

Figure 4.5. Vegetation zones within the development site

100 0 100 200 300 400 m

Coordinate System: MGA Zone 56 (GDA 94)



Legend

- Development Site
- Additional North-South Link Road Area

Groundwater Dependent Ecosystems

- Cumberland River Flat Forest

Grid North

Scale: 1:9,339 @ A3 page
Date prepared: 31/03/2017

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I:\...\15122\Figures\RP1_BAR\20170331\Figure 4.6. GDEs_Development Site

Figure 4.6. Groundwater dependent ecosystems within the development site

100 0 100 200 300 400 m

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Chapter 5

Threatened Species and Populations

5.1 Review of Existing Data

The following primary sources of information were consulted as part of a desktop assessment of potentially occurring threatened species and populations within the development site:

- Office of Environment and Heritage (OEH) Atlas of NSW Wildlife (OEH, 2015);
- Threatened Species Profile Database;
- Ecological Assessment – Oakdale Concept Plan (Cumberland Ecology, 2007);
- Oakdale South Estate Biodiversity Assessment Report (Cumberland Ecology, 2016);
- Oakdale South Biodiversity Assessment Report – Section 96 (Cumberland Ecology, 2016)
- Erskine Park Link Road Network Concept Plan (NSW Department of Planning, 2009); and
- Revised Biodiversity Management Plan Erskine Park Employment Area: 2007 (HLA-Envirosciences, 2007).

Information obtained during the review of existing data was utilised in determining candidate ecosystem credits species and species credit species.

5.2 Field Surveys

5.2.1 Habitat Assessment

A general fauna habitat assessment was undertaken within the Oakdale West Estate development site and adjoining land on 15 October 2015 and within the proposed Western North/South Link Road on 8 April 2016. Fauna habitat assessments were undertaken in conjunction with flora surveys during the development site assessment. Fauna habitat assessments included consideration of important indicators of habitat condition and complexity including the occurrence of microhabitats such as tree hollows, fallen logs, bush rock and wetland areas such as creeks and soaks and the presence of mistletoe and

flowering trees for nectivorous bird species. Hollows were used as a general indication of habitat quality for arboreal fauna, and hollow dwelling birds and bats.

5.2.2 Threatened Frog Habitat Suitability Assessment

Threatened frog habitat suitability assessment and diurnal surveys were conducted on 22 October 2015 during suitable weather conditions.

The habitat suitability assessment and diurnal search within the development site included five farm dams and surrounding vegetation (see **Figure 5.1**) and surveys were aimed at:

- Determining the range of frog species on the site; and
- Determining whether any threatened frogs may be present.

The assessment carried out at each dam to determine the suitability of the dam to support this species based on the following parameters:

- Cover of fringing vegetation;
- Cover of emergent vegetation;
- Type of vegetation around the dam;
- Presence of shallow dam edges;
- Varying water depth;
- Presence of submerged rocks and logs;
- Presence/absence of Gambusia; and
- Water turbidity.

Using these parameters as a guide for the suitability of the dam, the dams could then be considered either suitable or unsuitable for supporting threatened frog species. As a result of the habitat suitability assessments four of the five dams present within the impact area were considered to contain suitable features to support populations of Green and Golden Bell Frogs but none of the dams were considered suitable for Giant Burrowing Frogs.

5.2.3 Targeted Threatened Species Surveys

i. Flora

Targeted threatened flora searches were undertaken via random meanders during field surveys. Targeted searches were undertaken by a botanist within areas of vegetation suitable for supporting threatened species found in the locality on the 15 October 2015 within the Oakdale West Estate and on 8 April 2016 within the proposed North/South Link Road alignment. A total of 14 person hours were spent traversing the development site and

proximate sections of the Additional North South Link Road area within areas of suitable habitat for each threatened flora species assessed as a candidate species credit species.

ii. Fauna

The following targeted threatened fauna surveys were undertaken within the development site and adjoining land for species credit species that are candidate species or those that are candidate species for further assessment:

- Amphibian surveys: Green and Golden Bell Frog (*Litoria aurea*) and Giant Burrowing Frog (*Heleioporus australiacus*);
- Diurnal bird surveys: Regent Honeyeater (*Anthochaera phrygia*) and Black Bittern (*Ixobrychus flavicollis*);
- Spotlighting and call playback: Koala (*Phascolarctos cinereus*) and Squirrel Glider (*Petaurus norfolcensis*); and
- Cumberland Plain Land Snail (*Meridolum corneovirens*) searches.

The locations of targeted threatened fauna surveys are shown in **Figure 5.1**. Further details of each survey method utilised for this assessment are provided below. A summary of survey effort is shown in **Table 5.1**.

a. Amphibian Surveys

In accordance with the Commonwealth *Survey guidelines for Australia's threatened frogs* (DEWHA, 2010) surveys were conducted at the development site for a minimum of four nights.

Frog surveys were carried out on 22, 26, 27 and 28 October 2015. Weather conditions on all four surveys were dry and warm. The last rains before the commencement of the surveys had occurred on 14 October 2015 and heavy rains then occurred on 23 and 27 October 2015. Such conditions are suitable for frog surveys.

All potential frog sites were visited firstly during the day as part of basking surveys and tadpoles surveys for one visit. Following the first visit, each of the dams were visited at night for a further three nights to listen for calling frogs. Calling frogs were noted and non-calling frogs were detected using headlamps. Breeding call imitation and sound stimulation was used in each of the potential habitat areas of the Green and Golden Bell Frog to try to evoke calling by sheltering frogs. A listening period of two minutes followed each calling session.

b. Diurnal Bird Surveys

Visual observation and call identification of diurnal birds was carried out during each survey period within development site. Two (2) 30-minute diurnal bird census points were surveyed between two ecologists equating to a total of 60 minutes survey effort at each diurnal bird census survey point. Diurnal birds were also identified and recorded as they were encountered throughout the development site during all other surveys.

c. Arboreal Mammals Surveys

Although not required for this assessment, nocturnal spotlighting was conducted for arboreal mammals using a hand-held spotlight while walking around suitable habitat for arboreal mammals. During spotlighting surveys, call playback of taped Squirrel Glider and Koala calls were broadcast using a megaphone to illicit a response from targeted threatened nocturnal species. Calls were played for two minute periods at five minute intervals. This was followed by a period of quiet listening and spotlighting.

d. Cumberland Plain Land Snail Searches

Within suitable patches of woodland within the impact area, the bases of trees that had leaf litter present were searched for the presence of Cumberland Plain Land Snail. Approximately five minutes was spent at each tree hand searching through the leaf litter and around exposed root systems for the presence of live snails or shells.

e. Incidental Observations

Any incidental vertebrate fauna species that was observed, heard calling, or otherwise detected on the basis of tracks or signs were recorded and listed in the total species list for the development site.

f. Survey Effort

Fauna survey methods and survey effort are summarised in **Table 5.1**.

Table 5.1 Fauna survey effort

Survey Technique	Survey Dates	Total Survey Effort	Survey Effort within Development Site
Amphibian surveys	22 October, 26-28 October 2015	12 person hours (5 nights at 4 sites)	12 person hours (4 nights at 5 sites)
Diurnal bird surveys	22 and 23 October 2015 8 and 13 April 2016	20 person hours (10 sites)	20 person hours (10 sites)
Spotlighting and call playback	26-28 October 2015	4 sites for 3 nights	6 sites for 3 nights
Cumberland Plain Land Snail searches	15 October 2015	4 person hours (4 sites)	4 person hours (4 sites)
Incidental observations	Throughout survey periods	n/a	n/a

5.2.4 Weather Conditions

Weather conditions during flora and fauna surveys were generally appropriate for detection of a wide variety of flora and fauna. A summary of the weather conditions during surveys is shown in **Table 5.2**.

The weather conditions at the time of the flora surveys were generally favourable for plant growth and production of features required for identification of most species.

Conditions during the fauna survey were hot sunny days with clear, cool nights. Daytime maximums were generally between 25 – 32 ºC, with still evenings dropping to as low as 11.1 ºC. Conditions were deemed suitable for amphibians with recent rain prior to survey.

Table 5.2 Weather conditions during survey

Date	Minimum Temperature (ºC)*	Maximum Temperature(ºC)*	Rainfall (mm)**
12/10/2015	14.6	32.2	4.0
15/10/2015	13.8	29.6	0.0
16/10/2015	13.9	34.4	0.0
19/10/2015	17.7	28.8	0.0
20/10/2015	15.4	33.5	0.0
22/10/2015	16.9	22.1	2.0
23/10/2015	13.8	19.7	15.0
26/10/2015	14.0	25.2	0.0
27/10/2015	14.0	18.3	12.0
28/10/2015	11.1	21.2	0.0
08/04/2016	16.7	20.8	0.0
13/04/2016	14.2	25.0	0.0

* *Data obtained from the Horsley Park Equestrian Centre station (Bureau of Meteorology, 2015)*

** *Data obtained from the Erskine Park Reservoir (Bureau of Meteorology, 2015)*

5.2.5 Survey Limitations

i. Flora

The field surveys have produced reliable information regarding flora species occurrences within the development site and are considered to be adequate to support the assessment of the Project impacts. Notwithstanding this, the data produced by the surveys is intended only to be indicative of the types of species that could occur and not an absolute census of all flora species of the development site. Although many species were detected during field surveys, additional species are likely to be present that have not been observed. Factors such as seasonality, population density and cryptic life histories can all affect the ability to detect species on ground.

To address the above limitations, surveys were conducted to best account for flowering schedules and other variations that may affect detectability. In addition to this, a precautionary approach was used to assess threatened species impacts. Presence of suitable habitat was considered when assessing the potential occurrence of a given threatened species; where potential habitat was present and the species was known to occur at other locations in the locality, it was assumed that the species had potential to occur and were thus assessed accordingly.

ii. Fauna

Fauna surveys relied on literature review, database analysis, fauna habitat assessment and on site fauna surveys. In common with the flora surveys, the fauna surveys were undertaken in a short period of time and therefore the fauna species recorded are a "snapshot" only, of species that were active at the time. It is likely that additional species would be recorded with more survey effort. Taking into consideration all the ecological survey effort that has been spent on the development site and adjacent land, it is considered that the fauna surveys were adequate, and that all threatened species with potential to occur are known and have been satisfactorily assessed.

iii. Additional North South Link Road area

The surveys conducted included areas of the Additional North South Link Road area as a precautionary measure. Subsequent to the conduction of surveys, confirmation was received that further surveys and assessments were not required for areas contained within Fitzpatrick land as this area as previously been assessed in detail for ecological impacts (KMA, 2016) and has received approval for development subject to the creation of a conservation zone. Therefore areas within the Fitzpatrick land are excluded from the development site for this BAR.

5.3 Fauna Habitats within the Development Site

The majority of the development site is highly disturbed by activities associated with cattle grazing and forms mostly degraded and unsuitable habitat for many native fauna species. At the time of survey approximately 95% of the development site was exotic grassland.

5.3.1 Woodland Habitat

The intact woodland areas on the western edge of the development site contain mostly immature trees with some large mature trees scattered through the vegetation communities. The mid-storey and ground layer has been heavily grazed by cattle and Eastern Grey Kangaroos (*Macropus giganteus*). The majority of bird species were found in this habitat type. A greater diversity would be expected if this zone was wider and structurally more complex. Some regeneration is taking place in remnant patches of woodland and some areas also have a developing shrub layer of *Bursaria spinosa* (Blackthorn).

The majority of trees within the development site are young and do not contain hollows; however, several old trees have been retained within paddocks and several stags also occur

on site. The hollows of two of these stags were observed to be used by Red-rumped Parrots (*Psephotus haematonotus*) which would preclude them being used by any of the other threatened bird species recorded in the locality as roosting/nesting habitat.

No 'camps' or other roosting habitat is available for the Grey-headed Flying-fox (*Pteropus poliocephalus*) on or near the development site and there is little suitable habitat present to support roosting or breeding microbat species.

Foraging habitat does occur within the woodland remnants on the development - six native tree species were identified that produce blossoms and nectar:

- Rough-barked Apple (*Angophora floribunda*);
- Cabbage Gum (*Eucalyptus amplifolia*);
- Narrow-leaved Ironbark (*Eucalyptus crebra*);
- Broad-leaved Ironbark (*Eucalyptus fibrosa*);
- Grey Box (*Eucalyptus moluccana*); and
- Forest Red Gum (*Eucalyptus tereticornis*).

Photograph 5.1 Woodland habitat on the western edge of the development site

5.3.2 Aquatic Habitat

On the edges of these woodland areas are two small farm dams that have been eroded by cattle but does provide some habitat for wetland birds and frogs. In addition, two large dams and one smaller dam are present within the paddocks which also provide habitat for invertebrates, fish species, amphibians, reptiles and wetland birds. Some suitable habitat for Green and Golden Bell Frog occurs on the study area in and around un-shaded dams, particularly in areas containing reeds, bulrushes (*Typha* spp.) or spike rushes (*Eleocharis* spp.).

Photograph 5.2 Large dam on the eastern boundary of the development site

5.3.3 Grassland Habitat

Grassland habitats comprise the majority of the available habitat at the development site. Grassland habitats are devoid of logs, rocks, caves and outcrops, and are more suited to grazing macropods and introduced herbivores. Grassland habitat across the development site is relatively uniform with no features such as burrows observed during site inspections.

Photograph 5.3 Grassland habitat within the development site

5.3.4 Revegetation Area Habitat

The revegetation area is devoid of logs, rocks, caves and outcrops, and is more suited to grazing macropods. The revegetation area habitat within the development site is juvenile with no features such as hollows observed during site inspections.

Photograph 5.4 Revegetation area within the development site

5.4 Ecosystem Credit Species

5.4.1 Predicted Ecosystem Credit Species

The BioBanking Credit Calculator (BBCC) generates a list of predicted ecosystem credit species utilising a number of variables. **Table 5.3** shows the ecosystem credit species have the highest Tg value in each vegetation zone and **Table 5.4** lists the predicted ecosystem credit species for the development site, which has been based on the following:

- IBRA subregion: Cumberland;
- Associated PCTs: HN526, HN528, HN529 and HN594;
- Percent native vegetation in outer assessment circle: 16.09%;
- Condition of vegetation: moderate to good (all vegetation zones);
- Patch size: 224.15 ha (Vegetation Zones 1, 4, 7 and 9);
- Credit type: Ecosystem.

No additional assessment of habitat components for the predicted ecosystem credit species has been undertaken for this assessment.

Table 5.3 Ecosystem credit species with the highest Tg value in each vegetation zone

Vegetation Zone	Scientific Name	Common Name	Tg Value
1	*Tyto novaehollandiae*	Masked Owl	3.0
2	*Saccolaimus flaviventris*	Yellow-bellied Sheathtail-bat	2.2
3	*Saccolaimus flaviventris*	Yellow-bellied Sheathtail-bat	2.2
4	*Ninox connivens*	Barking Owl	3.0
5	*Saccolaimus flaviventris*	Yellow-bellied Sheathtail-bat	2.2
6	*Saccolaimus flaviventris*	Yellow-bellied Sheathtail-bat	2.2
7	*Ninox connivens*	Barking Owl	3.0
8	*Saccolaimus flaviventris*	Yellow-bellied Sheathtail-bat	2.2
9	*Tyto novaehollandiae*	Masked Owl	3.0

Table 5.4 Predicted ecosystem credit species

Scientific Name	Common Name	Tg Value	Predicted to occur within PCT/Vegetation Zone?								
			Zone 1 (HN526)	Zone 2 (HN526)	Zone 3 (HN526)	Zone 4 (HN528)	Zone 5 (HN528)	Zone 6 (HN528)	Zone 7 (HN529)	Zone 8 (HN529)	Zone 9 (HN594)
Rostratula australis	Australian Painted Snipe	1.3									Yes
Ninox connivens	Barking Owl	3.0	Yes			Yes			Yes		Yes
Melithreptus gularis subsp. gularis	Black-chinned Honeyeater (eastern subspecies)	1.3	Yes			Yes			Yes		
Climacteris picumnus subsp. victoriae	Brown Treecreeper (eastern subspecies)	2.0	Yes			Yes			Yes		
Burhinus grallarius	Bush Stone-curlew	2.6	Yes			Yes			Yes		Yes
Stagonopleura guttata	Diamond Firetail	1.3	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	
Falsistrellus tasmaniensis	Eastern False Pipistrelle	2.2	Yes			Yes			Yes		
Mormopterus norfolkensis	Eastern Freetail-bat	2.2	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Petroica phoenicea	Flame Robin	1.3	Yes			Yes			Yes		
Stictonetta naevosa	Freckled Duck	1.3									Yes
Callocephalon fimbriatum	Gang-gang Cockatoo	2.0	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	
Calyptorhynchus lathami	Glossy Black-Cockatoo	1.8									Yes
Scoteanax rueppellii	Greater Broad-nosed Bat	2.2	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Melanodryas cucullata subsp. cucullata	Hooded Robin (south-eastern form)	1.7	Yes			Yes			Yes		
Hieraaetus morphnoides	Little Eagle	1.4	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Table 5.4 Predicted ecosystem credit species

Scientific Name	Common Name	Tg Value	Predicted to occur within PCT/Vegetation Zone?								
			Zone 1 (HN526)	Zone 2 (HN526)	Zone 3 (HN526)	Zone 4 (HN528)	Zone 5 (HN528)	Zone 6 (HN528)	Zone 7 (HN529)	Zone 8 (HN529)	Zone 9 (HN594)
Glossopsitta pusilla	Little Lorikeet	1.8	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Tyto novaehollandiae	Masked Owl	3.0	Yes			Yes			Yes		Yes
Grantiella picta	Painted Honeyeater	1.3	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	
Ninox strenua	Powerful Owl	3.0	Yes			Yes			Yes		Yes
Petroica boodang	Scarlet Robin	1.3	Yes			Yes			Yes		
Chthonicola sagittata	Speckled Warbler	2.6	Yes			Yes			Yes		
Circus assimilis	Spotted Harrier	1.4	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	
Dasyurus maculatus	Spotted-tailed Quoll	2.6	Yes			Yes			Yes		Yes
Lophoictinia isura	Square-tailed Kite	1.4	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Lathamus discolor	Swift Parrot	1.3	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Neophema pulchella	Turquoise Parrot	1.8	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	
Daphoenositta chrysoptera	Varied Sittella	1.3	Yes			Yes			Yes		Yes
Saccolaimus flaviventris	Yellow-bellied Sheathtail-bat	2.2	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

5.5 Species Credit Species

5.5.1 Candidate Species Credit Species

The BBCC generates a list of candidate species credit species utilising a number of variables including classification of the species as a species credit species, the distribution of the species within the same IBRA subregion as the development site and the presence of habitat features or components associated with the species. The habitat features that have been assessed as present within the development site are as follows:

- Swamps, swamp margins or creek edges;
- Land within 40m of heath, woodland or forest;
- Land within 40 m of freshwater and estuarine wetlands, in areas of permanent water and dense vegetation or emergent aquatic vegetation;
- Land within 100 m of emergent aquatic or riparian vegetation;
- Wet and damp areas only;
- Land situated in damp, disturbed sites;
- Land containing bark or leaf litter accumulation;
- Alluvial soils; and
- Periodically waterlogged sites (including table drains and farm dams).

Species credit species that have been generated within the BBCC as candidate species for this assessment are listed in **Table 5.5**. This includes 21 flora species or populations and 10 fauna species.

5.5.2 Candidate Species for Further Assessment

Table 5.5 lists the candidate species credits generated within the credit calculator and an assessment of their potential presence within the development site based on habitat components and review of species distributions. The following species credit species have been considered as potentially occurring and are required to be further assessed:

- Flora species:
  - *Acacia pubescens*;
  - *Cynanchum elegans*;
  - *Dillwynia tenuifolia*;
  - *Dillwynia tenuifolia - endangered population Kemps Creek*;

- *Eucalyptus benthamii*;
- *Grevillea juniperina* subsp. *juniperina*;
- *Hypsela sessiliflora*;
- *Marsdenia viridiflora subsp. viridiflora - endangered population*;
- *Persicaria elatior*;
- *Persoonia bargoensis*;
- *Pilularia novae-hollandiae*;
- *Pimelea spicata*;
- *Pomaderris brunnea*; and
- *Wahlenbergia multicaulis - endangered population*.

➢ Fauna species:

- Cumberland Plain Land Snail;
- Green and Golden Bell Frog; and
- Regent Honeyeater.

Table 5.5 Assessment of potential presence of species credit species

Scientific name	Common name	Associated PCTs within the Development Site	Required Habitat Components	Assessment of Habitat Within the Development Site	Requires Further Assessment?
Flora					
Acacia bynoeana	Bynoe's Wattle	HN528, HN529	Occurs in heath or dry sclerophyll forest on sandy soils. Associated overstorey species include Red Bloodwood, Scribbly Gum, Parramatta Red Gum, Saw Banksia and Narrow-leaved Apple.	Unlikely to occur. No sandy soil and/or associated overstorey species present. No records of the species within a 10 km radius of the development site.	No
Acacia pubescens	Downy Wattle	HN528, HN529	Occurs on alluviums, shales and at the intergrade between shales and sandstones. The soils are characteristically gravely soils, often with ironstone. Occurs in open woodland and forest, in a variety of plant communities, including Cooks River/ Castlereagh Ironbark Forest, Shale/ Gravel Transition Forest and Cumberland Plain Woodland.	Potential to occur. Cumberland Plain Woodland is present within the development site. 7 records of the species within a 10 km radius of the development site.	Yes
Cynanchum elegans	White-flowered Wax Plant	HN526, HN528, HN529	Usually occurs on the edge of dry rainforest vegetation. Other associated vegetation types include littoral rainforest; Coastal Tea-tree–Coastal Banksia coastal scrub; Forest Red Gum aligned open forest and woodland; Spotted Gum aligned open forest and woodland; and Bracelet	Potential to occur. Woodland containing Forest Red Gum present within the development site. No records of the species within a 10 km radius of the development site.	Yes

Table 5.5 Assessment of potential presence of species credit species

Scientific name	Common name	Associated PCTs within the Development Site	Required Habitat Components	Assessment of Habitat Within the Development Site	Requires Further Assessment?
			Honeymyrtle scrub to open scrub.		
Dillwynia tenuifolia	Dillwynia tenuifolia	HN528, HN529	May be locally abundant particularly within scrubby/dry heath areas within Castlereagh Ironbark Forest and Shale Gravel Transition Forest on tertiary alluvium or laterised clays. May also be common in transitional areas where these communities adjoin Castlereagh Scribbly Gum Woodland.	Potential to occur. Some marginal habitat present within HN528. 56 records of the species within a 10 km radius of the development site.	Yes
Dillwynia tenuifolia - endangered population Kemps Creek	Dillwynia tenuifolia (a shrub) population, Kemps Creek	HN528, HN529	Occurs on a small outlier of the Berkshire Park Soil Landscape. The site supports a transition from Castlereagh Ironbark Forest to Castlereagh Scribbly Gum Woodland. Portions of the site contain a form of Shale Gravel Transition Forest	Potential to occur. Some marginal habitat present within HN528. 26 records of the species within a 10 km radius of the development site.	Yes
Eucalyptus benthamii	Camden White Gum	HN526, HN528, HN529	Occurs on the alluvial flats of the Nepean River and its tributaries. Requires a combination of deep alluvial sands and a flooding regime that permits seedling establishment. Associated canopy species include *Eucalyptus elata, E. bauerina, E. amplifolia, E. deanei, Angophora subvelutina, E. crebra, E. deanei, E. punctata.*	Potential to occur. *Eucalyptus amplifolia* present within HN526 and HN594. No records of the species within a 10 km radius of the development site.	Yes

Table 5.5 Assessment of potential presence of species credit species

Scientific name	Common name	Associated PCTs within the Development Site	Required Habitat Components	Assessment of Habitat Within the Development Site	Requires Further Assessment?
Grevillea juniperina subsp. juniperina	Juniper-leaved Grevillea	HN528, HN529	Grows on reddish clay to sandy soils derived from Wianamatta Shale and Tertiary alluvium (often with shale influence), typically containing lateritic gravels. Recorded from Cumberland Plain Woodland, Castlereagh Ironbark Woodland, Castlereagh Scribbly Gum Woodland and Shale/Gravel Transition Forest.	Potential to occur. Suitable habitat present in HN528. 96 records of the species within a 10 km radius of the development site.	Yes
Hibbertia sp. Bankstown	Hibbertia sp. Bankstown	HN526, HN529	Remnant vegetation at the known location (Bankstown Airport) and soil type (silty sandy alluvium) are consistent with an inferred pre-settlement cover of Castlereagh Ironbark Forest although some remnant vegetation at and near the site (along the channel in particular) suggests Castlereagh Scribbly Gum equally valid.	Unlikely to occur. Neither Castlereagh Scribbly Gum Forest nor Castlereagh Ironbark Forest are present on the soil, and associated sandy alluvium soils and soils containing laterites are not present. No records of the species within a 10 km radius of the development site.	No
Hypsela sessiliflora	Hypsela sessiliflora	HN526, HN528, HN529, HN594	Damp places	Potential to occur. Damp areas in HN526, HN528 and HN594 are present. 7 records of the species within a 10 km radius of the development site.	Yes
Marsdenia	Marsdenia viridiflora	HN526, HN528,	Grows in vine thickets and open shale	Potential to occur. Open Shale Woodland	Yes

Table 5.5 Assessment of potential presence of species credit species

Scientific name	Common name	Associated PCTs within the Development Site	Required Habitat Components	Assessment of Habitat Within the Development Site	Requires Further Assessment?
viridiflora subsp. viridiflora - endangered population	subsp. viridiflora in the Bankstown, Blacktown, Camden, Campbelltown, Fairfield, Holroyd, Liverpool and Penrith local government areas	HN529	woodland.	(HN528, HN529 and HN526) is present. 3 records of the species within a 10 km radius of the development site.	
Melaleuca biconvexa	Biconvex Paperbark	HN594	Swamps, swamp margins or creek edges. Generally grows in damp places, often near streams or low-lying areas on alluvial soils of low slopes or sheltered aspects.	Unlikely to occur. Suitable habitat in sheltered areas of HN526 and HN595 besides creek lines. However species is not known to occur in the Sydney Region. No records of the species within a 10 km radius of the development site.	No
Persicaria elatior	Tall Knotweed	HN526	Grows in damp places, especially beside streams and lakes. Occasionally in swamp forest or associated with disturbance.	Potential to occur. Damp places in creek lines in HN526 are present. No records of the species within a 10 km radius of the development site.	Yes
Persoonia bargoensis	Bargo Geebung	HN528, HN529	Occurs in woodland or dry sclerophyll forest on sandstone and on heavier, well drained, loamy, gravelly soils of the Wianamatta Shale and .Hawkesbury Sandstone.	Potential to occur. Dry Sclerophyll Forest on Wianamatta Shale derived soils is present on the site. No records of the species within a 10 km radius of the	Yes

Table 5.5 Assessment of potential presence of species credit species

Scientific name	Common name	Associated PCTs within the Development Site	Required Habitat Components	Assessment of Habitat Within the Development Site	Requires Further Assessment?
				development site.	
Pilularia novae-hollandiae	Austral Pillwort	HN526	Periodically waterlogged sites (including table drains). Grows in shallow swamps and waterways, often among grasses and sedges.	Potential to occur. Suitable habitat present within a first order stream within the development site. No records of the species within a 10 km radius of the development site.	Yes
Pimelea curviflora var. curviflora	*Pimelea curviflora var. curviflora*	HN528, HN529	Occurs on shaley/lateritic soils over sandstone and shale/sandstone transition soils on ridgetops and upper slopes amongst woodlands.	Unlikely to occur. Lateritic soils are not present, nor are transitional areas between shale and sandstone. No records of the species within a 10 km radius of the development site.	No
Pimelea spicata	Spiked Rice-flower	HN528, HN529	On the Cumberland Plain sites it is associated with Grey Box communities (particularly Cumberland Plain Woodland variants and Moist Shale Woodland) and in areas of ironbark.	Potential to occur. A grey box community is present on the site (HN528). 13 records of the species within a 10 km radius of the development site.	Yes
Pomaderris brunnea	Brown Pomaderris	HN526	Grows in moist woodland or forest on clay and alluvial soils of flood plains and creek lines.	Potential to occur. Moist woodland (HN526) associated with shale derived clay and alluvial soils are present along creek lines. No records of the species within a 10 km radius of the development	Yes

Table 5.5 Assessment of potential presence of species credit species

Scientific name	Common name	Associated PCTs within the Development Site	Required Habitat Components	Assessment of Habitat Within the Development Site	Requires Further Assessment?
				site.	
Pterostylis saxicola	Sydney Plains Greenhood	HN528, HN529	Typically in shallow /skeletal soils on rock shelves and platforms. The vegetation communities above the shelves where *Pterostylis saxicola* occurs are sclerophyll forest or woodland on shale/sandstone transition soils or shale soils.	Unlikely to occur. Site does not contain rock platforms, or associated skeletal soils. No records of the species within a 10 km radius of the development site.	No
Pultenaea pedunculata	Matted Bush-pea	HN526, HN528, HN529	In the Cumberland Plain the species favours sites in clay or sandy-clay soils (Blacktown Soil Landscape) on Wianamatta Shale-derived soils, usually close to patches of Tertiary Alluvium (Liverpool area) or at or near the Shale-Sandstone interface (Appin). All sites have a lateritic influence with ironstone gravel (nodules) present	Unlikely to occur. Site does not contain sandstone influenced soil. No records of the species within a 10 km radius of the development site.	No
Wahlenbergia multicaulis - endangered population	Wahlenbergia multicaulis (Tadgells Bluebell) population, Auburn, Bankstown, Baulkham Hills, Canterbury,	HN526	Found in disturbed sites and grows in a variety of habitats including forest, woodland, scrub, grassland and the edges of watercourses and wetlands. Typically occurs in damp, disturbed sites (with natural or human disturbance of	Potential to occur. Suitable habitat in the form of damp areas along creek lines, disturbed by cattle grazing, is present in patches of HN526. No records of the species within a 10 km radius of the	Yes

Table 5.5 Assessment of potential presence of species credit species

Scientific name	Common name	Associated PCTs within the Development Site	Required Habitat Components	Assessment of Habitat Within the Development Site	Requires Further Assessment?
	Hornsby, Parramatta and Strathfield local government areas		various forms), typically amongst other herbs rather than in the open.	development site.	
Fauna					
Anthochaera phrygia	Regent Honeyeater	HN526, HN528, HN529, HN594	The Regent Honeyeater is a generalist forager, which mainly feeds on the nectar from a wide range of eucalypts and mistletoes. Key eucalypt species include Mugga Ironbark, Yellow Box, Blakely's Red Gum, White Box and Swamp Mahogany. Also utilises: *Eucalyptus microcarpa, E. punctata, E. polyanthemos, E. moluccana, Corymbia robusta, E. crebra, E. caleyi, C. maculata, E. mckieana, E. macrorhyncha, E. laevopinea*, and *Angophora floribunda*. Nectar and fruit from the mistletoes *Amyema miquelii, A. pendula* and *A. cambagei* are also eaten during the breeding season.	Potential to occur. Occurrences of *Eucalyptus crebra* and *E. moluccana* may provide habitat for this species. One record of the species within a 10 km radius of the development site.	Yes
Botaurus poiciloptilus	Australasian Bittern	HN526, HN594	Occurs in terrestrial freshwater wetlands and, rarely, estuarine habitats. It favours wetlands with tall, dense vegetation, where it forages in	Unlikely to occur. No densely vegetated wetlands occur within the development site. No records of the species within a	No

Table 5.5 Assessment of potential presence of species credit species

Scientific name	Common name	Associated PCTs within the Development Site	Required Habitat Components	Assessment of Habitat Within the Development Site	Requires Further Assessment?
			still, shallow water up to 0.3 m deep, often at the edges of pools or waterways, or from platforms or mats of vegetation over deep water. The species favours permanent and seasonal freshwater habitats, particularly those dominated by sedges, rushes and/or reeds (e.g. *Phragmites, Cyperus, Eleocharis, Juncus, Typha, Baumea, Bolboschoenus*) or cutting grass (*Gahnia*) growing over muddy or peaty substrate	10 km radius of the development site.	
Callocephalon fimbriatum population in the Hornsby and Ku-ring-gai Local Government Areas	Gang-gang Cockatoo population, Hornsby and Ku-ring-gai Local Government Areas	HN528, HN529, HN594	Occurs within a variety of forest and woodland types. Usually frequents forested areas with old growth attributes required for nesting and roosting purposes. Requires hollows with diameter ≥ 10 cm and >9m above the ground in eucalypts	Unlikely to occur. Limited suitable habitat present. Percent native vegetation within the outer assessment circle is below the requirement of this species. No records of the species within a 10 km radius of the development site.	No
Cercartetus nanus	Eastern Pygmy-possum	HN526, HN528, HN529	Associated PCTs with an understorey containing heath, banksias or myrtaceous shrubs including Leptospermum spp. Trees with hollows >2cm, loose bark of eucalypts or accumulations of shredded bark in tree forks for nesting. As per	Unlikely to occur. No suitable habitat in the form of heath, banksias or myrtaceous shrubs. Percent native vegetation within the outer assessment circle is below the requirement of this	No

Table 5.5 Assessment of potential presence of species credit species

Scientific name	Common name	Associated PCTs within the Development Site	Required Habitat Components	Assessment of Habitat Within the Development Site	Requires Further Assessment?
			breeding and abandoned bird-nests, Ringtail Possum (*Pseudocheirus peregrinus*) dreys or thickets of vegetation, (e.g. grass-tree skirts) for shelter	species. No records of the species within a 10 km radius of the development site.	
Heleioporus australiacus	Giant Burrowing Frog	HN526, HN594	Heath, woodland or forest, on most soils except not generally found where there is a grassy ground layer. Often forage along tracks and roads during warm evenings. Soaks or pools in 1st or 2nd order streams, ponded sections of unmarked drainage lines, culverts and other ridge top structures containing water, upland swamps. Deep leaf litter and/or loose soil, burrow structures that they construct.	Unlikely to occur. No first order streams occur within the development site and the dams on site are devoid of bank vegetation. Percent native vegetation within the outer assessment circle is below the requirement of this species. No records of the species within a 10 km radius of the development site.	No
Ixobrychus flavicollis	Black Bittern	HN526, HN528, HN529, HN594	Associated PCTs bordering water bodies or watercourses. Inhabits both terrestrial and estuarine wetlands, generally in areas of permanent water and dense vegetation. During the day, roosts in trees or on the ground amongst dense reeds.	Unlikely to occur. No first order streams occur within the development site and the dams have little reed cover. No records of the species within a 10 km radius of the development site.	No
Litoria aurea	Green and Golden Bell	HN526, HN528,	Amongst emergent aquatic or riparian	Potential to occur. Five dams are	Yes

Table 5.5 Assessment of potential presence of species credit species

Scientific name	Common name	Associated PCTs within the Development Site	Required Habitat Components	Assessment of Habitat Within the Development Site	Requires Further Assessment?
	Frog	HN529, HN594	vegetation and amongst vegetation, fallen timber adjacent to and within 500m of breeding habitat, including grassland, cropland and modified pastures. Still or slow flowing natural waterbodies with some aquatic emergent vegetation such as Typha spp. or Eleocharis spp. Will use artificial waterbodies and non-native emergent vegetation. Vegetation, rocks and fallen timber, leaf litter, man-made ground cover, debris and in soil cracks up to 1km from breeding habitat.	present within the development site which have some ephemeral/emergent vegetation. Three records of the species within a 10 km radius of the development site.	
Meridolum corneovirens	Cumberland Plain Land Snail	HN526, HN528, HN529	Bark or leaf litter accumulation. Primarily inhabits Cumberland Plain Woodland, and also known from Shale Gravel Transition Forests, Castlereagh Swamp Woodlands and the margins of River-flat Eucalypt Forest.	Potential to occur. Some suitable habitat exists within the intact woodland in the west of the development site. However, due to the highly modified nature of the ground flora, the constant and long-term disturbance of the base of trees and tree roots by grazing cattle and the fragmentation of the vegetation communities in the development site from any nearby connecting habitat, much of	Yes

Table 5.5 Assessment of potential presence of species credit species

Scientific name	Common name	Associated PCTs within the Development Site	Required Habitat Components	Assessment of Habitat Within the Development Site	Requires Further Assessment?
				the development site is considered unsuitable for support this species. 153 records of the species within a 10 km radius of the development site.	
Petaurus norfolcensis	Squirrel Glider	HN526, HN528, HN529	Associated PCTs with mature, mix-age eucalypts with flowering shrubs and wattles in the understorey. Inhabits mature or old growth Box, Box-Ironbark woodlands and River Red Gum forest west of the Great Dividing Range and Blackbutt-Bloodwood forest with heath understorey in coastal areas. Tree hollows >5 cm diameter in eucalypt forests and woodlands.	Unlikely to occur. Some habitat features for this species is present within the intact woodland areas; however, much of the site does not contain vegetation typical for this species. No records of the species within a 10 km radius of the development site.	No
Phascolarctos cinereus	Koala	HN526, HN528, HN529	As per Koala Food Tree Species listed in Appendix 2 of the NSW State Koala Recovery Plan.	Unlikely to occur. Although two primary feed trees occur within the development site (*Eucalyptus tereticornis* and *E. amplifolia*), much of the habitat present within the development site is significantly fragmented from any nearby connecting habitat. Potential habitat in the intact woodland on the western edge of the development site is juvenile,	No

Table 5.5 Assessment of potential presence of species credit species

Scientific name	Common name	Associated PCTs within the Development Site	Required Habitat Components	Assessment of Habitat Within the Development Site	Requires Further Assessment?
				regenerating woodland not suitable for Koala. As such potential habitat within HN526, HN528 and HN529 is considered unsuitable for support this species. No records of the species within a 10 km radius of the development site.	

5.5.3 Presence of Candidate Species

Table 5.6 outlines the surveys that were undertaken for each of the candidate species that were assessed as requiring further assessment. Surveys for each of these species were undertaken at an appropriate time of year and weather conditions (see ***Section 5.2.2.i*** and **Table 5.5**).

During the threatened flora surveys of the proposed Western North/South Link Road, 24 Juniper-leaved Grevillea (*Grevillea juniperina subsp. juniperina*), a species credit species, were encountered within Fitzpatrick land. The location of each individual is provided in **Figure 5.2**. These individuals are located outside the development site and therefore are not considered further in this BAR as the offsetting for the removal of these individuals forms part of the approvals for the development of the Fitzpatrick land.

A list of flora and fauna species recorded during surveys is provided in **Appendix B** and **Appendix C**, respectively.

Table 5.6 Summary of surveys undertaken for candidate species credit species

Scientific Name	Common Name	Survey Type	Survey Timing
Flora			
Acacia pubescens	Downy Wattle	Random meanders in HN528 and HN529	15 October 2015 and 8 April 2016
Cynanchum elegans	White-flowered Wax Plant	Random meanders in HN526, HN528 and HN529	15 October 2015 and 8 April 2016
Dillwynia tenuifolia	Dillwynia tenuifolia	Random meanders in HN528 and HN529	15 October 2015 and 8 April 2016
Dillwynia tenuifolia - endangered population Kemps Creek	Dillwynia tenuifolia (a shrub) population, Kemps Creek	Random meanders in HN528 and HN529	15 October 2015 and 8 April 2016
Eucalyptus benthamii	Camden White Gum	Random meanders in HN526, HN528 and HN529	15 October 2015 and 8 April 2016
Grevillea juniperina subsp. juniperina	Juniper-leaved Grevillea	Random meanders in HN528 and HN529	15 October 2015 and 8 April 2016
Hypsela sessiliflora	Hypsela sessiliflora	Random meanders in HN526, HN528, HN529 and HN594	15 October 2015 and 8 April 2016
Marsdenia viridiflora subsp. viridiflora - endangered population	Marsdenia viridiflora subsp. viridiflora in the Bankstown, Blacktown, Camden, Campbelltown,	Random meanders in HN526, HN528 and HN529	15 October 2015 and 8 April 2016

Table 5.6 Summary of surveys undertaken for candidate species credit species

Scientific Name	Common Name	Survey Type	Survey Timing
	Fairfield, Holroyd, Liverpool and Penrith local government areas		
Persicaria elatior	Tall Knotweed	Random meanders in HN526 and HN594	15 October 2015 and 8 April 2016
Persoonia bargoensis	Bargo Geebung	Random meanders in HN528 and HN529	15 October 2015 and 8 April 2016
Pilularia novae-hollandiae	Austral Pillwort	Random meanders in HN526	15 October 2015 and 8 April 2016
Pimelea spicata	Spiked Rice-flower	Random meanders in HN528 and HN529	15 October 2015 and 8 April 2016
Pomaderris brunnea	Brown Pomaderris	Random meanders in HN526	15 October 2015 and 8 April 2016
Wahlenbergia multicaulis - endangered population	Wahlenbergia multicaulis (Tadgells Bluebell) population, Auburn, Bankstown, Baulkham Hills, Canterbury, Hornsby, Parramatta and Strathfield local government areas	Random meanders in HN526	15 October 2015 and 8 April 2016
Fauna			
Anthochaera phrygia	Regent Honeyeater	Targeted diurnal bird surveys in woodland habitats	22-23 October 2015
Litoria aurea	Green and Golden Bell Frog	Targeted spotlighting and call playback surveys in aquatic habitat	22 October 2015 and 26 – 28 October 2015
Meridolum corneovirens	Cumberland Plain Land Snail	Targeted leaf litter searches in HN526, HN528 and HN529	15 October 2015
Phascolarctos cinereus	Koala	Call playback in woodland habitats	26 – 28 October 2015 *
Petaurus norfolcensis	Squirrel Glider	Call playback in woodland habitats	26 – 28 October 2015 *

** Although Koala and Squirrel Glider do not require further assessment call playback for these species were conducted in conjunction with the Green and Golden Bell Frog surveys*

Coordinate System: MGA Zone 56 (GDA 94)

Legend

Development Site

Additional North-South Link Road Area

Survey Locations

- Amphibian surveys (Green and Golden Bell Frog and Giant Burrowing Frog)
- Cumberland Plain Land Snail searches
- Diurnal bird surveys (Regent Honeyeater and Black Bittern)
- Spotlighting and call playback (Koala and Squirrel Glider)
- Fauna Habitat Assessment

N

Grid North

Scale: 1:9,339 @ A3 page
Date prepared: 31/03/2017

Image Source:
Image © Nearmap
(dated 11/02/2017)

Data Source:
Image © 2015
NSW Land and Property Management Authority,
SIX Viewer

cumberland ecology

100 0 100 200 300 400 m

I:\...\15122\Figures\RP1_BAR\20170331\Figure 5.1. Species Credit Species Survey Sites

Figure 5.1. Targeted species credit species survey locations

Coordinate System: MGA Zone 56 (GDA 94)

Legend

- Development Site
- Additional North-South Link Road Area

Species Credit Species

- *Grevillea juniperina subsp. juniperina*

N
Grid North

Scale: 1:9,339 @ A3 page
Date prepared: 31/03/2017

Image Source:
Image © Nearmap
(dated 11/02/2017)

Data Source:
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SIX Viewer

cumberland ecology

100 0 100 200 300 400 m

I:\...\15122\Figures\RP1_BAR\20170331\Figure 5.2. Locations_Threatened Species

Figure 5.2. Locations of threatened species

cumberland ecology

Chapter 6

Avoid and Minimise Impacts

This chapter outlines the actions that have been undertaken to demonstrate that reasonable measures have been taken to avoid and minimise the potential direct and indirect impacts of a development proposal on biodiversity values.

6.1 Measures to Avoid

6.1.1 Avoidance of Direct Impacts

Under the FBA, a proponent must seek to avoid the direct impacts of the Major Project on all biodiversity values at the development site including impacts on:

- Endangered ecological communities (EECs) and critically endangered ecological communities (CEECs);
- PCTs that contain threatened species habitat;
- Areas that contain habitat for vulnerable, endangered or critically endangered threatened species or populations;
- An area of land that the Minister for Environment has declared as critical habitat in accordance with section 47 of the TSC Act;
- The riparian areas of 4th order or higher streams and rivers, important wetlands and estuaries; and
- State significant biodiversity links.

Demonstration of these is summarised in **Table 6.1**.

Table 6.1 Avoidance of direct impacts on biodiversity values at the development site

Direct impact to be avoided	Avoidance mechanism proposed
Impacts to endangered ecological communities (EECs) and critically endangered ecological communities (CEECs)	The development site is located within existing farmland so as to minimise environmental impacts to vegetation. Large areas of native vegetation are left intact to the west of the site. 95% of the

Table 6.1 Avoidance of direct impacts on biodiversity values at the development site

Direct impact to be avoided	Avoidance mechanism proposed
	vegetation within the development area comprises revegetation areas or exotic low diversity grassland. While the remaining 5% does include EECs or CEECs, they mostly consist of remnant patches of fragmented, degraded and/or isolated vegetation. It is unlikely that the impacted areas of EECs or CEECs are viable in the future if left in their current state.
Impacts to PCTs that contain threatened species habitat	The development site is located within the study area so as to minimise environmental impacts to PCTs that may provide threatened species habitat No threatened flora or fauna species were found during surveys. Due to historical agricultural land use, 95% of the site is degraded grassland dominated by exotic species. The remaining small patches of woodland are unlikely to provide habitat for endangered species due to their fragmentation, isolation and considerable edge effect. It is possible that some highly mobile species and transient species use the site for foraging. Nevertheless, the vegetation on site is to be considered of low value habitat and is unlikely to form part of viable future habitat for any endangered species.
Impacts to areas that contain habitat for vulnerable, endangered or critically endangered threatened species or populations	The development site is located within the study area so as to minimise environmental impacts to threatened species habitat. As discussed above, it is unlikely that the remnant patches of woodland on site constitute part of important habitat for threatened species or populations.
Impacts to an area of land that the Minister for Environment has declared as critical habitat in accordance with section 47 of the TSC Act	There are no areas of critical habitat within the study area.
Impacts to the riparian areas of 4th order or higher streams and rivers, important wetlands and estuaries	There are no 4th order or higher streams within the study area, nor are there wetlands or estuaries. Potential impacts by the proposed development, which comprises a tributary to Ropes Creek, are minimized by the construction of several Bio-Retention Basins, swales and storm water management during construction. Any impacts on streams, rivers, wetlands or

Table 6.1 Avoidance of direct impacts on biodiversity values at the development site

Direct impact to be avoided	Avoidance mechanism proposed
	estuaries are therefore unlikely.
Impacts to state significant biodiversity links	There is no record available of any state significant biodiversity links within or adjacent to the development area. No information regarding such links has been provided in the SEARS.

6.1.2 Site Selection

The selection of a suitable development site for this Project was informed by knowledge of biodiversity values. In addition to the current study, there have been desktop assessments and onsite assessments of biodiversity values, which include studies of both the study area (Oakdale West Estate), as well as other studies of biodiversity within the locality. A summary of considerations during site selection in accordance with Section 8.3.2.2 – 8.3.2.6 of the FBA is shown in **Table 6.2**.

Table 6.2 Consideration of the proposed development during site selection

FBA Section	FBA Criteria	Considerations of the FBA guidelines at Oakdale West Estate
8.3.2.2	Selecting a suitable development site for a Major Project or a route for linear projects, should be informed by knowledge of biodiversity values. An initial desktop assessment of biodiversity values would assist in identifying areas of native vegetation cover, EECs or CEECs, and potential habitat for threatened species.	Desktop surveys of the locality include online resources such as the Atlas of NSW Wildlife (OEH, 2015) and EPBC Protected Matters Search Tool (DoE, 2015). Studies of the biodiversity of the area includes Ecological Assessment - Oakdale Concept Plan (Cumberland Ecology, 2007) and Oakdale South Biodiversity Assessment Report (Cumberland Ecology, 2016). These datasets provided the preliminary information necessary to inform project planning. Early consideration of biodiversity values influenced site selection.
8.3.2.3	Stage 1 of the FBA will provide the preliminary information necessary to inform project planning. Early consideration of biodiversity values is recommended in site selection, or route selection for linear projects, and the planning phase.	Biodiversity values were given early consideration during the site selection plan. The development footprint has been amended several times to maximise environmental outcomes and minimise impacts on biodiversity.
8.3.2.4	The site/route selection process should include consideration and analysis of the biodiversity constraints of the proposed development site and consider the suitability of the Major Project based on the types of biodiversity values present on the development site.	Specific biodiversity constraints identified within the study area includes the presence of threatened ecological communities including Swamp Oak Forest, River Flat Eucalypt Forest and Cumberland Plain Woodland which are listed as EEC and CEEC respectively under the TSC Act. Cumberland Plain Woodland is also listed as a CEEC under the EPBC Act.
8.3.2.5	When considering and analysing the biodiversity constraints for the purpose of selecting a development site, the following matters should be addressed: (a) whether there are alternative sites within the property on which the	Given the size of the required impact footprint for construction of warehouses and offices, the alternative location of the development would involve impacts to significantly larger tranches

Table 6.2 Consideration of the proposed development during site selection

FBA Section	FBA Criteria	Considerations of the FBA guidelines at Oakdale West Estate
	proposed development is located where siting the proposed Major Project would avoid and minimise impacts on biodiversity values	of vegetation. The current development site has been selected to minimise impacts to biodiversity values.
	(b) how the development site can be selected to avoid and minimise impacts on biodiversity values as far as practicable	The development site is to be located on the exotic grassland which is of negligible biodiversity value. Much of the main impact has been avoided with the retention and enhancement of woodland and forest areas on site.
	(c) whether an alternative development site to the proposed development site, which would avoid adversely impacting on biodiversity values, might be feasible.	
8.3.2.6	For linear projects, the route selection process must include consideration and an analysis of the biodiversity constraints of the various route options. In selecting a preferred option, loss of biodiversity values must be weighed up and justified against social and economic costs and benefits.	The proposed development is not a linear project.

6.1.3 *Incorporating Principles of Avoidance and Minimising Impacts to Biodiversity*

i. Planning

Once a suitable development site has been selected, further analysis of the biodiversity constraints of the proposed development site were then used to inform concept planning, project siting and design. This includes the proposed location of temporary construction infrastructure such as roads, camps, stockpile sites and parking bays. All temporary construction works will be located within the development site.

Although there are TECs within the development site, the majority (95%) of the development site will be located in exotic grassland which is the lowest condition vegetation and poorest threatened species habitat. The development site is located whereby loss of native vegetation and impacts to biodiversity are minimised. The location of the development site also minimises losses of connectivity by retaining the riparian corridor along Ropes Creek in its entirety. A summary table of considerations during the planning phase is shown in **Table 6.3**.

6.2 Measures to Minimise Impacts

The proponent will implement reasonable measures to avoid and minimise any impacts that may occur during the operational phase of the proposed development, that are additional to the impacts which occurred during the site selection and planning phases.

As part of the proposed development a Biodiversity Management Plan will be created in order to guide all facets of biodiversity management and mitigation for the proposed development and will detail the management requirements for the following:

- Vegetation pre-clearance and clearance supervision;
- Dam and creek dewatering;
- Rehabilitation and habitat restoration; and
- Weed management.

6.2.1 *Minimising Impacts During Construction Phase*

Considerations have been given to minimising impacts during the construction phase. Considerations to minimise impacts to biodiversity at the development site includes:

- Method of clearing;
- Clearing operations protocols;
- Timing of construction; and

- Other measures that minimise inadvertent impacts of the proposed development on the biodiversity values indirect impacts during the construction phase.

Methods to minimise impacts during the construction phase are detailed below in **Table 6.3**.

Table 6.3 Considerations to minimise direct impacts of the proposed development during construction

FBA Section	FBA Criteria	Considerations of the FBA guidelines at Oakdale West Estate
8.3.2.10a	Method of clearing – using a method of clearing during the construction phase that avoids damage to retained native vegetation and reduces soil disturbance. For example, removal of native vegetation by chain-saw, rather than heavy machinery, is preferable in situations where partial clearing is proposed	The patches of vegetation to be removed are small remnants and can be removed safely with chainsaws rather than heavy machinery.
8.3.2.10b	Clearing operations – minimising direct harm to native fauna during actual construction operations through onsite measures such as undertaking pre-clearing surveys, daily fauna surveys and the presence of a trained ecologist during clearing events	The clearing will take place in two stages. During the first stage, all habitat trees will be marked and left standing, while the vegetation surrounding them will be cleared. A licensed wildlife carer and/or ecologist will capture and/or remove fauna that have the potential to be disturbed as a result of clearing activities. These fauna will be relocated into pre-determined habitat identified for fauna release. All fauna handling will be carried out by licensed wildlife carers and/or ecologists. The two-stage clearing process enables fauna to feel secure whilst clearing occurs around their tree, and allows them a chance to self-relocate upon nightfall, when foraging typically occurs The next day, during stage two, the remaining trees will be cleared. The ecologist will be present during all clearing activities to rescue animals injured during the operation. Any fauna found will be captured and relocated to nearby remnant vegetation and released after nightfall to minimise the risk of predation by diurnal predators. Any animals that are inadvertently injured will be taken to the nearest veterinary clinic for treatment, or if the animal is unlikely to survive, it will be humanely euthanized. All persons working on the vegetation clearing will be briefed about the

Table 6.3 Considerations to minimise direct impacts of the proposed development during construction

FBA Section	FBA Criteria	Considerations of the FBA guidelines at Oakdale West Estate
		possible fauna present at the time of construction, and what procedures should be undertaken in the event of an animal being injured or disturbed. Results and outcomes of pre-clearing and clearing fauna surveys shall be documented by the ecologist and submitted to the proponent.
8.3.2.10c	Timing of construction – identifying reasonable measures that minimise the impacts on biodiversity. For example, timing construction activities for when migratory species are absent from the site, or when particular species known to or likely to use the habitat on the site are not breeding or nesting, can minimise the impacts of construction activities on biodiversity	There are limited fauna species that utilise the site. However, as it is likely there are several microchiropteran bat species that use the development site, clearing should be proposed to not occur over winter when animals are in torpor.
8.3.2.10d	Other measures that minimise inadvertent impacts of the Major Project on the biodiversity values – measures such as installing temporary fencing to protect significant environmental features such as riparian zones, promoting the hygiene of construction vehicles to minimise spread of weeds or pathogens, appropriately training and inducting project staff and contractors so that they can implement all measures that minimise inadvertent adverse impacts of the Major Project on biodiversity values.	Temporary fencing should be installed prior to clearing works to delineate impact from protected areas. All mobile plant should be brought to site in clean condition to prevent the spread of weeds or pathogens into areas outside the development site. Stormwater run-off will be managed during the construction phase of the project.

In addition to measures proposed above to minimise direct impacts to biodiversity, the following measures are proposed to minimise indirect impacts during the construction phase as shown in **Table 6.4**.

Table 6.4 Proposed measures to minimise indirect impacts to biodiversity during construction

Indirect impact	Proposed measure to minimise impact
Sedimentation and run-off	Sediment barriers, sedimentation ponds, and detention basins have been incorporated into the project design to protect adjacent waterways from sediment and run-off. This measure will protect Ropes Creek to the east of the development site.
Noise, dust or light spill	The area is currently protected by topography to lighting from nearby residential and industrial areas. Construction should be limited to daylight hours to mitigate for noise and light spill impacts to fauna in adjacent vegetation. Dust will be managed onsite through an approved Construction Environment Management Plan (CEMP) at the time of construction.
Inadvertent impacts on adjacent habitat or vegetation	Fencing should be erected to delineate the extent of the development site and protect adjacent vegetation from impacts such as vehicular traffic. All set down areas and lay down areas should be located outside of areas of native vegetation, within the development site.
Feral pest, weed and/or pathogen encroachment into vegetation on land adjoining the development site	Light vehicles and mobile plant should all be clean when entering the site to prevent the introduction of pathogens that may impact vegetation outside the development site.

6.2.2 Minimising Impacts During Operational Phase

The following matters should be considered in order to avoid and minimise direct impacts on biodiversity values at the operational phase as described in **Table 6.5**.

Table 6.5 Consideration of measures to minimise direct impacts the proposed development during operation

FBA Section	FBA Criteria	Considerations of the FBA guidelines at Oakdale West Estate
8.3.2.12.a	Seasonal impacts – whether there are likely to be any impacts that occur during specific seasons. Minimisation measures may include amending operational times to minimise impacts on biodiversity during periods when seasonal events such as breeding or species migration occur	There are no seasonal impacts of the proposed development during operation.
8.3.2.12.b	Artificial habitats – using 'artificial habitats' for fauna where they may be effective in minimising impacts on such fauna. These include nest boxes, glider-crossings or habitat bridges.	Nest boxes are useful in reducing the impact to fauna habitat within the study area. Nest boxes should be erected for each natural hollow that is removed during the contraction phase. Nest boxes are to be erected before removal of hollow bearing trees. The total quantum of nest boxes required is to be established during pre-clearing surveys identified in Table 6.3.
8.4.1.4.f	Impacts during the operational phase – measures to avoid or minimise the indirect impacts on threatened species and threatened species habitat on land adjoining the development site, migratory species or flight pathways as a result of the operation of the development. Such measures may include those adopted to avoid and minimise: (i) trampling of threatened flora species (ii) rubbish dumping (iii) noise (iv) light spill	There are no threatened flora species known within the study area. Dumping of rubbish will be prevented by permanent fencing to prevent access to the riparian woodland along Ropes Creek. The proposed development will also have suitable security measures in place to prevent illegal dumping. Noise from the warehouse facilities will be contained within the buildings onsite. All noise will result from traffic which will unlikely exceed current levels adjacent to the study area. Noise will be managed onsite to relevant standards. Light spill will be managed by directing street lighting eastward to provide light for access and security within the warehouse facilities, and preventing excessive light spill into the riparian corridor.

Table 6.5 Consideration of measures to minimise direct impacts the proposed development during operation

FBA Section	FBA Criteria	Considerations of the FBA guidelines at Oakdale West Estate
	(v) weed encroachment (vi) nutrient run-off (vii) increased risk of fire, and (viii) Pest animals.	There will not be an increased risk of fire as a result of the development. The occurrence of feral cats and foxes might increase as a result of the proposed development. A pest management plan will be incorporated into the Biodiversity Management Plan for the development site.

6.3 Summary of Measures

Although the Project has sought to avoid and minimise impacts, not all biodiversity impacts can be avoided for many aspects of the development as detailed above. The measure described in **Table 6.6** should be implemented to mitigate impacts during construction and operation.

Table 6.6 Measures to be implemented to mitigate the impacts on biodiversity

Impact	Mitigation measure	Outcome	Timing	Responsibility
General flora and fauna impacts	A Flora and Fauna Management Plan would be prepared as part of the CEMP. Native vegetation clearing would not occur until the Flora and Fauna Management Plan is approved	Flora and fauna would be managed in accordance with the requirements of the FFMP.	Pre-construction and construction	Goodman and Contractor
Degradation of aquatic habitats	Install appropriate drainage infrastructure (e.g. sediment basins, diversion drains), sediment and erosion controls prior to the commencement of construction.	Prevention of sedimentation and erosion leading to a reduction in water quality and degradation of aquatic habitats in Ropes Creek.	Pre-construction/ Construction	Construction Contractor
	Clearing of vegetation would be timed to avoid periods when rain is forecast	Prevention of sedimentation and erosion leading to a reduction in water quality and degradation of aquatic habitats in Ropes Creek.	Construction	
	Locate soil or mulch stockpiles away from watercourses and key stormwater flow paths to limit potential transport of these substances into the watercourses via runoff.	Prevents soil and mulch reaching waterways.	Construction	
	Dust suppression activities to be undertaken where appropriate.	Prevents sedimentation and erosion leading to a reduction in water quality and degradation of aquatic habitats in Ropes Creek.	Construction	
	Stabilisation of disturbed areas, including revegetation in accordance with the Flora and Fauna Management Plan, is to be undertaken as soon as practicable after disturbance.	Prevents sedimentation and erosion leading to a reduction in water quality and degradation of aquatic habitats in Ropes Creek.	Construction	

Table 6.6 Measures to be implemented to mitigate the impacts on biodiversity

Impact	Mitigation measure	Outcome	Timing	Responsibility
	Emergency response protocols and procedures for implementation in the event of a contaminant spill or leak to be clearly articulated in the Construction and Operational Environmental Management Plans.	Prevents pollution of waterways.	Pre-construction and construction	Goodman and Construction Contractor
	Spill kits to be located to allow for timely response to uncontained spills. Site inductions are to include a briefing on the use of spill kits.	Prevents pollution of waterways.	Pre-construction and construction	Goodman and Construction Contractor
	Bio-retention installed in base of channels and swales to capture and store stormwater consisting of bio-filtration layers, planting and subsoil collection and drainage.	Reduces impacts from altered hydrological regimes leading to an increase in impervious surface such as changes in runoff and infiltration, redirection of flows.	Construction	Construction Contractor
Vegetation removal or disturbance	Clearly identifying sensitive areas ('no-go areas') which cannot be impacted by construction and managing clearing such that clearing activities are constrained to these approved areas only.	Prevention of over clearing of vegetation	Pre-construction and construction	Construction Contractor
	Site inductions are to include a briefing regarding the local threatened of the site and protocols to be undertaken if they are encountered.	Prevention of impacts to threatened species	Construction and operation	Goodman and Construction Contractor
Weed invasion and spread	Management of weeds in and adjacent to cleared areas will occur in accordance with the FFMP CEMP and OEMP. This plan would include details relating to the monitoring, management and where	Prevention of weed establishment and invasion	Pre-construction, construction and operation	Goodman and Construction Contractor

Table 6.6 Measures to be implemented to mitigate the impacts on biodiversity

Impact	Mitigation measure	Outcome	Timing	Responsibility
	necessary eradication of weeds, disposal of green waste, and vehicle/plant weed wash down protocols if required.			
	Management of noxious weeds is to be undertaken in accordance with the Noxious Weeds Act 1993.	Prevention of weed establishment and invasion	Pre-construction and construction	Goodman and Construction Contractor
	Equipment used for treating weed infestation will be cleaned prior to moving to a new area within the development site to minimise the likelihood of transferring any plant material and soil.	Prevention of weed establishment and invasion	Pre-construction and construction	Goodman and Construction Contractor
	Soil stripped and stockpiled from areas containing known weed infestations are to be stored on cleared land at least 40 m from native vegetation.	Prevention of weed establishment and invasion	Construction	Construction Contractor
Impacts to fauna and fauna habitat	Fauna microhabitat such as hollow logs should be removed from areas to be cleared and relocated to the proposed Oakdale Onsite BioBank Site in the presence of an ecologist.	Retaining fauna habitat resources	Pre-construction and construction	Construction Contractor
	A nest box management strategy would be prepared prior to clearing of hollow bearing trees. The strategy would inform the installation of nest boxes in retained native vegetation in the riparian corridor of the proposed Oakdale Onsite BioBank	Replaces lost hollow resources in the landscape	Pre-construction, construction and operation	Construction Contractor

Table 6.6 Measures to be implemented to mitigate the impacts on biodiversity

Impact	Mitigation measure	Outcome	Timing	Responsibility
	Site and the on-going monitoring and maintenance of nest boxes through the construction and operational phases.			
	High visibility plastic fencing is to be installed to clearly define the limits of the works area.	Prevents disturbance or over clearing of fauna habitat and native vegetation outside the construction area	Construction	Construction Contractor
	Undertake a pre-start-up check for sheltering native fauna of all infrastructure, plant and equipment and/or during relocation of stored construction materials.	Prevents fauna injury/mortality	Construction	Construction Contractor
	Undertake a two-stage approach to clearing: • Remove non-hollow bearing trees at least 48 hours before habitat trees are removed. • Hollow bearing trees are to be knocked with an excavator bucket or other machinery to encourage fauna to evacuate the tree immediately prior to felling. • Felled trees must be left for a short period of time on the ground to give any fauna trapped in the trees an opportunity to escape before further	Prevents fauna injury/mortality	Construction	Construction Contractor

Table 6.6 Measures to be implemented to mitigate the impacts on biodiversity

Impact	Mitigation measure	Outcome	Timing	Responsibility
	processing of the trees. • Felled hollow bearing trees must be inspected by an ecologist as soon as possible (not longer than 2 hours after felling).			
	Site inductions are to include a briefing regarding the local fauna of the site and protocols to be undertaken if fauna are encountered.	Prevents fauna injury/mortality	Construction	Construction Contractor
	If any animal is injured, contact the relevant local wildlife rescue agency (e.g. WIRES) and/or veterinary surgery as soon as practical. Until the animal can be cared for by a suitably qualified animal handler, if possible minimise stress to the animal and reduce the risk of further injury by: • Handling fauna with care and as little as possible. • Covering larger animals with a towel or blanket and placing in a large cardboard box. • Placing small animals in a cotton bag, tied at the top	Prevents fauna injury/mortality	Pre-construction, construction and operation	Goodman and Construction Contractor

Table 6.6 Measures to be implemented to mitigate the impacts on biodiversity

Impact	Mitigation measure	Outcome	Timing	Responsibility
	Keeping the animal in a quiet, warm, ventilated and dark location.			
	If any pits/trenches are to remain open overnight, they are to be securely covered, where reasonable and feasible. Alternatively, fauna ramps (logs or wooden planks) are to be installed to provide an escape for trapped fauna.	Prevents fauna injury/mortality	Construction	Construction Contractor
	The extent of vegetation clearing is to be clearly identified on construction plans.	Prevents impacts to fauna habitat and native vegetation outside the development footprint	Pre-construction	Goodman and Construction Contractor
	In circumstances where native vegetation or mature tree clearing is required outside of the biodiversity study area, an ecologist will inspect the proposed area and provide advice on the impact to flora and fauna and appropriate management.	Prevents impacts to fauna habitat and native vegetation outside the development footprint	Construction	Goodman and Construction Contractor
	Directional lighting will be used where lighting is required in construction areas.	Minimises disruption to fauna foraging, nesting or roosting behaviours	Construction	Construction Contractor
	Frequent maintenance of construction machinery and plant will be undertaken to minimise unnecessary noise.	Minimises disruption to fauna foraging, nesting or roosting behaviours	Construction	Construction Contractor

Table 6.6 Measures to be implemented to mitigate the impacts on biodiversity

Impact	Mitigation measure	Outcome	Timing	Responsibility
	Speed limits will be developed so as to minimise the potential for fauna to be struck by a vehicle within the construction areas. All vehicles and plant in operation during construction are to adhere to site rules relating to speed limits.	Prevents fauna injury/ mortality	Construction	Construction Contractor
Bushfire risk connectivity	Bushfire awareness included in staff induction and in toolbox talks pre-commencement.	Reduces risk of possible bushfire events impacting on biodiversity values.	Pre-construction and construction	Construction Contractor

6.4 Assessment of Impacts

6.4.1 Direct Impacts

Direct impacts relating to the development site include:

- Vegetation clearance; and
- Habitat removal.

The direct impacts associated with vegetation removal are discussed further within **Chapter 7**.

6.4.2 Indirect Impacts

Indirect impacts of the Project during construction and operation phase includes the following impacts:

- Sedimentation and run off;
- Noise, dust and light during construction;
- Impacts to adjacent native vegetation outside the development site;
- Weed encroachment;
- Accumulation of rubbish; and
- Feral pest encroachment.

6.5 Identification of Final Project Footprint

The layout for the Project has been refined through the consideration of a number of alternatives which have reduced the potential for adverse impacts to the environment, including specific impacts on threatened ecological communities. The final footprint is referred to as the development site and is shown in **Figure 1.3**.

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Chapter 7

Impact Summary

7.1 Introduction

The Project will involve direct impacts on native vegetation and fauna habitat, primarily within the construction phase. As the operation of the development will be relatively contained within the warehouse facilities, impacts of the operation phase will be minimal and confined to indirect impacts. The direct impacts of the construction phase are summarised below.

7.2 Summary of Impacts

A summary of the impacts of the Oakdale West Masterplan is shown in **Table 7.1.**

Table 7.1 Summary of Impacts

Likely Impact	Details	Extent/scale
Loss and fragmentation of native vegetation	Woodland and forest vegetation communities	5.44 ha of native vegetation (including 4.93 ha naturally occurring vegetation and 0.51 ha planted vegetation) will be cleared
Loss of threatened ecological communities	Cumberland Plain Woodland CEEC	2.20 ha (1.96 ha EPBC Act)
	River-flat Eucalypt Forest EEC	1.11 ha
	Swamp Oak Forest EEC	1.62 ha
Loss of threatened flora species and fragmentation of habitat	Juniper-leaved Grevillea (*Grevillea juniperina subsp. juniperina*)	None: The removal of 24 individuals occurs under separate approval for Fitzpatrick land
Loss of fauna habitat	Remnant woodland and forest and farm dams offer habitat for a diversity of reptiles, amphibians, birds and mammals. A total of 8.21 ha of fauna habitat will be removed comprising 4.93 ha of remnant forest and woodland, 0.51 ha of planted native vegetation and 2.77 ha of farm dams	8.21 ha of fauna habitat is proposed to be cleared
Fauna fragmentation	Removal of commuting habitat of fauna species	May reduce the capacity of some less mobile fauna to

Table 7.1 Summary of Impacts

Likely Impact	Details	Extent/scale
		move within and between patches of remaining habitat adjacent to the development site.
Fauna mortality	May result from clearance works, earthworks or collisions with vehicles or machinery	Most likely during clearance activities
Degradation of aquatic habitats	Caused by changes in run-off, infiltration, pollution and erosion. May influence downstream habitats.	Ropes Creek most susceptible during construction.
Impacts on fish passage	No important fish passage habitat is present within the development site	None
Edge effects and week invasion	Vehicles and plant may transport weed propagules into the development site. No new edges will be created as a result of the development.	Most likely during clearance activities
Alteration to air quality and noise environments	May impact upon the roosting, breeding and foraging activities of locally occurring fauna	Temporary and localised scale of impacts during construction.

7.2.1 Direct Loss of Native Vegetation

The proposal will unavoidably remove 4.93 ha of remnant native vegetation and 111.31 ha of exotic vegetation or planted vegetation that does not meet the determination of a PCT and does not require further assessment under the FBA. Native vegetation to be removed includes four PCTs conforming to three separate vegetation communities listed under the TSC Act as TECs. A summary of the areas directly impacted within the development site is shown in **Table 7.2**.

Table 7.2 Summary of areas directly impacted by the Project

Vegetation	TSC Act Status	EPBC Act Status)	Area to be Removed (ha)
HN526: Forest Red Gum - Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney Basin	EEC	-	1.11
HN528: Grey Box - Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin (TSC and EPBC Acts)	CEEC	CEEC	0.89

Table 7.2 Summary of areas directly impacted by the Project

Vegetation	TSC Act Status	EPBC Act Status)	Area to be Removed (ha)
HN528: Grey Box - Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin (TSC Act only)	CEEC	-	0.14
HN529: Grey Box - Forest Red Gum grassy woodland on shale of the southern Cumberland Plain, Sydney Basin Bioregion (TSC and EPBC Acts)	CEEC	CEEC	1.07
HN529: Grey Box - Forest Red Gum grassy woodland on shale of the southern Cumberland Plain, Sydney Basin Bioregion (TSC Act only)	CEEC	-	0.10
HN594: Swamp Oak swamp forest fringing estuaries, Sydney Basin Bioregion and South East Corner Bioregion	EEC	-	1.62
Revegetation Areas, Exotic grassland and Cleared Land	-	-	113.85
Total			**118.78**

TSC Act / EPBC Act Status: EEC = endangered ecological community; CEEC = critically endangered ecological community

7.2.2 Direct Loss of Fauna Habitat

Although the condition and nature of the habitats within the development site have been greatly altered by existing and historical land uses, it is evident that they still retain some value for the resident and visiting native fauna that were recorded in the development site. The regrowth areas generally lack many habitat features but areas of more mature habitat are also present in the development site that do retain valuable habitat features. Important fauna habitat features that will most likely be removed by the Project include:

- **Understorey vegetation** – loss of shelter and foraging habitat for amphibians, reptiles, small birds and terrestrial mammals;
- **Fallen logs, woody debris and leaf litter** – although limited within the development site, loss of shelter habitat for amphibians, reptiles and terrestrial mammals, and forage habitat for woodland bird species;
- **Hollow-bearing living trees and stags** – loss of habitat for a range of fauna species which may rely on them for shelter, breeding or roosting. Loss of mature remnant hollow-bearing trees will have important implications for threatened species such as reptiles, birds, arboreal mammals and micro bats;
- **Nectar-producing trees and shrubs** – loss of food resources for blossom-dependant birds, arboreal mammals and mega chiropteran bats (flying-foxes);

- **Shrubs and grasses** – loss of food for a range of passerine birds and herbivorous mammals;
- **Emotional (edge) communities** – loss of foraging habitat for many species, particularly birds such as raptors;
- **Ephemeral drainage lines** – loss of limited foraging, shelter and breeding habitat for amphibians, aquatic reptiles, wetland birds and aquatic mammals; and
- **Constructed farm dams with limited aquatic vegetation** – loss of foraging and breeding habitat for amphibians, aquatic reptiles and wetland birds.

Much of the impact of the Project occurs within revegetation areas and cleared land (exotic grassland) that offer little suitable fauna habitat and therefore it is considered that primary fauna habitat impact will be restricted to the 4.89 ha of woody native vegetation communities and to the scattered mature trees within the exotic grassland.

7.3 Thresholds for Assessing Unavoidable Impacts

Unavoidable impacts of the Project have been considered and a determination made of the assessment and offsetting requirements of such impacts. **Table 7.3** summarises these requirements which include:

- Impacts that require further consideration by consent authority;
- Impacts for which the assessor is required to determine an offset;
- Impacts for which the assessor is not required to determine an offset; and
- Impacts that do not require further assessment by the assessor.

Figure 7.1 shows the location of these areas within the development site. A discussion of each of these components is provided below. The Biodiversity Credit Report generated by the Project is provided in **Appendix D**.

Table 7.3 Thresholds for the assessment and offsetting of unavoidable impacts of the Project

Threshold	Biodiversity Value	Criteria	Applicable to the Project?
I. Impacts that require further consideration by consent authority	Landscape Features	Impacts that will substantially reduce the width of vegetation in the riparian buffer zone bordering rivers and streams 4th order or greater	No
		Impacts in state biodiversity links	No
		Impacts on important wetlands and their buffers	No
		Impacts in the buffer zone along estuaries	No
	Native Vegetation	Any impact on a CEEC (unless specifically excluded in the SEARs) because it is likely to: • cause the extinction of the CEEC from the IBRA subregion, or • significantly reduce the viability of the CEEC	**Yes** – The Project will remove 1.03 ha of HN528 and 1.17 ha of HN529 CEEC
		Any impact on an EEC nominated in the SEARs because it is likely to: • cause the extinction of the EEC from the IBRA subregion, or • significantly reduce the viability of the EEC	No
	Species and populations	Impacts on areas of land that the Minister for Environment has declared as critical habitat in accordance with section 46 of the TSC Act and which is listed on the Register of Critical Habitat in NSW	No
		Any impact on a critically endangered species (unless specifically excluded in the SEARs)	No
		Any impact on a threatened species or population nominated in the SEARs because it is likely to: • cause the extinction of a species or population from an IBRA subregion, or • significantly reduce the viability of a species or population	No
		Any impact on a threatened species or population that has not previously been recorded in	No

Table 7.3 Thresholds for the assessment and offsetting of unavoidable impacts of the Project

Threshold	Biodiversity Value	Criteria	Applicable to the Project?
		the IBRA subregion according to records in the NSW Wildlife Atlas	
II. Impacts for which the assessor is required to determine an offset	Landscape Features	Not applicable to the FBA	n/a
	Native Vegetation	Impacts on CEECs that are specifically excluded from requiring further consideration in the SEARS	No
		Impacts on PCTs that are EECs not specifically nominated as requiring further consideration in the SEARs	**Yes** – The Project will impact on two EECs, HN526 and HN594, that are not specifically nominated as requiring further consideration in the SEARs.
		Impacts on PCTs associated with threatened species habitat and which have a site value score ≥17	No
	Species and populations	Impacts on a critically endangered species that is specifically excluded from requiring further consideration in the SEARS	No
		Impacts on threatened species, populations and threatened species habitat not specifically nominated as requiring further consideration in the SEARs	No
		Impacts on threatened species habitat associated with a PCT and which has a site value score of ≥17	No
III. Impacts for which the assessor is not required to determine an offset	Landscape Features	Not applicable to the FBA	n/a
	Native Vegetation	Impacts on PCTs that: • have a site value score <17, or • are not identified as CEECs / EECs	No

Table 7.3 Thresholds for the assessment and offsetting of unavoidable impacts of the Project

Threshold	Biodiversity Value	Criteria	Applicable to the Project?
		Impacts on PCTs that are not associated with threatened species habitat and are not identified as CEECs / EECs	No
	Species and populations	Impacts on non-threatened species and populations that do not form part of a CEEC or EEC	**Yes** – The Project will impact on non-threatened species and populations that do not form part of a CEEC or EEC
		Impacts on threatened species habitat associated with a PCT within a vegetation zone with a site value score of <17	No
V. Impacts that do not require further assessment by the assessor	Landscape Features	Areas of land without native vegetation, unless the area of land requires assessment under the SEARs issued for the Major Project	No
	Native Vegetation	Areas of land without native vegetation, unless the area of land requires assessment under the SEARs issued for the Major Project	**Yes** – the Project will impact on 113.85 ha of land that does not confirm to a PCT
	Species and populations	Not applicable since all areas of land must be assessed for threatened species, even if they do not contain native vegetation	n/a

7.4 Impacts that Require Further Consideration

7.4.1 Landscape Features

No landscape features relevant to the Project required further consideration.

7.4.2 Native Vegetation

Impacts of the Project that fall into the threshold of impacts that require further consideration comprise the removal of a total 2.20 ha of CEEC which comprises 0.89 ha of HN528 and 1.07 ha of HN529 that are both TSC Act listed and EPBC Act listed CEEC of Cumberland Plain Woodland. The remaining 0.14 ha of HN528 and 0.10 ha of HN529 being listed CEEC under TSC Act only.

An assessment of impacts to this vegetation is provided below. No other impacts of the Project require further consideration.

i. Calculation of Credits

A summary of the vegetation zones comprising Cumberland Plain Woodland that fall within the threshold of requiring further consideration and their credit requirement is shown in **Table 7.4**. Vegetation Zones 4 and 7 are CEECs listed under both TSC Act and EPBC Act and Vegetation Zones 5, 6 and 8 are listed under the TSC Act only.

Table 7.4 Impacts that require further consideration

Vegetation Zone	PCT	Condition	Area (ha)	Current Site Value	Future Site Value	Credit Requirement
4	HN528	Moderate/Good	0.89	53.86	0.00	39
5	HN528	Moderate/Good_High	0.05	53.86	0.00	2
6	HN528	Moderate/Good_Medium	0.10	53.86	0.00	4
7	HN529	Moderate/Good	1.07	39.86	0.00	35
8	HN529	Moderate/Good_High	0.10	39.86	0.00	3
		TOTAL	**2.20**			**83**

ii. Further Information

(a) the area and condition of the CEEC or EEC to be impacted directly and indirectly by the proposed development

An area of 2.20 ha of Cumberland Plain Woodland will be removed. This will constitute removal of 100% of the occurrence of the CEEC from the development site.

(b) the extent and overall condition of the CEEC or EEC within an area of 1000 ha and then 10,000 ha surrounding the proposed development footprint

Within the 1,000 ha area around the development site, there are scattered occurrences of Cumberland Plain Woodland which total 116.97 ha with the majority of the vegetation immediately surrounding the development is highly fragmented. There are no intact occurrences of the CEEC within the locality with security of tenure such as National Parks, Reserves, or Priority Conservation Areas.

Within 10,000 ha of the development site, there are several intact occurrences of Cumberland Plain Woodland. Prospect Nature Reserve occurs approximately 5 km to the west of the development site. There are also three Priority Conservation Areas, Hoxton, Castlereagh, and Mulgoa, which occur within a 10,000 ha area of the development site. The 2013 update for the Cumberland Plain Vegetation Mapping (DECCW, 2007), has identified up to 743.54 ha of Cumberland Plain Woodland within 10,000 ha of the development site.

(c) an estimate of the extant area and overall condition of the CEEC or EEC remaining in the IBRA subregion after the impact of the proposed development has been taken into consideration

The proposed development will reduce the extent of the CEEC by 2.20 ha within the Cumberland IBRA subregion. The proposed development will not affect the condition of the CEEC beyond the development site. The remaining 741.38 ha of CEEC within 10,000ha of the development site is a more mature version of that found on the development site and is of much greater quality. Much of it is already maintained and managed within a voluntary conservation agreement that is present on the CEEC to the north of the development site.

(d) the development proposal's impact on:

(i) abiotic factors critical to the long-term survival of the CEEC or EEC. For example, will the impact lead to a reduction of groundwater levels or substantial alteration of surface water patterns?

(ii) characteristic and functionally important species through impacts such as, but not limited to, inappropriate fire/flooding regimes, removal of understorey species or harvesting of plants

(iii) the quality and integrity of an occurrence of the CEEC or EEC through threats and indirect impacts including, but not limited to, assisting invasive flora and fauna species to become established or causing regular mobilisation of fertilisers, herbicides or other chemicals or pollutants which may harm or inhibit growth of species in the CEEC or EEC.

The Project will not affect abiotic factors critical to the long term survival of the CEEC beyond the development site. Impacts of the Project such as groundwater or substantial alterations to surface water patterns will be confined to the development site.

The Project will remove 2.20 ha of the CEEC from the development site. The Project will not affect the CEEC beyond the development site as it will not affect fire/flooding regimes, will it impact on the community by removal of understorey species.

Cumberland Plain Woodland has previously been substantially cleared and or modified within the development site and adjoining land. The Project will not affect the integrity or occurrence of the CEEC, as the remaining CEEC does not occur nearby to the development site. The Project will not affect the CEEC within the development site through introduction of invasive flora and fauna species, as the entire extent of the CEEC within the development site will be removed.

(e) direct or indirect fragmentation and isolation of an important area of the CEEC or EEC

The occurrence of the CEEC within the development site is a small area (2.20 ha) of regrowth of the community that is fragmented across the development site and is only present in small, isolated stands of the community. The development site is not located within or nearby any National Parks or Priority Conservation Areas identified as important areas for the CEEC.

(f) the measures proposed to contribute to the recovery of the CEEC or EEC in the IBRA subregion.

The proponent of the Project proposes to acquire offsets in the form of BioBanking Credits commensurate to the exact credit requirement prescribed by the BBCC. A summary of the credit requirements for this CEEC are outlined in **Table 7.4**.

7.4.3 Species and Populations

No species and populations have been assessed as impacted by the Project, therefore none require further consideration.

Coordinate System: MGA Zone 56 (GDA 94)

Legend

- Development Site
- Additional North-South Link Road Area
- Area of unavoidable impact (Native vegetation)

N

Grid North

Scale: 1:9,339 @ A3 page
Date prepared: 31/03/2017

Image Source:
Image © Nearmap
(dated 11/02/2017)

Data Source:
Image © 2015
NSW Land and Property Management Authority,
SIX Viewer

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I:\..\15122\Figures\RP1_BAR\20170331\Figure 7.1. Location of Impact Thresholds

Figure 7.1. Location of impact thresholds

100 0 100 200 300 400 m

7.5 Impacts Requiring Offsetting

7.5.1 Landscape Features

No landscape features relevant to the Project required further consideration.

7.5.2 Native Vegetation

Native vegetation impacts of the Project that fall into the threshold of impacts that require offsetting comprise:

- The removal of 1.11 ha of HN526 which comprises the River-Flat Eucalypt Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions EEC; and
- The removal of 1.62 ha of HN594 which comprises Swamp Oak Floodplain Forest of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions EEC.

The offset requirement for HN526 and HN594 were calculated using the BBCC. A summary of the vegetation zone impacted, threatened species associated with that vegetation zone, loss landscape value, loss in site value, and the number of ecosystem credits required for the impacts is detailed in **Table 7.5**.

Table 7.5 Ecosystem Credit requirement of the Project

Zone	PCT	Associated TECs and/or Ecosystem Credit Species	Loss in Landscape Value	Loss in Site Value Score	Required Ecosystem Credits
1	HN526: Forest Red Gum - Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney Basin	River-Flat Eucalypt Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions Masked Owl	12.80	28.65	14
2	HN526: Forest Red Gum - Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney Basin	River-Flat Eucalypt Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions Yellow-bellied Sheath-tail Bat	12.80	28.65	5
3	HN526: Forest Red	River-Flat Eucalypt Forest	12.80	28.65	8

Table 7.5 Ecosystem Credit requirement of the Project

Zone	PCT	Associated TECs and/or Ecosystem Credit Species	Loss in Landscape Value	Loss in Site Value Score	Required Ecosystem Credits
	Gum - Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney Basin	on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions Yellow-bellied Sheath-tail Bat			
9	HN594: Swamp Oak swamp forest fringing estuaries, Sydney Basin Bioregion and South East Corner Bioregion	Swamp Oak Floodplain Forest of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions Masked Owl	12.80	65.22	84

7.5.3 Species and Populations

The removal of 24 Juniper-leaved Grevillea (*Grevillea juniperina* subsp. *juniperina*) would comprise a species impact that falls into the threshold of impacts that require offsetting under the FBA. However as the offsetting for the removal of these individuals forms part of the approvals for the development of the Fitzpatrick land, further offsetting is for this species is not considered within this BAR.

7.6 Impacts not Requiring Offsetting

7.6.1 Native Vegetation

All native vegetation relevant to the Project is required to be further assessed (see ***Section 7.4***) or requires an offset (see ***Section 7.5***).

7.6.2 Species and Populations

A number of non-threatened species and populations have been recorded within the development. In accordance with Section 9.4.2 of the FBA these species do not require offsetting.

7.7 Impacts that do not Require Further Assessment

The development site includes 113.85 ha of revegetated, exotic or cleared land that is not considered to comprise of a PCT or habitat for threatened species and populations. In accordance with Section 9.5.1.1 of the FBA this area of land does not require further assessment.

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Appendix A

Plot and Transect Data

Table A.1 Plot and Transect Data from the Development Site

Plot Name	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Q14	Q15
PCT	HN526	HN594	HN594	HN594	HN528	HN529	HN529	HN529	Exotic	Exotic	Exotic	Exotic	HN528	Reveg	Exotic
Date	16-Oct-15	16-Oct-15	16-Oct-15	16-Oct-15	16-Oct-15	16-Oct-15	16-Oct-15	19-Oct-15	19-Oct-15	19-Oct-15	19-Oct-15	19-Oct-15	19-Oct-15	8-Apr-16	8-Apr-16
Easting	29674	295977	296992	297378	296320	295940	295895	296761	296073	296465	297214	296785	297046	297062	297090
Northing	6254609	6254396	6254280	6255300	6254107	6254931	6254622	6254107	6254796	6254369	6254751	6255036	6254490	6255368	6255553
Native Plant Species Richness	11	19	23	20	25	24	26	31	2	6	5	4	17	21	11
Over-storey Cover	28	30.5	20	18	68	62	72	19	0	0	0	0	33	0	0
Mid-storey Cover	21	0	8	5	0	0	0	4	0	0	0	0	27	5.5	0
Native Ground Cover (Grasses	0	78	54	94	0	0	0	100	6	18	0	0	70	9	11
Native Ground Cover (Shrubs)	0	0	18	20	21	18	23.3	46	0	0	0	0	0	3.5	1.5
Native Ground Cover (Other)	0	0	0	10	38	45.5	69	88	0	0	2	0	0	2	2
Exotic Plant Cover	27.3	24	32.6	20	0	0	0	10	33.3	33.3	100	100	23.3	31	47
Number of Trees with Hollows	0	0	1	0	0	0	1	0	0	0	0	0	1	0	0
Over-storey Regeneration	0	1	1	1	1	1	1	1	0	0	0	0	0	1	0
Total Length of Fallen Logs	9	23	2	0	24	10	15.5	25	0	0	0	0	15	0	0

Appendix B

Flora Species List

Table B.1 Flora species list from development site

Form	Family *	Scientific Name	Common Name	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Q14	Q15
1 - Trees	Casuarinaceae	*Casuarina glauca*	Swamp Oak		X	X	X											
1 - Trees	Myrtaceae	*Angophora subvelutina #*																
1 - Trees	Myrtaceae	*Eucalyptus amplifolia #*	Cabbage Gum															
1 - Trees	Myrtaceae	*Eucalyptus crebra*	Narrow-leaved Ironbark	X				X								X		
1 - Trees	Myrtaceae	*Eucalyptus eugenioides*	Thin-leaved Stringybark								X					X		
1 - Trees	Myrtaceae	*Eucalyptus molucanna*														X		
1 - Trees	Myrtaceae	*Eucalyptus tereticornis*	Forest Red Gum	X				X	X	X	X					X		
2 - Small Trees	Casuarinaceae	*Casuarina glauca*	Swamp Oak		X	X	X										X	
2-Small Trees	Fabaceae (Mimosoideae)	*Acacia decurrens*	Sydney Wattle														X	
2 - Small Trees	Fabaceae (Mimosoideae)	*Acacia parramattensis*	Parramatta Wattle								X							
2 - Small Trees	Myrtaceae	*Eucalyptus amplifolia #*	Cabbage Gum															
2 - Small Trees	Myrtaceae	*Eucalyptus crebra #*	Narrow-leaved Ironbark															
2 - Small Trees	Myrtaceae	*Eucalyptus eugenioides*	Thin-leaved Stringybark								X							
2 - Small Trees	Myrtaceae	*Eucalyptus tereticornis*	Forest Red Gum						X	X	X						X	

Table B.1 Flora species list from development site

Form	Family	*	Scientific Name	Common Name	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Q14	Q15
2 - Small Trees	Myrtaceae		*Melaleuca styphelioides*	Prickly-leaved Tea Tree			X												
2 - Small Trees	Myrtaceae		*Melaleuca decora*		X														
3 - Shrubs	Asteraceae		*Ozothamnus diosmifolius*	Rice Flower								X							
3 - Shrubs	Brassicaceae		*Lepidium africanum* #																
3 - Shrubs	Casuarinaceae		*Casuarina glauca*	Swamp Oak			X	X										X	
3 - Shrubs	Dilleniaceae		*Hibbertia diffusa*	Wedge Guinea Flower								X							
3 - Shrubs	Fabaceae (Mimosoideae)		*Acacia decurrens*	Sydney Wattle														X	
3 - Shrubs	Fabaceae (Mimosoideae)		*Acacia falcata*	Sickle Wattle														X	
3 - Shrubs	Fabaceae (Mimosoideae)		*Acacia parramattensis*	Parramatta Wattle				X											
3 - Shrubs	Fabaceae (Faboideae)		*Dillwynia siebri*	Prickly Parrot-pea														X	
3 - Shrubs	Myrtaceae		*Callistemon pinifolius*	Pine-leaved Bottlebrush															X
3 - Shrubs	Myrtaceae		*Callistemon salignus*	Willow Bottlebrush														X	
3 - Shrubs	Myrtaceae		*Eucalyptus crebra* #	Narrow-leaved															

Table B.1 Flora species list from development site

Form	Family	*	Scientific Name	Common Name	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Q14	Q15
				Ironbark															
3 - Shrubs	Myrtaceae		*Eucalyptus tereticornis*	Forest Red Gum							X	X						X	
3 - Shrubs	Myrtaceae		*Melaleuca linariifolia*	Flax-leaved Paperbark			X												
3 - Shrubs	Myrtaceae		*Melaleuca nodosa*	Prickly-leaved Paperbark															X
3 - Shrubs	Myrtaceae		*Melaleuca styphelioides*	Prickly-leaved Tea Tree			X												
3 - Shrubs	Pittosporaceae		*Bursaria spinosa*	Blackthorn			X	X	X		X	X					X	X	
3 - Shrubs	Rosaceae	*	*Rosa rubiginosa*	Sweet Bria			X												
3 - Shrubs	Solanaceae	*	*Cestrum parqui*	Green Cestrum			X		X										
3 - Shrubs	Solanaceae	*	*Lycium ferocissimum*	African Boxthorn			X	X	X	X							X		
4 - Ferns and Allies	Lindsaeaceae		*Cheilanthes distans #*	Bristly Cloak Fern															
4 - Ferns and Allies	Pteridaceae		*Cheilanthes sieberi*							X									
5 - Herbs (Dicots)	Acanthaceae		*Brunoniella australis*	Blue Trumpet		X	X	X	X		X	X							
5 - Herbs (Dicots)	Amaranthaceae		*Alternanthera denticulata*	Lesser Joyweed				X											
5 - Herbs (Dicots)	Amaranthaceae		*Alternanthera nanab #*	Hairy Joyweed															
5 - Herbs (Dicots)	Apiaceae	*	*Centella asiatica*	Indian Pennywort				X											
5 - Herbs (Dicots)	Apiaceae	*	*Cyclospermum leptophyllum*	Slender Celery	X	X	X		X	X	X		X	X		X	X		

Table B.1 Flora species list from development site

Form	Family	*	Scientific Name	Common Name	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Q14	Q15
5 - Herbs (Dicots)	Apiaceae		*Daucus glochidiatus*	Native Carrot						X									
5 - Herbs (Dicots)	Asteraceae	*	*Bidens pilosa*	Cobblers Peg	X			X	X	X	X	X						X	
5 - Herbs (Dicots)	Asteraceae	*	*Bidens subalternans*	Greater Beggar's Ticks														X	
5 - Herbs (Dicots)	Asteraceae		*Chrysocephalum apiculatum #*	Common Everlasting															
5 - Herbs (Dicots)	Asteraceae	*	*Cirsium vulgare*	Spear Thistle	X	X	X	X	X	X	X					X	X	X	
5 - Herbs (Dicots)	Asteraceae	*	*Conyza bonariensis*	Flax-leaf Fleabane														X	
5 - Herbs (Dicots)	Asteraceae	*	*Conyza sumatrensis*	Tall Fleabane	X	X	X	X		X	X		X			X		X	X
5 - Herbs (Dicots)	Asteraceae		*Cotula australis*	Common Cotula	X	X			X	X	X						X		
5 - Herbs (Dicots)	Asteraceae	*	*Cotula coronopifolia*	Water Buttons	X		X												
5 - Herbs (Dicots)	Asteraceae		*Cymbonotus lawsonianus*	Bears-ear		X													
5 - Herbs (Dicots)	Asteraceae		*Eclipta platyglossa*				X												
5 - Herbs (Dicots)	Asteraceae		*Euchiton sphaericus*			X			X	X	X	X						X	
5 - Herbs (Dicots)	Asteraceae	*	*Facelis retusa*	Annual Trampweed													X		
5 - Herbs (Dicots)	Asteraceae	*	*Gamochaeta americana*	Cudweed		X	X						X			X		X	X
5 - Herbs (Dicots)	Asteraceae	*	*Gamochaeta calviceps*	Cudweed						X	X					X	X		
5 - Herbs (Dicots)	Asteraceae	*	*Gamochaeta purpurea #*	Purple Cudweed															
5 - Herbs (Dicots)	Asteraceae	*	*Hypochaeris microcephala*	White Flatweed	X	X	X	X	X	X	X			X		X	X	X	X

Table B.1 Flora species list from development site

Form	Family	*	Scientific Name	Common Name	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Q14	Q15
5 - Herbs (Dicots)	Asteraceae	*	*Hypochaeris radicata*	Catsear	X	X		X	X	X	X	X	X	X	X		X		X
5 - Herbs (Dicots)	Asteraceae	*	*Lactuca saligna*	Willow-leaved Lettuce	X			X											
5 - Herbs (Dicots)	Asteraceae	*	*Lactuca serriola*	Prickly Lettuce						X									
5 - Herbs (Dicots)	Asteraceae	*	*Senecio madagascariensis*	Fireweed	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
5 - Herbs (Dicots)	Asteraceae	*	*Senecio pterophorus*					X											
5 - Herbs (Dicots)	Asteraceae		*Sigesbeckia orientalis*				X												
5 - Herbs (Dicots)	Asteraceae	*	*Soliva sessilis*	Jo-jo		X				X		X		X		X			
5 - Herbs (Dicots)	Asteraceae	*	*Sonchus asper #*	Prickly Sowthistle															
5 - Herbs (Dicots)	Asteraceae	*	*Sonchus oleraceus*	Common Sowthistle	X	X	X	X	X		X						X		
5 - Herbs (Dicots)	Asteraceae	*	*Tagetes minuta*	Stinking Roger															
5 - Herbs (Dicots)	Asteraceae	*	*Taraxacum officinale*	Dandelion	X			X											
5 - Herbs (Dicots)	Asteraceae		*Triptilodiscus pygmaeus*	Common Sunray															
5 - Herbs (Dicots)	Asteraceae		*Vernonia cinerea #*																
5 - Herbs (Dicots)	Asteraceae		*Vittandina cuneata*	Fuzzweed														X	
5 - Herbs (Dicots)	Aizoaceae		*Tetragonia tetragonioides*	New Zealand Spinach				X											
5 - Herbs (Dicots)	Brassicaceae	*	*Brassica fruticulosa*	Twiggy Turnip															
5 - Herbs (Dicots)	Brassicaceae	*	*Brassica sp.*						X								X		

Table B.1 Flora species list from development site

Form	Family	*	Scientific Name	Common Name	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Q14	Q15
5 - Herbs (Dicots)	Brassicaceae	*	*Lepidium africanum*						X								X		
5 - Herbs (Dicots)	Brassicaceae	*	*Lepidium bonariense*		X	X	X			X									
5 - Herbs (Dicots)	Brassicaceae	*	*Rorippa nasturtium-aquaticum*	Watercress			X												
5 - Herbs (Dicots)	Brassicaceae	*	*Sisymbrium officinale*	Hedge Mustard					X										
5 - Herbs (Dicots)	Campanulaceae	*	*Paronychia brasiliana*	Chilean Whitlow Wort	X				X	X							X		
5 - Herbs (Dicots)	Campanulaceae		*Wahlenbergia communis*	Tufted Bluebell								X							
5 - Herbs (Dicots)	Campanulaceae		*Wahlenbergia gracilis*	Sprawling Bluebell			X		X	X		X		X		X	X		
5 - Herbs (Dicots)	Caryophyllaceae	*	*Cerastium glomeratum* #	Mouse-ear Chickweed															
5 - Herbs (Dicots)	Caryophyllaceae	*	*Petrorhagia dubia*							X									
5 - Herbs (Dicots)	Caryophyllaceae	*	*Polycarpon tetraphyllum*	Four-leaved Allseed	X				X	X							X		
5 - Herbs (Dicots)	Caryophyllaceae	*	*Silene gallica var. gallica*						X										
5 - Herbs (Dicots)	Caryophyllaceae	*	*Spergularia bocconei* #	Bocconi's Sand-spurrey															
5 - Herbs (Dicots)	Caryophyllaceae	*	*Spergularia levis*		X														
5 - Herbs (Dicots)	Caryophyllaceae	*	*Stellaria media*	Common Chickweed			X								X	X	X		
5 - Herbs (Dicots)	Chenopodiaceae	*	*Chenopodium album*	Fat Hen															

Table B.1 Flora species list from development site

Form	Family	*	Scientific Name	Common Name	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Q14	Q15
5 - Herbs (Dicots)	Chenopodiaceae	*	*Chenopodium glaucum #*																
5 - Herbs (Dicots)	Chenopodiaceae	*	*Chenopodium murale*	Nettle-leaf Goosefoot	X														
5 - Herbs (Dicots)	Chenopodiaceae	*	*Einadia nutans #*	Climbing Saltbush															
5 - Herbs (Dicots)	Chenopodiaceae		*Einadia nutans subsp. nutans*	Climbing Saltbush	X	X	X			X									
5 - Herbs (Dicots)	Chenopodiaceae		*Einadia nutans subsp. linifolia*						X		X								
5 - Herbs (Dicots)	Chenopodiaceae		*Einadia polygonoides*									X							
5 - Herbs (Dicots)	Chenopodiaceae		*Einadia trigonos*	Fishweed					X			X					X		
5 - Herbs (Dicots)	Clusiaceae		*Hypericum gramineum*	Small St. John's Wort						X									
5 - Herbs (Dicots)	Convolvulaceae		*Dichondra repens*	Kidney Weed		X	X	X	X	X	X	X					X		
5 - Herbs (Dicots)	Fabaceae (Faboideae)		*Bossiaea prostrata*									X							
5 - Herbs (Dicots)	Fabaceae (Faboideae)	*	*Lotus uliginosus*	Birds-foot Trefoil	X	X	X			X	X		X	X	X	X	X		
5 - Herbs (Dicots)	Fabaceae (Faboideae)	*	*Medicago lupulina #*	Black Medic															
5 - Herbs (Dicots)	Fabaceae	*	*Medicago polymorpha #*	Burr Medic															

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Form	Family	*	Scientific Name	Common Name	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Q14	Q15
	(Faboideae)																		
5 - Herbs (Dicots)	Fabaceae (Faboideae)	*	*Trifolium campestre*	Hop Clover											X	X			
5 - Herbs (Dicots)	Fabaceae (Faboideae)	*	*Trifolium dubium*	Yellow Suckling Clover									X						
5 - Herbs (Dicots)	Fabaceae (Faboideae)	*	*Trifolium repens #*	White Clover															
5 - Herbs (Dicots)	Fabaceae (Faboideae)	*	*Vicia sativa #*																
5 - Herbs (Dicots)	Gentianaceae	*	*Centaurium tenuiflorum*										X			X	X		
5 - Herbs (Dicots)	Geraniaceae		*Geranium solanderi*	Native Geranium					X								X		
5 - Herbs (Dicots)	Goodeniaceae		*Goodenia hederacea*	Forest Goodenia								X							
5 - Herbs (Dicots)	Juncaginaceae		*Triglochin procera*	Water Ribbons				X											
5 - Herbs (Dicots)	Lamiaceae		*Plectranthus parviflorus*	Cockspur Flower			X												
5 - Herbs (Dicots)	Lamiaceae		*Scutellaria humilis*	Dwarf Skullcap			X												
5 - Herbs (Dicots)	Linaceae	*	*Linum trigynum*	French Flax		X	X			X	X								
5 - Herbs (Dicots)	Lobeliaceae		*Pratia purpurascens*	Whiteroot			X	X			X	X							
5 - Herbs (Dicots)	Malvaceae	*	*Malva parviflora*	Small-flowered Mallow					X										
5 - Herbs (Dicots)	Malvaceae	*	*Modiola caroliniana*	Red-flowered		X	X	X	X		X	X							

Table B.1 Flora species list from development site

Form	Family	*	Scientific Name	Common Name	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Q14	Q15
				Mallow															
5 - Herbs (Dicots)	Malvaceae	*	*Sida rhombifolia*	Paddy's Lucerne	X		X	X	X	X	X	X					X		
5 - Herbs (Dicots)	Myrsinaceae	*	*Anagallis arvensis*	Scarlet Pimpernel	X	X			X	X	X	X	X	X	X		X		
5 - Herbs (Dicots)	Myrtaceae		*Eucalyptus tereticornis*	Forest Red Gum						X									
5 - Herbs (Dicots)	Oleaceae	*	*Olea europaea subsp. Cuspidata*	African Olive				X											
5 - Herbs (Dicots)	Oxalidaceae		*Oxalis perennans*			X	X	X	X	X	X	X	X		X		X	X	
5 - Herbs (Dicots)	Phyllanthaceae		*Phyllanthus virgatus*							X	X								
5 - Herbs (Dicots)	Phyllanthaceae		*Poranthera microphylla*							X		X					X		
5 - Herbs (Dicots)	Plantaginaceae		*Plantago debilis*		X	X													
5 - Herbs (Dicots)	Plantaginaceae	*	*Plantago lanceolata*	Lamb's Tongue	X	X	X	X	X	X	X	X		X		X			
5 - Herbs (Dicots)	Plantaginaceae		*Veronica plebeia*	Trailing Speedwell							X	X					X		
5 - Herbs (Dicots)	Polygonaceae	*	*Polygonum aviculare*	Wireweed	X														
5 - Herbs (Dicots)	Polygonaceae	*	*Rumex crispus*	Curled Dock			X												
5 - Herbs (Dicots)	Polygonaceae	*	*Rumex brownii*	Swamp Dock	X		X		X										
5 - Herbs (Dicots)	Rubiaceae		*Asperula conferta*	Common Woodruff		X	X	X	X		X	X		X					
5 - Herbs (Dicots)	Rubiaceae		*Galium leptogonium*				X												
5 - Herbs (Dicots)	Rubiaceae		*Opercularia diphylla*									X							
5 - Herbs (Dicots)	Rubiaceae	*	*Sherardia arvensis*	Field Madder			X												

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Form	Family	*	Scientific Name	Common Name	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Q14	Q15
5 - Herbs (Dicots)	Scrophulariaceae		*Eremophila debilis*	Winter Apple							X								
5 - Herbs (Dicots)	Solanaceae	*	*Solanum americanum*	Glossy Nightshade			X			X									
5 - Herbs (Dicots)	Solanaceae	*	*Solanum linnaeanum*	Apple of Sodom		X	X	X	X	X	X	X					X		
5 - Herbs (Dicots)	Solanaceae		*Solanum prinophyllum*	Forest Nightshade		X	X	X	X	X	X								
5 - Herbs (Dicots)	Solanaceae	*	*Solanum pseudocapsicum*	Madeira Winter			X	X	X										
5 - Herbs (Dicots)	Solanaceae	*	*Solanum sisymbriifolium*	Sticky Nightshade														X	
5 - Herbs (Dicots)	Stackhousiaceae		*Stackhousia viminea*	Slender Stackhousia								X							
6 - Herbs (Monocots - Grasses)	Poaceae		*Aristida ramosa*	Purple Wiregrass		X			X	X	X	X	X	X			X	X	
6 - Herbs (Monocots - Grasses)	Poaceae		*Aristida vagans*	Threeawn Speargrass													X	X	
6 - Herbs (Monocots - Grasses)	Poaceae	*	*Axonopus fissifolius*	Narrow-leafed Carpet Grass						X			X		X		X		X
6 - Herbs (Monocots - Grasses)	Poaceae	*	*Briza minor*	Shivery Grass											X	X	X		
6 - Herbs (Monocots - Grasses)	Poaceae	*	*Briza subaristata*			X	X	X	X	X	X	X	X	X	X	X	X		X
6 - Herbs (Monocots - Grasses)	Poaceae		*Bothriochloa decipiens*	Red Grass														X	X

Table B.1 Flora species list from development site

Form	Family	*	Scientific Name	Common Name	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Q14	Q15
6 - Herbs (Monocots - Grasses)	Poaceae		*Bothriochloa macra*	Red Grass		X				X	X			X					X
6 - Herbs (Monocots - Grasses)	Poaceae	*	*Bromus catharticus*	Prairie Grass	X		X	X	X	X	X					X	X		
6 - Herbs (Monocots - Grasses)	Poaceae	*	*Chloris gayana*	Rhodes Grass	X	X		X						X				X	
6 - Herbs (Monocots - Grasses)	Poaceae		*Chloris ventricosa*	Plump Windmill Grass		X			X	X		X							
6 - Herbs (Monocots - Grasses)	Poaceae		*Cymbopogon refractus*	Barbed Wire Grass										X				X	
6 - Herbs (Monocots - Grasses)	Poaceae	*	*Cynodon dactylon*	Couch	X	X	X	X	X	X	X		X		X	X	X	X	X
6 - Herbs (Monocots - Grasses)	Poaceae		*Dichelachne micrantha*	Shorthair Plumegrass						X	X				X				
6 - Herbs (Monocots - Grasses)	Poaceae		*Echinopogon caespitosus*	Bushy Hedgehog-grass					X		X						X		
6 - Herbs (Monocots - Grasses)	Poaceae	*	*Ehrharta erecta*	Panic Veldtgrass			X		X		X								
6 - Herbs (Monocots - Grasses)	Poaceae		*Elymus scaber*						X										
6 - Herbs (Monocots -	Poaceae		*Eragrostis brownii*	Brown's Lovegrass														X	X

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Form	Family	*	Scientific Name	Common Name	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Q14	Q15
Grasses)																			
6 - Herbs (Monocots - Grasses)	Poaceae	*	*Eragrostis curvula*	African Lovegrass				X		X			X	X		X	X	X	X
6 - Herbs (Monocots - Grasses)	Poaceae		*Eragrostis leptostachya*	Paddock Lovegrass					X		X	X					X		X
6 - Herbs (Monocots - Grasses)	Poaceae	*	*Hordeum leporinum*	Barley Grass												X			
6 - Herbs (Monocots - Grasses)	Poaceae		*Lachnagrostis filiformis*		X			X		X	X				X	X	X		
6 - Herbs (Monocots - Grasses)	Poaceae	*	*Lolium perenne*	Perennial Ryegrass	X				X										
6 - Herbs (Monocots - Grasses)	Poaceae		*Microlaena stipoides*	Weeping Grass	X	X	X	X	X	X	X	X					X	X	X
6 - Herbs (Monocots - Grasses)	Poaceae		*Oplismenus aemulus*	Australian Basket Grass			X	X											
6 - Herbs (Monocots - Grasses)	Poaceae		*Paspalidium distans*							X									
6 - Herbs (Monocots - Grasses)	Poaceae	*	*Paspalum dilatatum*	Paspalum	X	X	X	X		X		X	X	X	X	X	X		X
6 - Herbs (Monocots - Grasses)	Poaceae	*	*Poa annua*	Winter Grass											X				

Table B.1 Flora species list from development site

Form	Family	*	Scientific Name	Common Name	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Q14	Q15
6 - Herbs (Monocots - Grasses)	Poaceae		*Rytidosperma bipartitum*	Wallaby Grass														X	
6 - Herbs (Monocots - Grasses)	Poaceae		*Rytidosperma fulvum*	Wallaby Grass					X		X								
6 - Herbs (Monocots - Grasses)	Poaceae		*Rytidosperma racemosum*						X										
6 - Herbs (Monocots - Grasses)	Poaceae	*	*Setaria parviflora*					X										X	X
6 - Herbs (Monocots - Grasses)	Poaceae	*	*Sporobolus africanus* #	Parramatta Grass															
6 - Herbs (Monocots - Grasses)	Poaceae		*Sporobolus creber*	Western Rat-tail Grass		X								X				X	X
6 - Herbs (Monocots - Grasses)	Poaceae		*Sporobolus elongatus* #	Slender Rat's Tail Grass															
6 - Herbs (Monocots - Grasses)	Poaceae		*Themeda triandra*	Kangaroo Grass								X						X	
6 - Herbs (Monocots - Grasses)	Poaceae	*	*Vulpia bromoides*	Squirrel Tail Fescue												X			
7 - Herbs (Monocots - Other)	Anthericaceae	*	*Arthropodium milleflorum* #	Pale Vanilla-lily															
7 - Herbs (Monocots -	Anthericaceae		*Arthropodium sp. B*							X									

Table B.1 Flora species list from development site

Form	Family	*	Scientific Name	Common Name	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Q14	Q15
Other)																			
7 - Herbs (Monocots - Other)	Anthericaceae		*Dichopogon fimbriatus*	Nodding Chocolate Lily								X							
7 - Herbs (Monocots - Other)	Anthericaceae		*Tricoryne elatior*	Yellow Autumn-lily													X		
7 - Herbs (Monocots - Other)	Colchicaceae		*Wurmbea dioica subsp. dioica #*	Early Nancy															
7 - Herbs (Monocots - Other)	Cyperaceae		*Carex appressa #*	Tall Sedge															
7 - Herbs (Monocots - Other)	Cyperaceae		*Carex inversa*	Knob Sedge		X		X		X	X	X					X		X
7 - Herbs (Monocots - Other)	Cyperaceae	*	*Cyperus eragrostis*	Umbrella Sedge	X		X	X											
7 - Herbs (Monocots - Other)	Cyperaceae		*Cyperus tetraphyllus*				X												
7 - Herbs (Monocots - Other)	Cyperaceae		*Fimbristylis dichotoma*	Common Fringe-sedge														X	X
7 - Herbs (Monocots - Other)	Cyperaceae		*Isolepis cernua*	Nodding Club-rush											X				
7 - Herbs (Monocots - Other)	Iridaceae	*	*Romulea rosea*	Onion Grass									X	X	X				

Table B.1 Flora species list from development site

Form	Family	*	Scientific Name	Common Name	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Q14	Q15
7 - Herbs (Monocots - Other)	Iridaceae	*	*Romulea rosea var. australis* #	Onion Grass															
7 - Herbs (Monocots - Other)	Iridaceae	*	*Sisyrinchium rosulatum*	Scourweed		X				X	X		X			X	X		
7 - Herbs (Monocots - Other)	Juncaceae	*	*Juncus acutus*	Sharp Rush			X	X											
7 - Herbs (Monocots - Other)	Juncaceae		*Juncus bufonius*	Toad Rush												X			
7 - Herbs (Monocots - Other)	Juncaceae		*Juncus subsecundus*												X				
7 - Herbs (Monocots - Other)	Juncaceae		*Juncus usitatus*		X			X			X					X	X		X
7 - Herbs (Monocots - Other)	Juncaceae		*Juncus planifolius*		X														
7 - Herbs (Monocots - Other)	Lomandraceae		*Lomandra filiformis*	Wattle Mat-rush					X										
7 - Herbs (Monocots - Other)	Lomandraceae		*Lomandra filiformis subsp. filiformis*									X							
7 - Herbs (Monocots - Other)	Lomandraceae		*Lomandra multiflora*	Many-flowered Mat-rush								X							

Table B.1 Flora species list from development site

Form	Family	*	Scientific Name	Common Name	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Q14	Q15
7 - Herbs (Monocots - Other)	Phormiaceae		*Dianella longifolia*	Blueberry Lily								X							
7 - Herbs (Monocots - Other)	Phormiaceae		*Dianella longifolia var. longifolia* #																
8 - Herbs (Vines and Climbers)	Convolvulaceae		*Polymeria calycina*									X							
8 - Herbs (Vines and Climbers)	Fabaceae (Faboideae)		*Desmodium varians*	Slender Tick-trefoil							X	X							
8 - Herbs (Vines and Climbers)	Fabaceae (Faboideae)		*Glycine microphylla*	Small-leaf glycine		X	X	X		X	X	X					X		
8 - Herbs (Vines and Climbers)	Fabaceae (Faboideae)		*Glycine tabacina*			X		X		X	X	X							
8 - Herbs (Vines and Climbers)	Rosaceae	*	*Rubus fruticosus*	Blackberry				X							X	X	X		

 # Incidental record of species only

** denotes exotic species*

Appendix C

Fauna Species List

Table C.1 Fauna species list from the development site

Family	Species Name	Common Name	TSC Act Status	EPBC Act Status	Exotic
Aves					
Acanthiza	*Acanthiza nana*	Yellow Thornbill			
Accipitridae	*Aquila audax*	Wedge-tailed Eagle			
Acrocephalidae	*Acrocephalus australis*	Australian Reed-Warbler			
Anatidae	*Chenonetta jubata*	Australian Wood Duck			
Anatidae	*Anas castanea*	Chestnut Teal			
Anatidae	*Anas gracilis*	Grey Teal			
Anatidae	*Anas platyrhynchos*	Mallard			*
Anatidae	*Anas superciliosa*	Pacific Black Duck			
Anatidae	*Cygnus atratus*	Black Swan			
Ardeidae	*Ardea ibis*	Cattle Egret		Migratory	
Ardeidae	*Ardea intermedia*	Intermediate Egret			
Ardeidae	*Egretta novaehollandiae*	White-faced Heron			
Ardeidae	*Ardea pacifica*	White-necked Heron			
Artamidae	*Cracticus tibicen*	Australian Magpie			
Artamidae	*Artamus cyanopterus*	Dusky Woodswallow			
Artamidae	*Cracticus torquatus*	Grey Butcherbird			
Artamidae	*Cracticus nigrogularis*	Pied Butcherbird			
Artamidae	*Strepera graculina*	Pied Currawong			
Cacatuidae	*Eolophus roseicapillus*	Galah			
Cacatuidae	*Cacatua sanguinea*	Little Corella			
Cacatuidae	*Cacatua galerita*	Sulphur-crested Cockatoo			
Campephagidae	*Coracina novaehollandiae*	Black-faced Cuckoo-shrike			
Campephagidae	*Lalage sueurii*	White-winged Triller			
Columbidae	*Ocyphaps lophotes*	Crested Pigeon			
Corvidae	*Corvus coronoides*	Australian Raven			
Cuculidae	*Cuculus pallidus*	Pallid Cuckoo			
Cuculidae	*Scythrops novaehollandiae*	Channel-billed Cuckoo			
Estrildidae	*Neochmia temporalis*	Red-browed Finch			
Falconidae	*Falco cenchroides*	Nankeen Kestrel			

Table C.1 Fauna species list from the development site

Family	Species Name	Common Name	TSC Act Status	EPBC Act Status	Exotic
Hirundinidae	*Petrochelidon ariel*	Fairy Martin			
Hirundinidae	*Petrochelidon nigricans*	Tree Martin			
Hirundinidae	*Hirundo neoxena*	Welcome Swallow			
Maluridae	*Malurus cyaneus*	Superb Fairy-wren			
Meliphagidae	*Anthochaera carunculata*	Red Wattlebird			
Meliphagidae	*Manorina melanocephala*	Noisy Miner			
Monarchidae	*Grallina cyanoleuca*	Magpie-lark			
Motacillidae	*Anthus novaeseelandiae*	Australasian Pipit			
Oriolidae	*Oriolus sagittatus*	Olive-backed Oriole			
Pachycephalidae	*Pachycephala pectoralis*	Golden Whistler			
Pachycephalidae	*Pachycephala rufiventris*	Rufous Whistler			
Pardalotidae	*Pardalotus striatus*	Striated Pardalote			
Pelecanidae	*Pelecanus conspicillatus*	Australian Pelican			
Petroicidae	*Eopsaltria australis*	Eastern Yellow Robin			
Psittacidae	*Platycercus eximius*	Eastern Rosella			
Psittacidae	*Trichoglossus haematodus*	Rainbow Lorikeet			
Psittacidae	*Psephotus haematonotus*	Red-rumped Parrot			
Pycnonotidae	*Pycnonotus jocosus*	Red-whiskered Bulbul			*
Rallidae	*Gallinula tenebrosa*	Dusky Moorhen			
Rallidae	*Fulica atra*	Eurasian Coot			
Rallidae	*Porphyrio porphyrio*	Purple Swamphen			
Rhipiduridae	*Rhipidura leucophrys*	Willie Wagtail			
Sturnidae	*Sturnus tristis*	Common Myna			*
Sturnidae	*Sturnus vulgaris*	Common Starling			*
Tachybaptus	*Tachybaptus novaehollandiae*	Australasian Grebe			

Table C.1 Fauna species list from the development site

Family	Species Name	Common Name	TSC Act Status	EPBC Act Status	Exotic
Threskiornithidae	*Platalea regia*	Royal Spoonbill			
Mammalia					
Canidae	*Vulpes vulpes*	Fox			*
Macropodidae	*Macropus giganteus*	Eastern Grey Kangaroo			
Amphibia					
Hylidae	*Litoria peronii*	Peron's Tree Frog			
Hylidae	*Litoria fallax*	Eastern Dwarf Tree Frog			
Myobatrachidae	*Crinia signifera*	Common Eastern Froglet			
Myobatrachidae	*Limnodynastes peronii*	Brown-striped Frog			
Myobatrachidae	*Uperoleia laevigata*	Smooth Toadlet			
Reptilia					
Chelidae	*Chelodina longicollis*	Eastern Snake-necked Turtle			

Appendix D

Biodiversity Credit Report

Biodiversity credit report

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

Date of report: 31/03/2017 Time: 10:48:42AM Calculator version: v4.0

Major Project details

Proposal ID:	0057/2016/2408MP
Proposal name:	15122 - Oakdale West (V4=Updated Veg)
Proposal address:	PO Box 2474 Carlingford Court NSW 2118
Proponent name:	Cumberland Ecology
Proponent address:	PO Box 2474 Epping NSW 2121
Proponent phone:	0298681933
Assessor name:	David Robertson
Assessor address:	PO BOX 2474 Carlingford Court NSW 2118
Assessor phone:	02 9868 1933
Assessor accreditation:	0057

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	1.11	27.40
Grey Box - Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin Bioregion	1.04	45.54
Grey Box - Forest Red Gum grassy woodland on shale of the southern Cumberland Plain, Sydney Basin Bioregion	1.17	38.72
Swamp Oak floodplain swamp forest, Sydney Basin Bioregion and South East Corner Bioregion	1.62	84.43
Total	4.94	196

Credit profiles

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

Number of ecosystem credits created	39
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

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

Number of ecosystem credits created	7
IBRA sub-region	Cumberland - Hawkesbury/Nepean

Offset options - Plant Community types	Offset options - IBRA sub-regions
Grey Box - Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin Bioregion, (HN528)	Cumberland - Hawkesbury/Nepean and any IBRA subregion that adjoins the IBRA subregion in which the development occurs

3. Grey Box - Forest Red Gum grassy woodland on shale of the southern Cumberland Plain, Sydney Basin Bioregion, (HN529)

Number of ecosystem credits created	35
IBRA sub-region	Cumberland - Hawkesbury/Nepean

Offset options - Plant Community types	Offset options - IBRA sub-regions
Grey Box - Forest Red Gum grassy woodland on shale of the southern Cumberland Plain, Sydney Basin Bioregion, (HN529) Grey Box - Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin Bioregion, (HN528)	Cumberland - Hawkesbury/Nepean and any IBRA subregion that adjoins the IBRA subregion in which the development occurs

4. Grey Box - Forest Red Gum grassy woodland on shale of the southern Cumberland Plain, Sydney Basin Bioregion, (HN529)

Number of ecosystem credits created	3
IBRA sub-region	Cumberland - Hawkesbury/Nepean

Offset options - Plant Community types	Offset options - IBRA sub-regions
Grey Box - Forest Red Gum grassy woodland on shale of the southern Cumberland Plain, Sydney Basin Bioregion, (HN529) Grey Box - Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin Bioregion, (HN528)	Cumberland - Hawkesbury/Nepean and any IBRA subregion that adjoins the IBRA subregion in which the development occurs

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

Number of ecosystem credits created	14
IBRA sub-region	Cumberland - Hawkesbury/Nepean

Offset options - Plant Community types	Offset options - IBRA sub-regions
Forest Red Gum - Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney Basin Bioregion, (HN526)	Cumberland - Hawkesbury/Nepean and any IBRA subregion that adjoins the IBRA subregion in which the development occurs

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

Number of ecosystem credits created	13
IBRA sub-region	Cumberland - Hawkesbury/Nepean

Offset options - Plant Community types	Offset options - IBRA sub-regions
Forest Red Gum - Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney Basin Bioregion, (HN526)	Cumberland - Hawkesbury/Nepean and any IBRA subregion that adjoins the IBRA subregion in which the development occurs

7. Swamp Oak floodplain swamp forest, Sydney Basin Bioregion and South East Corner Bioregion, (HN594)

Number of ecosystem credits created	84
IBRA sub-region	Cumberland - Hawkesbury/Nepean

Offset options - Plant Community types	Offset options - IBRA sub-regions
Swamp Oak floodplain swamp forest, Sydney Basin Bioregion and South East Corner Bioregion, (HN594) Swamp Oak swamp forest fringing estuaries, Sydney Basin Bioregion and South East Corner Bioregion, (HN595)	Cumberland - Hawkesbury/Nepean and any IBRA subregion that adjoins the IBRA subregion in which the development occurs

Summary of species credits required