Australian Government

BUILDING OUR FUTURE

The Northern Road Upgrade – Mersey Road, Bringelly to Glenmore Parkway, Glenmore Park

Submissions and Preferred Infrastructure Report

Volume 2: Appendices

Roads and Maritime Services | December, 2017

NSW GOVERNMENT

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Appendix C

Technical Memorandum: Biodiversity

JACOBS

Memorandum

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Date	26 October 2017
From	Lukas Clews
Subject	**TECHNICAL MEMO – Biodiversity**

1 Project description

Roads and Maritime Services (Roads and Maritime) propose to upgrade 16 km of The Northern Road between Mersey Road, Bringelly and Glenmore Parkway, Glenmore Park (the project).

The project generally comprises the following key features:

- A six-lane divided road between Mersey Road, Bringelly and Bradley Street, Glenmore Park (two general traffic lanes and a kerbside bus lane in each direction). A wide central median would allow for an additional travel lane in each direction in the future, if required
- An eight-lane divided road between Bradley Street, Glenmore Park and just south of Glenmore Parkway, Glenmore Park (three general traffic lanes and a kerbside bus lane in each direction separated by a central median)
- About eight kilometres of new road between Mersey Road, Bringelly and just south of the existing Elizabeth Drive, Luddenham to realign the section of The Northern Road that currently runs through the Western Sydney Airport site
- About eight kilometres of upgraded and widened road between the existing Elizabeth Drive, Luddenham and just south of Glenmore Parkway, Glenmore Park
- Access to the Luddenham town centre from north of the realigned The Northern Road and the existing The Northern Road
- Twin bridges over Adams Road, Luddenham
- Four new traffic light intersections and new traffic lights at existing intersections
- Local road changes and upgrades to current access arrangements for businesses and private properties
- A new shared path for pedestrians and cyclists on the western side of The Northern Road and footpaths on the eastern side of The Northern Road where required.

A detailed description of the project, including design refinements since exhibition of the EIS is provided in Chapter 5 of the Submissions and Preferred Infrastructure Report for the project.

2 Purpose and background

The Environmental Impact Statement (EIS) for the project was publicly displayed for information and comment between 21 June and 2 August 2017. The EIS considered a range of environmental, social and planning issues and nominated a number of measures to mitigate or manage these potential impacts.

In accordance with section 115Z(6) of the *Environmental Planning and Assessment Act 1979* (EP&A Act), Roads and Maritime is required to prepare a Submissions and Preferred Infrastructure Report to respond to any issues or questions raised by stakeholders and the community received during the EIS exhibition. The Submissions and Preferred Infrastructure Report also describes any refinements to the project's design and outlines revised environmental management measures identified in response to any changes and the submissions received. The Submissions and Preferred Infrastructure Report, including this Memorandum, will also inform the Final EIS to be prepared for the project in accordance with Part 8 of the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act), to be finalised based on the submissions received during exhibition.

The purpose of this Memorandum is to provide additional information to the Biodiversity Assessment Report (BAR) that was prepared for the project (Appendix I of the EIS), taking into consideration design refinements made during the detailed design phase (refer to Section 3) and issues raised by stakeholders and the community during the EIS exhibition (refer to Section 4).

This Memorandum should be read in conjunction with the EIS, Submissions and Preferred Infrastructure Report and any subsequent post-determination documentation. Details on design refinements are explained in the following sections.

3 Environmental assessment of design refinements

There have been a number of design refinements during detailed design of the project, as outlined in Chapter 5 of the Submissions and Preferred Infrastructure Report. These design refinements have resulted in changes to the construction and operational footprints which have affected the calculated direct impacts of the project as assessed within the Biodiversity Assessment Report (BAR) and subsequently presented within the environmental impact statement (EIS).

This section provides a revised assessment of the impacts under the Framework for Biodiversity Assessment (FBA) including recalculation of landscape values, impacts to native vegetation (including threatened ecological communities), impacts to threatened species, and impacts to Matters of National Environmental Significance (MNES), including impacts to the environment of commonwealth land.

The structure and methodology of this assessment is therefore similar to that presented within the BAR, with a focus on biodiversity values and impacts that have changed as a result of the design refinements since exhibition of the EIS.

3.1 Landscape values

As the project is a road upgrade, it is a linear shaped development and landscape value must be assessed according to Appendix 5 of the FBA (Assessing landscape value for linear shaped developments, or multiple fragmentation impacts). Alteration to the proposed construction footprint has resulted in the need for recalculation of landscape value components applicable to linear shaped developments including:

- Percent extent of native vegetation cover in the landscape
- Area to perimeter ratio.

The connectivity value and patch size calculations remain valid with the design change and no recalculation was required.

The revised percent extent of native vegetation cover in the landscape and area to perimeter ratio calculations were undertaken using ESRI ArcGIS software. To undertake the revised assessment of landscape values, a 550 metre buffer was established from the outside edge of the revised construction footprint. While this is a linear road project there are some detached construction compounds which made using a buffer from the centreline problematic. This increased the size of the landscape assessment from the BAR which assessed from the centreline.

3.1.1 Percent native vegetation cover

Once the native vegetation cover was digitised, the extent of native vegetation in the landscape before and after the development was recalculated based on the revised construction footprint (see Table 3.1). The 550 metre landscape buffer is 2,659.65 hectares in size. Current percent native vegetation cover is estimated at 12.26 per cent (score 2.5 as outlined in Table 16 of Appendix 5 of the FBA). After the development, percent native vegetation cover is estimated at 11.13 per cent (rounded to 11 per cent - score 2.5 as outlined in Table 16 of Appendix 5 of the FBA). The score for percent native vegetation cover is 0 as no change in category is predicted. The score in the BAR prepared for the EIS was calculated at 1.25.

Table 3.1 : Percent native vegetation cover in the landscape before and after development

Assessment buffer	Before development		After development		Score for % native vegetation cover in the development footprint buffer
	Native vegetation cover (ha)	Cover (%)	Native vegetation cover (ha)	Cover (%)	
2,659.65 ha (550m from the edge of the construction footprint)	326.51	12.26 (score 2.5)	284.83	11.13 (score 2.5)	0

3.1.2 Area to perimeter ratio

For a major project that is a linear shaped development or multiple fragmentation development, the change in area to perimeter ratio of patches impacted must be assessed. This has been recalculated based on the revised construction footprint.

The total area (square metres) and perimeter (metres) of vegetation patches impacted by the development within the 550 metre buffer is outlined in Table 3.2. The area to perimeter ratio before the development is 24 (previously 22) and after development is 21. The proportional change in area to perimeter ratio as calculated by the credit calculator is 12.5 (previously 4.5) and the score for the proportional change in area to perimeter ratio is 2 according to Table 19 in Appendix 5 of the FBA (see Table 3.2).

This is a change from the EIS design assessed in the BAR in which a score of 1 was calculated, however this is still a relatively small change in area to perimeter ratio and is expected as the vegetation currently has a high area to perimeter ratio (due to many small fragments of vegetation in the landscape) which will not be increased significantly by the project.

Table 3.2 : Area to perimeter ratio of vegetation patches before and after development

Before development			After development			Proportional change	Score
Vegetation area (m^2)	Vegetation perimeter (m)	Area to perimeter ratio (whole number)	Vegetation area (m^2)	Vegetation perimeter (m)	Area to perimeter ratio (whole number)		
462,329.27	19,653.96	24	342,393.32	16,340.50	21	12.5	2

3.1.3 Landscape value score

A summary of the recalculated landscape value assessment is provided here. As noted above, the connectivity value and patch size calculations remain valid with the design change therefore no recalculation was required for these.

The landscape component scores are as follows:

- Percent native vegetation cover = 0 (previously 1.25)
- Connectivity value class = 2.5 (no change from original assessment)
- Area / perimeter ratio score = 2 (previously 1)
- Average patch size score = 12.5 (no change from original assessment).

The landscape value score as determined by the BioBanking credit calculator is 17, similar to that previously assessed in the BAR in which the landscape value score was calculated as 17.25.

3.2 Removal of native vegetation

The revised potential loss of vegetation and habitat associated with the project is summarised in Table 3.3. The construction footprint would impact on up to about 40.79 hectares of native vegetation (see Table 3.3). This is a decrease of 3.50 hectares when compared to the EIS design assessed in the BAR (the original impact to all Vegetation Zones was 44.29 hectares).

These impacts have been quantified based on the development footprint after detailed design and take into consideration potential temporary disturbance during construction including compound sites and upgrading of drainage. This calculation also takes into account the clearing required within the Department of Defence land to provide vehicle access along the Defence Establishment Orchard Hills (DEOH) site inside of the new fence line proposed in some parts of the project, which was not assessed in the BAR.

Based on the detailed design, the overall impact to the critically endangered Cumberland Plain Woodland in the Sydney Basin Bioregion ecological community has reduced by 2.96 hectares. The impact to the River-Flat Eucalypt Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions endangered ecological community has been reduced by 0.43 hectares.

Table 3.3 : Impacts to native vegetation from the detailed design footprint

Vegetation zone	PCT	Condition	Status (TSC Act)	Original impact (ha)	Area to be impacted by detailed design (ha)	Change
1	Grey Box - Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin Bioregion	Moderate/ Good	CEEC Cumberland Plain Woodland in the Sydney Basin Bioregion	6.67	5.38	1.29 ha reduction
2	Forest Red Gum - Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney Basin Bioregion	Moderate/ Good	EEC River-Flat Eucalypt Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions	2.53	2.43	0.1 ha reduction
3	Grey Box - Forest Red Gum grassy woodland on shale of the southern Cumberland Plain, Sydney Basin Bioregion	Moderate/ Good	CEEC Cumberland Plain Woodland in the Sydney Basin Bioregion	4.92	4.92	No change

Vegetation zone	PCT	Condition	Status (TSC Act)	Original impact (ha)	Area to be impacted by detailed design (ha)	Change
4*	Grey Box - Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin Bioregion	Moderate/Good _Poor	CEEC Cumberland Plain Woodland in the Sydney Basin Bioregion	4.68	4.30	0.38 ha reduction
5	Grey Box - Forest Red Gum grassy woodland on shale of the southern Cumberland Plain, Sydney Basin Bioregion	Moderate/Good _Poor	CEEC Cumberland Plain Woodland in the Sydney Basin Bioregion	3.21	3.11	0.1 ha reduction
6	Forest Red Gum - Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney Basin Bioregion	Moderate/Good _Poor	EEC River-Flat Eucalypt Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions	1.76	1.43	0.33 ha reduction
7	Grey Box - Forest Red Gum grassy woodland on shale of the southern Cumberland Plain, Sydney Basin Bioregion	Moderate/Good _High	CEEC Cumberland Plain Woodland in the Sydney Basin Bioregion	1.25	1.37	0.12 ha increase
8	Grey Box - Forest Red Gum grassy woodland on shale of the southern Cumberland Plain, Sydney Basin Bioregion	Moderate/Good _Derived grassland	CEEC Cumberland Plain Woodland in the Sydney Basin Bioregion	12.01	10.81	1.2 ha reduction
9	*Phragmites australis* and *Typha orientalis* coastal freshwater wetlands of the Sydney Basin Bioregion	Moderate/Good _Other	-	6.17	6.05	0.12 ha reduction
10	Grey Box - Forest Red Gum grassy woodland on shale of the southern Cumberland Plain, Sydney Basin Bioregion	Moderate/Good _Medium	CEEC Cumberland Plain Woodland in the Sydney Basin Bioregion	1.09	0.98	0.11 ha reduction
			Totals	**44.29**	**40.79**	**3.50 ha reduction**

Notes: * = The impacts to Vegetation Zone 4 have been included in Table 3.3 above to provide an overview of all impacts to native vegetation. Due to the manual override of the 'Number of Trees with Hollows' and 'Fallen Logs' for HN 528, Vegetation Zone 4 now has a site score of 29.17 and requires an offset to be calculated.

3.3 Removal of threatened fauna species habitat and habitat features

Of the known habitat for the Cumberland Plain Land Snail within the study area (i.e. vegetation in moderate to good condition including where live snails or shells were found during the field survey as part of the original assessment), the development footprint is predicted to impact on about 12.40 hectares. This is a decrease of 0.60 hectares from the original assessment in the BAR which identified 13 hectares of potential habitat.

The development footprint is predicted to impact on 24.10 hectares of potential habitat for the Regent Honeyeater. This is a decrease of 2.15 hectares form the original assessment in the BAR which identified 26.25 hectares of potential habitat.

The potential impacts to identified species credit fauna species is summarised in Table 3.4. Overall, based on detailed design, the project would have less impact on threatened fauna species habitat and habitat features than that the EIS design assessed in the BAR.

Table 3.4 : Summary of threatened fauna species impacts from the detailed design footprint

Threatened species	Ecosystem or species credit species	Status		Original habitat impact (ha)	Habitat to be impacted by detailed design (ha)	Change
		TSC Act	EPBC Act			
Cumberland Plain Land Snail	Species credit species	Endangered	Not listed	13	12.40	0.60 ha avoided
Regent Honeyeater	Species credit species	Critically endangered	Critically endangered	26.25	24.10	2.15 ha avoided

3.4 Removal of threatened plants

There would be an impact to the following threatened plant species and endangered population:

- *Pultenaea parviflora* (Endangered – TSC Act)
- *Marsdenia viridiflora* subsp. *viridiflora* population in the Bankstown, Blacktown, Camden, Campbelltown, Fairfield, Holroyd, Liverpool and Penrith local government areas (Endangered population – TSC Act).

The predicted impact to *Pultenaea parviflora* and the *Marsdenia viridiflora* subsp. *viridiflora* endangered population are outlined below in Table 3.5.

An additional targeted survey to those undertaken for the BAR were conducted for *Pultenaea parviflora* and *Marsdenia viridiflora* subsp. *viridiflora* (and other threatened plants) around the Vineyard Road extension on the 7th August 2017. This was to account for the footprint changes at this location. Additionally, as stated in the BAR, this area was not able to be accessed during the fieldwork undertaken for the original assessment therefore additional survey was required at this location following detailed design.

In total an additional area of habitat of approximately 4.7 hectares was surveyed by an experienced botanist following the methods described in the *NSW Guide to Surveying Threatened Plants* (Office of Environment and Heritage, 2016). Traverses of this habitat were undertaken over a three-hour period for a distance of 3.131 kilometres (3,131 metres) (see Figure 3.1). The survey located a further six *Pultenaea parviflora* plants (two of which were in the design footprint, and four outside of the footprint). No additional *Marsdenia viridiflora* subsp. *viridiflora* were recorded.

The original construction footprint based on the EIS design contained (and therefore would have removed) all known individuals and habitat for the *Marsdenia viridiflora* subsp. *viridiflora* endangered population in the study area. The detailed design has resulted in the avoidance of four *Marsdenia viridiflora* subsp. *viridiflora* plants in the area of the DEOH fence between Kings Hill Road and Longview Road (see Figure 3.2). There is no requirement to impact on the location of these plants and exclusion zones would be established around the plants during construction in accordance with standard Roads and Maritime procedure. This reduces the overall impact to 31 individuals (see Table 3.5).

The original construction footprint would have removed the four known *Pultenaea parviflora* plants within the EIS design footprint as well as the two additional plants recorded in the Vineyard Road extension during the August 2017 survey (six *Pultenaea parviflora* plants in total). The August 2017 survey of the Vineyard Road extension recorded six additional *Pultenaea parviflora* plants of which four are outside of the construction footprint so have been avoided. The impact assessed in the EIS was to four *Pultenaea parviflora* plants because the extent of habitat along Vineyard Road extension was unable to be surveyed at the time. The overall impact to *Pultenaea parviflora* is now estimated at six plants (see Table 3.5).

Table 3.5 : Summary of threatened plant species impacts from the detailed design footprint

Threatened species	Ecosystem or species credit species	Status		Original habitat impact	Individuals to be impacted by detailed design	Change
		TSC Act	EPBC Act			
Pultenaea parviflora	Species credit species	Endangered	Vulnerable	4 individuals	6 individuals	2 additional plants to be impacted 4 plants avoided
Marsdenia viridiflora subsp. *viridiflora* – endangered population	Species credit species	Endangered population	Not listed	35 individuals	31 individuals	4 individuals avoided

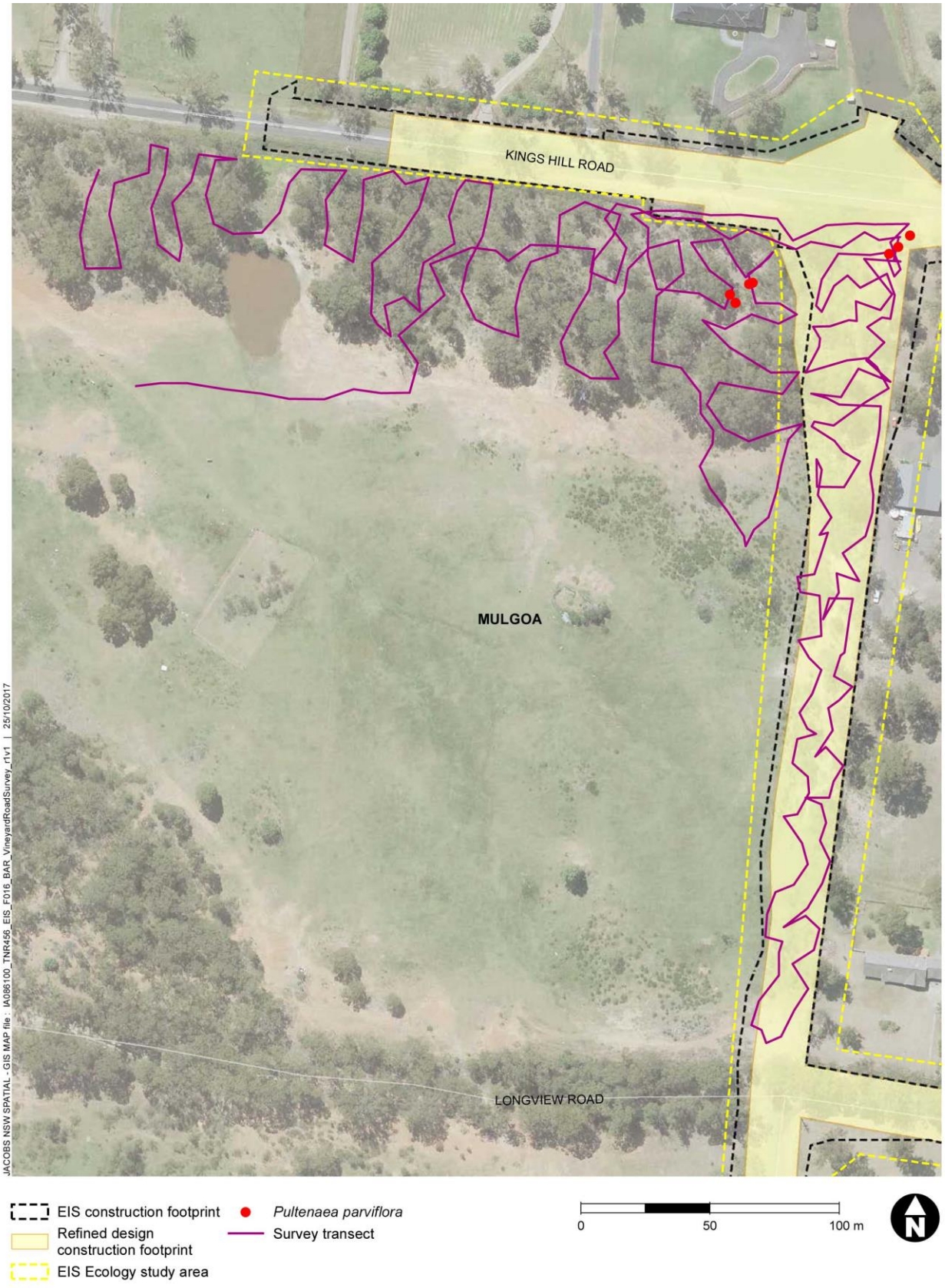

Figure 3-1 | Additional targeted survey for Pultenaea parviflora and Marsdenia viridiflora subsp. viridiflora undertaken in the Vineyard Road extension

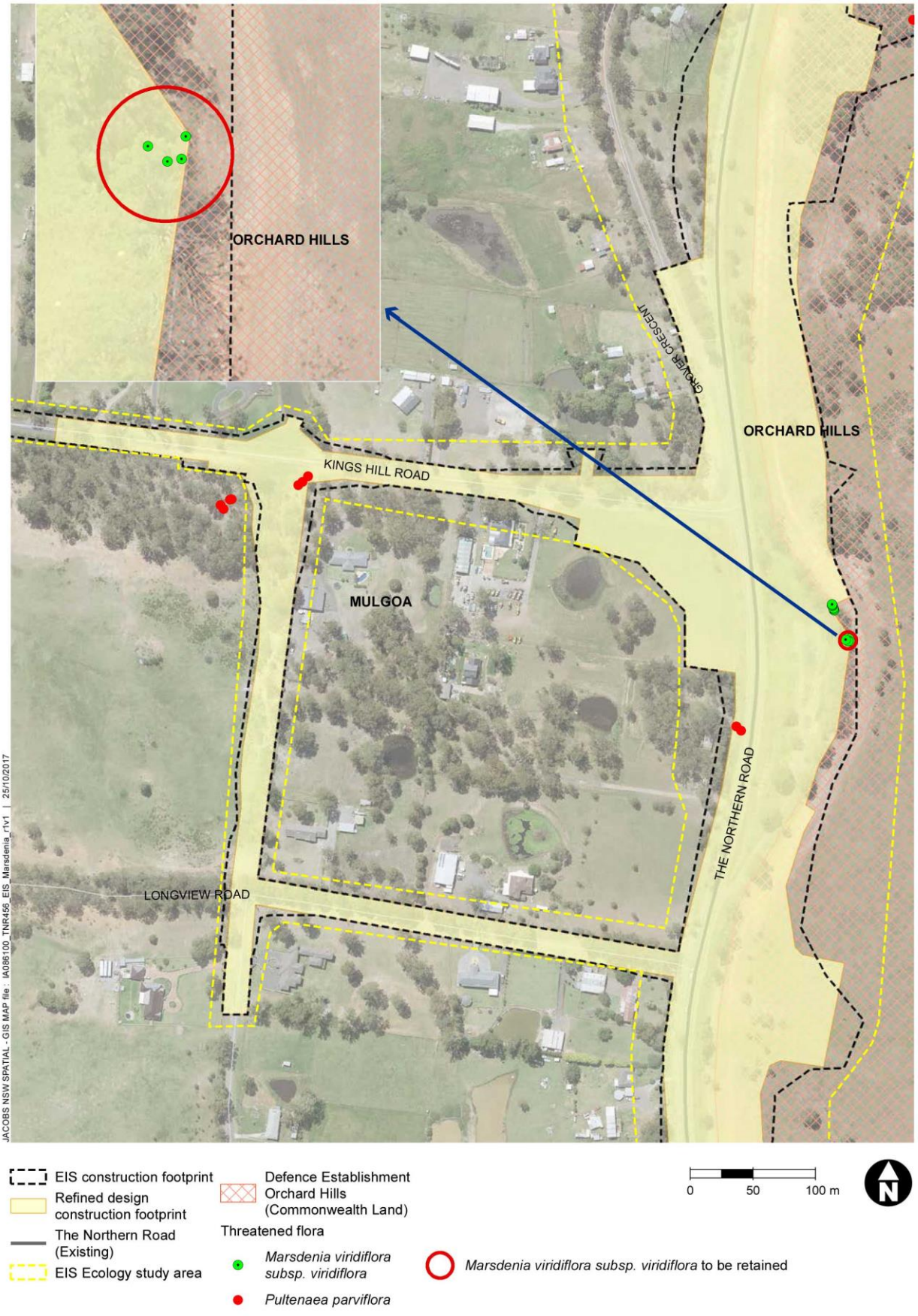

Figure 3-2 | Marsdenia viridiflora subsp. Viridiflora to be retained

3.5 Impacts to Matters of National Environmental Significance

3.5.1 Listed ecological communities

The original calculations in the BAR of the extent of direct clearing required to the critically endangered Cumberland Plain Shale Woodlands and Shale-Gravel Transition Forest ecological community represented a worst case scenario based on the EIS construction footprint. This impact has been reduced at the detailed design phase.

Based on the EIS construction footprint, the project would result in the direct clearing of about 16.37 hectares of the critically endangered Cumberland Plain Shale Woodlands and Shale-Gravel Transition Forest ecological community. After detailed design, this impact has been reduced by 1.29 hectares to 15.08 hectares (refer to Table 3.6).

Table 3.6 : Summary of impacts to the critically endangered Cumberland Plain Shale Woodlands and Shale-Gravel Transition Forest ecological community

Cumberland Plain Shale Woodlands and Shale-Gravel Transition Forest condition category	Original impact (ha)	Detailed design impact (ha)	Change
Category A (core)	10.69	9.99	0.70 ha reduction
Category C	1.47	1.50	0.03 ha increase
Category C Derived Native Grassland	4.21	3.59	0.62 ha reduction
Total	**16.37**	**15.08**	**1.29 ha reduction**

3.5.2 Listed threatened flora species

The EIS construction footprint would have removed all known *Pultenaea parviflora* plants. The overall impact to *Pultenaea parviflora* is now removal of six plants since the additional plants were found along the Vineyard Road extension. The August 2017 survey of the Vineyard Road extension recorded six additional *Pultenaea parviflora* plants of which four are outside of the construction footprint so would be avoided.

3.5.3 Listed threatened terrestrial fauna species

The original construction footprint was identified as having impacts to habitat for the following threatened species that are listed as threatened under the EPBC Act:

- Grey-headed Flying-fox
- Regent Honeyeater
- Swift Parrot
- Large-eared Pied Bat.

Based on the EIS construction footprint, habitat for these four species was expected to be reduced in extent by about 26.25 hectares due to clearing requirements. Based on detailed design, the extent of this impact would be reduced by 2.15 hectares with a total of 24.10 hectares of foraging habitat expected to be impacted by the project. No breeding habitat would be affected.

3.6 The environment on Commonwealth land (including the Orchard Hills Cumberland Plain Woodland)

An update of the potential impacts to the environment of Commonwealth land as a result of construction and operation of the project is provided in this section as it relates to biodiversity. This includes the DEOH land, and land that has been acquired by the Commonwealth for the purposes of developing the Western Sydney Airport at Badgerys Creek. There would be a decrease in clearing of remnant native vegetation by approximately 0.88 ha (see Table 3.7). This includes a decrease in clearing of the Critically endangered Cumberland Plain Shale Woodlands and Shale-Gravel Transition Forest ecological community by 0.8 hectares (see Table 3.7).

Table 3.7 : Revised impacts to vegetation on Commonwealth land

Feature	Original impact	Revised impact after detailed design	Difference
Remnant native vegetation (excluding man-made dams)	13.34 ha	12.46 ha	0.88 ha decrease
Critically endangered Cumberland Plain Shale Woodlands and Shale-Gravel Transition Forest ecological community	10.07 ha	9.27 ha	0.80 ha decrease

3.7 Offsetting required

The results of the revised assessment undertaken within the BioBanking credit calculator are presented here. The required ecosystem credits are outlined in Table 3.8.

Table 3.9 outlines the required species credits. The revised credit calculations take into account the amendments to the landscape assessment, altered areas of impact, avoidance of some threatened species impacts, amendment of some benchmark data in the BioBanking credit calculator, and reassignment of the Derived Native Grassland to HN 529. Due to the manual override of the ‘Number of Trees with Hollows' and 'Fallen Logs' benchmark values for HN 528 (see section 4.12) this has affected the number of credits generated by the credit calculator (a key change is that Vegetation Zone 4 now has a site score of 29.17 and requires an offset to be calculated). Reassignment of Derived Native Grassland to HN 529 as advised by the OEH (see Section 4.11) has resulted in an altered offset requirement for HN 529 as the Derived Native Grassland PCT is no longer used in the assessment.

Table 3.8 : Ecosystem credits summary

PC type code	Plant community type (PCT)	Original area (ha)	Original credits created	Area (ha)	Credits created
HN526	Forest Red Gum - Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney Basin Bioregion	4.29	178.00	3.86	160.54
HN528	Grey Box - Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin Bioregion	11.35	307.00	9.68	346.77
HN529	Grey Box - Forest Red Gum grassy woodland on shale of the southern Cumberland Plain, Sydney Basin Bioregion	10.47	409.66	21.19*	684.68*
HN630	Phragmites australis and Typha orientalis coastal freshwater wetlands of the Sydney Basin Bioregion	6.17	142.00	6.05	139.00
HN627	Derived grasslands on shale hills of the Cumberland Plain (50-300m asl)	12.01	223.39	-	-
	Total	**44.29**	**1,260**	**40.79**	**1,331**

Notes: * = Grey Box - Forest Red Gum grassy woodland on shale of the southern Cumberland Plain, Sydney Basin Bioregion now includes the impact and credit requirement for Derived grasslands on shale hills of the Cumberland Plain (50-300m asl).

Table 3.9 : Species credits summary

Scientific name	Common name	TS offset multiplier	Original credit requirement	Species credits required
Meridolum corneovirens	Cumberland Plain Land Snail	1.3	169	161
Marsdenia viridiflora subsp. *viridiflora* - endangered population	*Marsdenia viridiflora* subsp. *viridiflora* in the Bankstown, Blacktown, Camden, Campbelltown, Fairfield, Holroyd, Liverpool and Penrith local government areas	4.0	1,400	1,240
Pultenaea parviflora	Pultenaea parviflora	1.5	60	90
Anthochaera phrygia	Regent Honeyeater	7.7	2,021	1,856

4 Response to issues raised by stakeholders and the community

A number of issues raised by stakeholders and the community during the EIS exhibition related to biodiversity and are addressed in this section of the Memorandum. Where similar issues have been raised in different submissions, only one response has been provided.

The issues raised and the response to these issues forms the basis of this section of the memorandum and would be used to inform the Submissions and Preferred Infrastructure Report for the project.

4.1 General objection to the project

Submission number(s)

7, 12, 25

Issue description

A number of respondents were generally opposed to the project.

The NSW Biodiversity Offsets Policy for Major Projects (BOPMP) provides a standard method for assessing impacts of major projects on biodiversity and determines offsetting requirements. In the State Significant Infrastructure (SSI) application process, the Environmental Impact Statement (EIS) must address the Secretary's Environmental Assessment Requirements (SEARs) requested by Department of Planning and Environment (DPE) and apply the Framework for Biodiversity Assessment (FBA). The FBA adopts the BOPMP and provides an assessment methodology to identify terrestrial biodiversity values, assess impacts and quantify and describe biodiversity offsets required for unavoidable impacts.

This Biodiversity Assessment Report (BAR) was completed in accordance with the requirements specified by the SEARs issued on 28 July 2015, the amended SEARs issued on 9 March 2016 and Commonwealth EIS Guidelines issued on 24 August 2016. Additional assessment in the form of this Memorandum has also been undertaken in accordance with these requirements to assess some of the changes to biodiversity values and impacts as a result of design refinements as outlined in Section 3.

Despite avoidance and mitigation, residual impacts from the clearing of native vegetation and fauna habitat features is acknowledged in the EIS. These impacts have been quantified using the BioBanking Credit Calculator, and will form the basis of offsets for the project. There would be impacts to the following matters which need to be offset via biodiversity credits:

- Forest Red Gum - Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney Basin Bioregion
- Grey Box - Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin Bioregion
- Grey Box - Forest Red Gum grassy woodland on shale of the southern Cumberland Plain, Sydney Basin Bioregion (including derived native grasslands)
- Phragmites australis and Typha orientalis coastal freshwater wetlands of the Sydney Basin Bioregion
- *Pultenaea parviflora*
- *Marsdenia viridiflora* subsp. *viridiflora* - endangered population
- Cumberland Plain Land Snail
- Regent Honeyeater.

Cumberland Plain Woodland is listed as a critically endangered ecological community (CEEC) under the *NSW Threatened Species Conservation Act, 1995* (TSC Act). The project may significantly reduce the viability of this CEEC within the locality and therefore it is considered a matter for further consideration under the FBA. While not recorded during the surveys, there is also likely to be impacts to potential habitat for the critically endangered Regent Honeyeater. As such, this species is also considered a matter for further consideration.

The project is likely to result in a range of impacts to biodiversity which are not covered under the FBA including impacts to the aquatic environment, changes to hydrology, habitat fragmentation, edge effects, injury and mortality of fauna (including indirect impacts associated with vehicle strike), invasion and establishment of weeds, potential for invasion and spread of pathogens and disease, noise, vibration, dust, light and contaminant pollution, and a range of cumulative impacts to vegetation and associated species within the Cumberland Plain region.

Some of the higher quality patches of Cumberland Plain Woodland meet the description of the Cumberland Plain Shale Woodlands and Shale-Gravel Transition Forest CEEC listed under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). The plant species *Pultenaea parviflora* is also listed as vulnerable under the EPBC Act. Other Matters of National Environmental Significance that may be impacted by the project include habitat for the listed Regent Honeyeater, Swift Parrot, Grey-headed Flying-fox and Large-eared Pied Bat. As such, the project has been identified as a controlled action under the EPBC Act due to predicted significant impacts to listed threatened species and ecological communities and Commonwealth land. The controlled action is considered by the Department of the Environment and Energy (DoEE), likely to have a significant impact on the following EPBC Act listed threatened species and ecological communities:

- Critically endangered – Cumberland Plain Shale Woodlands and Shale-Gravel Transition Forest (Cumberland Plain Woodlands)
- Critically endangered – *Lathamus discolor* (Swift Parrot)
- Critically endangered – *Anthochaera phrygia* (Regent Honeyeater)
- Vulnerable – *Pultenaea parviflora*
- Vulnerable – *Pteropus poliocephalus* (Grey-headed Flying-fox).

A Biodiversity Offset Strategy (BOS) has been prepared for the project. The project offsets will aim to provide ‘like for like’ offsets for all biodiversity values, with this being the minimum requirement for those matters listed under the EPBC Act. The final offset requirement for the Project would be determined during development of the offset package.

4.2 Offsetting

Submission number(s)

27

Issue description

The respondents raised the following issues:

- Concern regarding the offsetting of Conservation Lands located on the DEOH site
- Requests that Roads and Maritime provide the respondent transparency of the offset process
- Concern regarding the ineffectiveness of BioBanking to offset the losses of critically endangered vegetation communities in Western Sydney
- There are insufficient offsets available to supply the offset needs for current development
- Requests that Roads and Maritime procure land to be managed for conservation

The BOS outlines the offsets required for unavoidable (residual) biodiversity impacts associated with the project and demonstrates that appropriate offsets are available and can be delivered for the project. Roads and Maritime are currently working in consultation with OEH to determine the quantum of offsets or supplementary measures that are required for the project. The preferred approach to securing offsets for the project is to purchase credits from the market. Where credits are unavailable for purchase on the market, Roads and Maritime would work with public and private landholders to enter a BioBanking Agreement on their land and then buy the credits issued.

Supplementary measures at a landscape scale are also being investigated in conjunction with the OEH. The final offset requirement for the Project would be determined during development of the offset package in consultation with the OEH. Following discussions with Roads and Maritime, DoEE and OEH, it was decided that an additional supplementary measures package would be developed in consultation with OEH and DoEE with a focus on landscape scale measures within the local area. The package may include measures such as weed eradication programs within Cumberland Plain Woodland.

Refer also to Section 4.22 regarding additional offsets for impact to Cumberland Plain Woodland and Section 4.23 regarding measures to secure offsets.

4.3 Dewatering and backfilling of dams and relocation of aquatic species

Submission number(s)

1, 3, 4, 5, 16, 19, 38

Issue description

The respondents raised the following issues:

- Concern regarding impacts to fauna, such as turtles, in dams near the project
- Request that the project include measures to protect and manage fauna, including capture and relocation of fauna by an appropriately qualified person prior to farm dam dewatering
- Non-native fish species should not be relocated.

The construction and operation of the project has the potential to impact aquatic ecosystems due to changes in water quality, hydrology, habitat loss and instream barriers. Many of the watercourses in the study area are artificial dams, situated in minor gullies which are either first or second order streams, and as such are not considered key fish habitat. Threatened species are unlikely to be present within these dams, however there is a possibility that native and invasive fish species have colonised these dams as well as freshwater turtles and eels. Should dams or creeks be dewatered during the construction of the project, then aquatic fauna will need to be relocated in to a similar aquatic environment to which it was found by trained aquatic ecologists under a Fisheries Permit issued by DPI.

The dewatering of farm dams would be undertaken in accordance with the relevant procedures to be outlined in the construction environmental management plan (CEMP) and relevant sub plans (e.g. the flora and fauna management plan, the soil and water management plan). This would include the management and re-location of Eastern long neck turtles and other aquatic species. All fish and aquatic fauna works will require a Fisheries Permit issued by the NSW Department of Primary Industries (DPI) under Section 37 of the FM Act. Any native fish or aquatic fauna (including turtles) present would be relocated into a similar aquatic environment to which it was found by trained aquatic ecologists.

The selection of relocation sites would be conducted in consultation with DPI Fisheries upon permit application, and will consider permanence of water, any upstream disturbances, habitat, water quality conditions. Fish and other aquatic fauna should be relocated into a waterway with similar water quality and habitat characteristics to minimise stress. Where possible the relocation site would be within the same sub-catchment to avoid the inadvertent dispersal of fauna into unsuitable habitat.

During relocation, fish would be relocated into aerated transportation tubs. Tubs would be located in the shade during capture and transportation to avoid sudden changes in temperature. Frogs, turtles, fish and eels would be treated in a similar manner, however different fauna should not be transported within the same tub to prevent injury or consumption of smaller fauna. Turtles and frogs should be damp, but not submerged in water. Fish and other aquatic fauna would be transported to the recipient site as quickly as practical. Any invasive species would be euthanised in accordance with animal care and ethics permits requirements. Accurate records of species released or euthanised (in the case of exotic species) would be recorded and provided to NSW DPI upon completion.

The EIS includes an existing mitigation measure for the development of a farm dam dewatering plan (SWC-1), this measure would be revised as follows and incorporated into the revised environmental management measures for the project (refer to Section 5):

A farm dam dewatering plan would be prepared which includes:

- A map showing locations of farm dams to be dewatered and the selected relocation sites
- Fisheries Permit and Animal Care and Ethics requirements
- Methodology for the capture, storage, relocation, release of fish and other aquatic fauna
- Euthanisation procedure (as required)
- Location of any offsite discharge points and measures to manage encounters of poor water quality.

4.4 Wildlife corridors and habitat connectivity

4.4.1 Impacts to wildlife corridors and habitat connectivity

Submission number(s)

7, 11, 17, 18, 25, 27, 29

Issue description

The respondents also raised the following issues:

- Concern regarding the impact of the project on wildlife corridors and habitat connectivity
- The EIS does not accurately assess existing wildlife permeability along The Northern Road
- Construction of the bike track to Mulgoa Nature Reserve would impact wildlife connectivity
- No bike trails should be installed through or across the Surveyors Creek Corridor
- The importance of the Glenmore Park Biodiversity Corridor is not fully assessed in the EIS
- Concern regarding impacts of the project on the Flame Robin, Rose Robin and Eastern Grey Kangaroos
- Specific assessment should be made of potential barriers to the annual migration of the Flame Robin and Scarlet Robin over The Northern Road, especially to known habitat in DEOH

Due to the linear nature of the project, it will result in fragmentation of habitats. Habitat fragmentation is considered an important impact of the project and fragmentation impacts and the impact of barriers are discussed in the EIS. The EIS acknowledges fully that there would be localised fragmentation of local wildlife corridors between the existing Northern Road and Willowdene Avenue where some intact habitat patches would be broken apart. The hard barrier introduced by the project would restrict fauna movement. The widening of the existing Northern Road in the north of the study area would further exacerbate the existing barrier effects of this roadway where it bisects Regional Corridor 17 as identified in the OEH BIOMAP.

The EIS acknowledges the existing habitat connectivity within the landscape. Connectivity value has been assessed in accordance with Appendix 5 of the FBA. The connecting links have been identified and a connectivity value score was assigned. The EIS indicates that the project will impact on local area biodiversity links (as defined under the FBA). Several local area biodiversity links have been identified (see Figure 2.3 of the Biodiversity Assessment Report). The EIS acknowledges that the existing Northern Road is a single carriage (two lanes) road and is therefore not considered a barrier of a size that would sever a connecting link. As such, the connecting links identified in the EIS cross the existing Northern Road. The existing Northern Road does however contribute to a considerable reduction in local connectivity when compared to areas without existing roadways (the links are not severed but are highly modified). The Northern Road is a heavily used roadway and significant barrier effects are currently present. The fence along the edge of the Defence Establishment Orchard Hills does increase the barrier effect provided by the existing Northern Road in this area. In this location, dispersal of fauna is currently limited but is not entirely prevented.

The EIS acknowledges that habitat connectivity would be altered during and after construction. There may be declines in population density and/or species richness within the remaining vegetation patches as a result of the project. There may also be an alteration to community composition, altered species interactions, and altered or ecosystem functioning in the locality due to the action. Due to the importance of connectivity, dispersal opportunities and habitat quality, for species at a local scale the project is considered likely to be detrimental to the dispersal of relatively sedentary species such as mammals, frogs, and reptiles. Local division of some wildlife populations, isolation of key habitat resources, loss of genetic interchange, and loss of population viability may result from the fragmentation caused by the project.

The impacts of altered connectivity on fauna species, including Eastern Grey Kangaroos and east-west obligatory migrant species such as the Flame Robin and Scarlet Robin, have been assessed according to the assessment process outlined in the FBA. The Flame Robin and Scarlet Robin are Ecosystem Credit species and direct impacts to these species, along with common species including the Eastern Grey Kangaroo, have been assessed in conjunction with general biodiversity values as they have been assessed as being at least moderately likely to be present in the habitats that would be impacted. Suitable habitat for these species is present and this is identified in the Biodiversity Assessment Report. As with other fauna species, east-west obligatory migrant species such as the Flame Robin and Scarlet Robin would be detrimentally impacted by habitat fragmentation, as would macropods such as the Eastern Grey Kangaroo.

It is noted that the scope of the project does not include any separated bike trails that would impact on the corridor, the proposed shared path is immediately adjacent to the road corridor along the length of the upgrade. There are no plans for bike baths beyond this shared path.

4.4.2 Connectivity measures

Submission number(s)

11, 12, 17, 18, 21, 25, 27, 29, 38

Issue description

A number of respondents suggested additional fauna crossings, underpasses and other connectivity measures be included in the design.

Other issued raised include:

- Further consideration of the u-turn facility in Kings Hill Road and whether this has potential to reduce the fragmentation of a potential west-east biodiversity corridor
- The height of the proposed fauna underpass (1.5 metres) is not suitable for Eastern Grey Kangaroos
- Services should be routed to avoid interfering with Surveyors Creek Corridor and its future restoration on both eastern and western (DEOH) sides
- Insufficient consultation regarding a suitable solution for the safe movement of fauna in the vicinity of the Defence Establishment Orchard Hills.

The proposed design at Kings Hill Road includes a roundabout which would provide a u-turn facility for motorists. The proposed design in this area also includes a link road between Kings Hill Road and Longview Road. The intersection of Longview Road and The Northern Road would be left-in and left-out only and therefore the link road is required to ensure motorists travelling south on the Northern Road can access Longview Road. The connectivity value of the vegetation and the impact of the proposed design on fragmentation of this area has been assessed in BAR.

Connectivity measures are being considered during detailed design in accordance with the Wildlife Connectivity Guidelines for Road Projects (currently in preparation). In particular, maintenance of current connectivity and potential future connectivity has been considered in culvert design, lighting and fencing.

Connectivity between the Mulgoa Nature Reserve and the DEOH via Regional Corridor 17 (Surveyors Creek Corridor) would be planned for in the future with construction of a fauna crossing to allow for future connectivity to the DEOH land. The proposed fauna crossing is a 2.4-metre-tall dry passage underpass (see Figure 4.1). This would be suitable for larger species such as the Eastern Grey Kangaroo based on monitoring results from Pacific Highway projects. The culvert would lead from the Surveyors Creek corridor under the road and will exit at the new DEOH fencing within the road reserve. For DEOH security reasons and traffic safety, the underpass would be blocked onto DEOH land until the DEOH fencing is removed in the future. This is to prevent the public from gaining unauthorised access to the DEOH land through the underpass and to prevent animals from exiting the culvert onto the roadway. Fauna exclusion fencing would be provided either side of the crossing in accordance with Roads and Maritime standards.

Fauna passage would also be provided at Badgery's Creek with the construction of a fauna friendly drainage culvert of similar internal dimensions to the Surveyors Creek / DEOH culvert (see Figure 4.2).

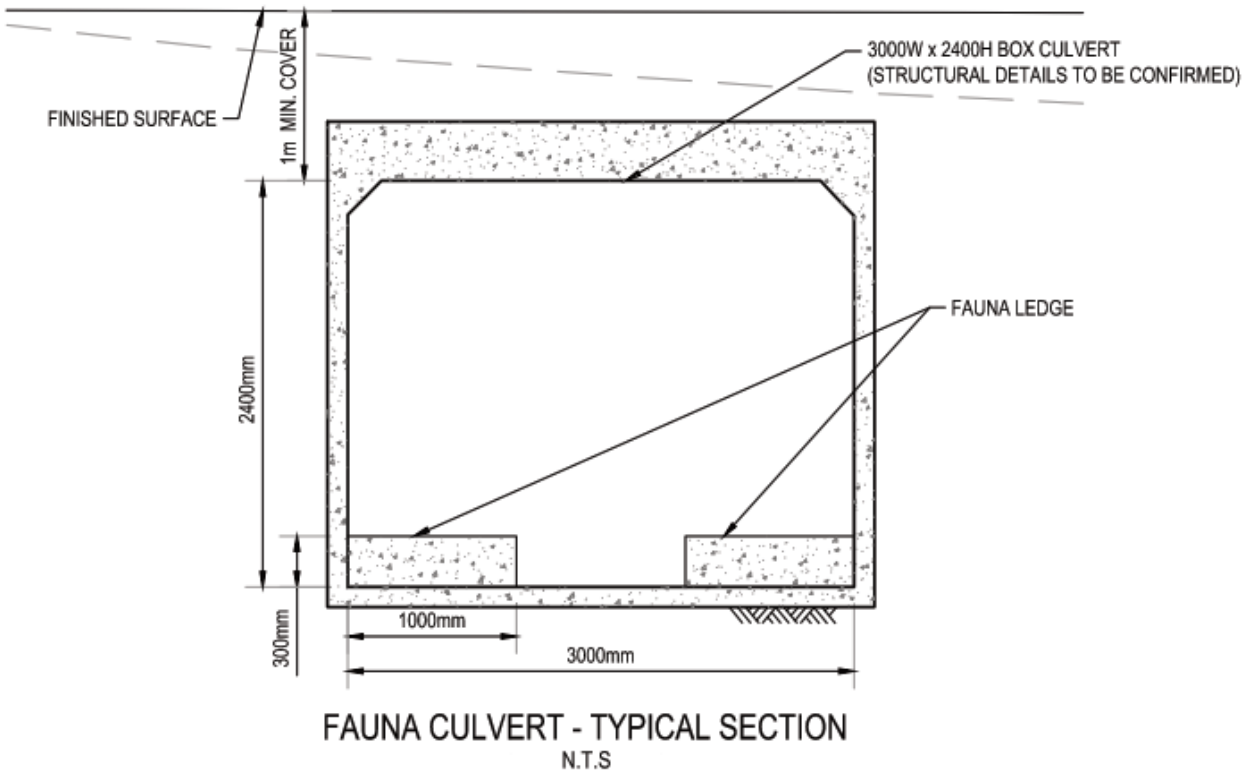

Figure 4.1 : Cross section of the proposed culvert at Surveyors Creek

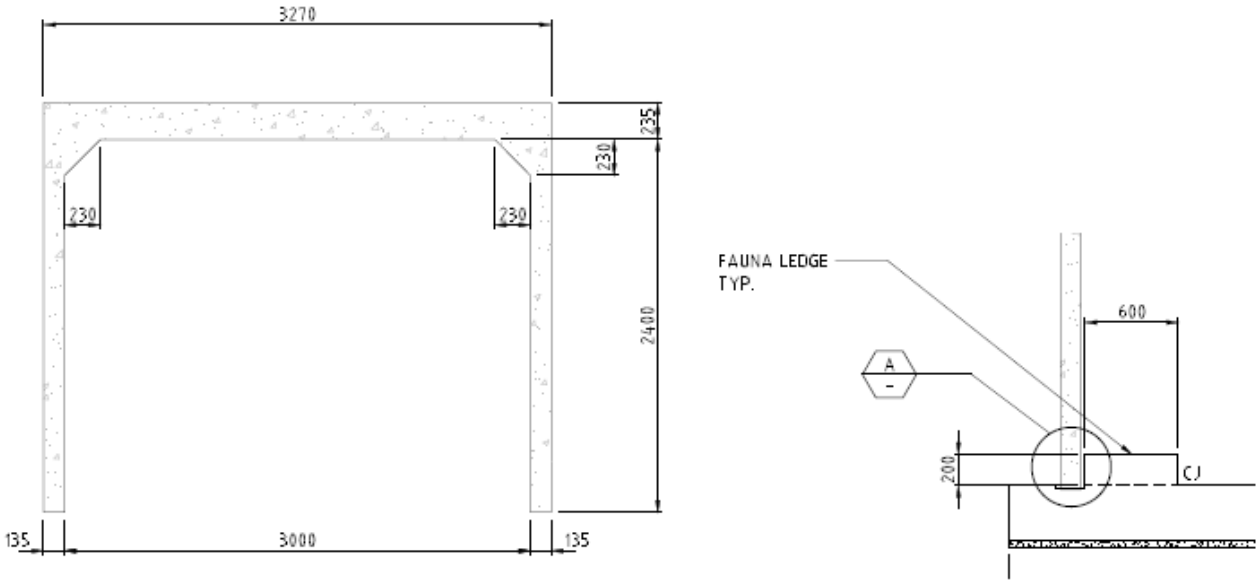

Figure 4.2 : Cross section of the proposed culvert at Badgery's Creek

4.4.3 Fencing of DEOH land

Submission number(s)

11

Issue description

Physical barriers more than two metres high should not be located along the DEOH boundary.

There is a particular fencing specification required for the DEOH boundary. A Class 2 chain link perimeter fence is required to be installed to delineate the base boundary, as it is adjacent to a public road. This fence would be a galvanised, rail-less chain wire security fence and gates 2.4 metres high, topped with at least three strands of barbed (or similar) wire to a total height of 3 metres (see Figure 4.3). The mesh size of the fence would be approximately 50mm x 50mm. The fence would be kept clear of trees and other vegetation to a distance of 5 metres. This fence will continue the current level of fragmentation in the landscape until it is removed in the future.

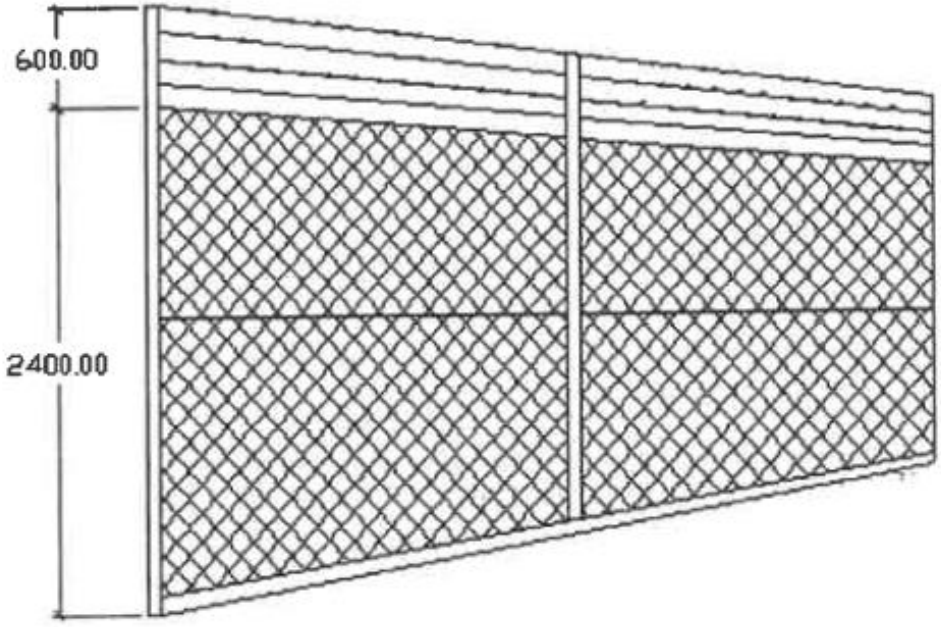

Figure 4.3 : Example of the perimeter fence along the DEOH boundary, with chainmesh and barbed wire

4.5 Large remnant trees

4.5.1 Impacts to large remnant trees

Submission number(s)

11, 12, 16, 17, 18, 21, 25, 29

Issue description

The respondents raised the following issues:

- Concern regarding impacts to large remnant trees, including hollow-bearing trees
- Concern regarding impacts to important trees, particularly *Eucalyptus molucanna*
- Requests that the project retain as many mature trees as possible, in particular two old-growth remnant trees or example near the Orchard Hills roundabout
- Loss of habitat has not been adequately assessed or quantified in the EIS. The EIS must identify the number of tree hollows that will be impacted. Noted that several habitat trees are located within the road shoulder or median strip and can be retained rather than removed.

The EIS recognises the loss of hollow-bearing trees as a long term impact that will affect local fauna populations. The number of hollow-bearing trees was counted at each plot/transect location within the study area and this data forms a component of the assessment of ecosystem composition and function under the FBA. The impact to hollow-bearing trees is offset as part of the ecosystem credit requirement for the project.

Some large remnant hollow-bearing trees, including the trees located near the truck inspection bay at Orchard Hills would be removed by the project. The safe retention of these trees within the median is not a viable option due to road safety, line of sight and other engineering purposes. Additionally, the wide central median has been included in the design to allow for future road capacity upgrades, therefore these trees would likely be subject to removal in the future, regardless of whether or not they could be retained in the current design.

4.5.2 Large tree removal process

Submission number(s)

16

Issue description

Concern regarding impacts to fauna during the tree removal process.

The EIS includes a mitigation measure for a two staged clearing process (B-3), which the contractor would be required to incorporate into the flora and fauna management plan (FFMP) to be developed for the project and implemented during construction. This has been updated to include additional detail and would be included as part of the revised environmental management measures for the project (refer to Section 5 of this Memorandum):

A staged habitat removal process is to be used when hollow-bearing trees are to be removed as follows:

- Make contact with vets and wildlife carers before works start to ensure they are willing to assist treating injured animals if necessary.
- An experienced and licensed wildlife carer and/or ecologist will be present on site during all habitat removal activities to capture and relocate fauna that may be encountered.

- Progressive habitat removal will take place around habitat identified and marked during the pre-clearing process. Remove non-hollow-bearing trees, undergrowth, feed-trees, regrowth and grass. Do not fell trees towards exclusion zones.
- Identified habitat (e.g. hollow-bearing trees) will be left for at least 24 hours after removing non-habitat vegetation to allow fauna to escape. A licensed wildlife carer and/or ecologist will check hollow-bearing trees are not being used by fauna before felling. If necessary, fauna may need to be trapped and relocated to pre-determined habitat identified for fauna release.
- Fell habitat trees as carefully as possible to avoid injury to any fauna still remaining in trees. Use equipment that would allow the habitat trees to be lowered to the ground with minimal impact (e.g. claw extension). Do not fell trees towards exclusion zones.
- An experienced and licensed wildlife carer and/or ecologist will inspect habitat once it is removed e.g. after a tree is felled. Animals that emerge should be captured, inspected for injury then relocated to pre-determined habitat identified for fauna release.
- All hollows have the potential to support fauna and will be placed in adjacent habitat until the following day for further inspection by a licensed wildlife carer and/or ecologist to verify no fauna is present. If possible, the hollows could be permanently relocated in adjacent areas. Inspect woody debris for fauna immediately before chipping to avoid injury or death to fauna that may be present.
- The project manager and/or environment manager should ensure that the outcomes of the clearing process are recorded. Reporting is usually the responsibility of an ecologist or environment officer. Reports are to be submitted to relevant personnel e.g. environment manager or Roads and Maritime regional environmental staff.
- Consider the seasonal impact of clearing on species identified in the environmental assessment or pre-clearing process or that are known to occur in the area.

4.6 Impacts due to landscaping and lighting

4.6.1 Landscaping

Submission number(s)

11, 17, 18

Issue description

The respondents raised the following issues:

- The Orchard Hills stretch of road should be kept rural in character. Landscaping should be avoided along the Defence Establishment Orchard Hills boundary and Cumberland Plain Woodland verges should be retained
- The use of local native flora species for roadside plantings will create habitat, help retain local character, and reduce roadside maintenance
- The width of the existing Surveyors Creek Corridor on both western and eastern sides should be capped with suitable Cumberland Plain Woodland substrate via soil translocation following earthworks
- The Surveyors Creek Corridor and median strip and verges for chains adjoining the Defence Establishment Orchard Hills bushland should not be landscaped. The sites should be restored to BAM/FBA-criteria functional Cumberland Plain Woodland.

An urban design and landscape concept has been developed for the project as documented in the EIS, based on the project objectives and principles, to achieve an integrated design for the project. It incorporates the urban and landscape design concept plans for the project and a landscape planting concept including recommended species. As identified in the EIS, this would be adopted and further developed during detailed design and implemented as part of the Urban Design Landscape Plan

(UDLP) for the project which is currently ongoing. This plan would be developed in consultation with Council.

The EIS includes a mitigation measure for the re-establishment of native vegetation (B-6), which the contractor would be required to incorporate into the flora and fauna management plan (FFMP) to be developed for the project and implemented during construction. This has been updated to include additional detail and would be included as part of the revised environmental management measures for the project (refer to Section 5 of this Memorandum):

Native vegetation would be re-established in disturbed areas and along the roadway using the following procedure:

- Ecologists and landscape architects will work together on the preparation of revegetation plans and specifications that clearly identify the locations of areas to be revegetated.
- Allocate sufficient time for the collection of seed to be used in revegetation.
- Carry out all seed collection in accordance with RTA Seed Collection QA Specification R176 and the Florabank Guidelines and Model Code of Practice.
- Use experienced and licensed seed collectors to carry out seed collection.
- Where possible, procured plants should be grown from local provenance seed.
- Consideration should be given to a range of characteristics such as species, height and drought tolerance when procuring native plants.
- Planting operations should be in accordance with RTA Landscape Planting QA Specification R179.
- Use only plants that have been certified disease free for revegetation works.
- Collect local native topsoils and leaf litter and store for use in revegetation works.
- Soils in areas to be revegetated should match surrounding soil conditions as closely as possible unless adjacent areas are weedy or contaminated.
- Ensure areas to be revegetated have an appropriate level of natural drainage.
- Avoid compaction of soils in areas identified for revegetation. Where compaction has occurred, the soil should be loosened.
- When planting consider seasonal risks of frost, drought, flooding and sun exposure to avoid damaging plants and to encourage growth.
- Ensure plant spacing and diversity follows the landscaping plan for the project, reflects local conditions and is dense enough to ensure plants achieve a timely coverage of the ground.
- Consider appropriate shade and drainage conditions when planting. Provide mulching around plants for dry or potentially weedy sites to help retain moisture and suppress weeds.
- Inspection, monitoring and maintenance of revegetated areas should be conducted in accordance with the landscape management plan. Outline the roles and responsibilities in landscape management and revegetation plans including the schedule for monitoring and maintenance activities.

4.6.2 Lighting

Submission number(s)

11, 17, 18, 27

Issue description

The respondents raised the following issues:

- Concern regarding the impacts of light pollution on fauna
- Reduced street lighting would minimise impacts to native fauna
- Request for lighting to be limited to larger traffic intersections to reduce impacts to fauna, such as threatened bat and owl populations, as well as other nocturnal species
- Lighting should be excluded from the width of the Surveyors Creek Corridor on both eastern and western sides, and along the length of Cumberland Plain Woodland on the DEOH site.

The EIS acknowledges that night works would be required during construction which would involve the use of temporary lighting. Additionally, street lighting would be provided along the full length of the project to light the carriageway and shared path as required to support the safe operation of the road and paths. Street lighting would be designed to ensure relevant guidelines are adhered to including on light spill. As such, the immediate area surrounding the project activities, and the roadside during operation, would be subject to artificial lighting. This would essentially create permanent 'daylight' conditions in the area around the lights. Ecological light pollution may potentially affect nocturnal fauna by temporarily interrupting their life cycle. Due to the frequency and sustained nature of the lighting, it is unlikely that animals would habituate to the light disturbance and a long-term impact in the area of lighting is likely. Despite efforts to minimise the impacts of lighting, localised impacts from light spill would remain and this has been identified and assessed as a residual impact in the BAR/EIS for the project.

4.7 Impacts to Cumberland Plain Woodland

Submission number(s)

12, 21, 25

Issue description

The respondents raised the following issues:

- Concern regarding the impacts of the project on Cumberland Plain Woodland
- Concern regarding the impacts of the project on Cumberland Plain Shale Woodland and Shale-Gravel Transition Forest.

The EIS identified the potential impacts to Cumberland Plain Woodland and this community is identified as a Matter for Further Consideration in the Biodiversity Assessment Report as the project is considered likely to significantly reduce the viability of Cumberland Plain Woodland.

Based on the original construction footprint, the project would result in the direct clearing of about 33.83 hectares of the TSC Act listed critically endangered Cumberland Plain Woodland in the Sydney Basin Bioregion ecological community. After detailed design, this impact has reduced by 2.96 hectares to about 30.87 hectares.

Based on the original construction footprint, the project would result in the direct clearing of about 16.37 hectares of the EPBC Act listed critically endangered Cumberland Plain Shale Woodlands and Shale-Gravel Transition Forest ecological community. After detailed design, this impact has been reduced by 1.29 hectares to 15.08 hectares.

4.8 Details of proposed mitigation measures

Submission number(s)

29

Issue description

- Penrith City Council requested further detail on some of the mitigation measures outlined in the EIS
- Three additional mitigation measures regarding seeding and reuse of topsoil were identified
- Three additional mitigation measures regarding hollows, re-use of large woody debris and installation of suitable habitat boxes were identified.

Further details of the mitigation measures for the project as outlined in the EIS are provided in Table 4.1. Additional mitigation measures proposed for the project are outlined in Section 5.

Table 4.1 : Description of mitigation measures

Impact	Proposed mitigation measure	Description of actions
Removal of native vegetation	Native vegetation removal will be minimised through detailed design.	Native vegetation removal has been reduced by 3.50 hectares during detailed design.
	Pre-clearing surveys will be undertaken in accordance with *Guide 1: Pre-clearing process* of the Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects (NSW Roads and Traffic Authority, 2011).	The pre-clearing process involves: • Review the environmental assessment and associated documentation for the project to identify known locations of biodiversity features such as threatened flora and fauna (and their habitat), threatened populations and communities that need to be considered during the pre-clearing process. • Identify nearby habitat that would be suitable for the release of fauna that may be encountered during the pre-clearing process or habitat removal. Consult with an ecologist to determine suitable habitat. Mark the pre-determined habitat identified for fauna release on a map. • The project manager and/or environment manager will develop an unexpected threatened species finds procedure for projects and maintenance works. This should be part of the Construction Environmental Management Plan (CEMP), flora and fauna management sub-plan or Environmental Work Method Statement (EWMS). Follow the unexpected threatened species finds procedure if additional threatened species or communities are identified that have not been considered in the environmental assessment. • The project manager and/or environment manager will incorporate biodiversity management measures identified during the pre-clearing process into the project CEMP and/or designs. • The project manager and/or environment manager should engage an ecologist to undertake the following procedure in the weeks before clearing begins: a. Confirm the locations of biodiversity features identified in the environmental assessment. b. Identify any fauna that have the potential to be disturbed, injured or killed as a result of clearing activities (eg nesting birds). c. Check for the presence of threatened flora and fauna species that were identified in the environmental assessment as likely to occur. This check should be: i. Conducted by licensed ecologists experienced in fauna handling and the identification of local flora and fauna species. ii. If possible, under taken during optimal weather conditions, season and time of day/night for identifying targeted flora and fauna species. d. If not already available, record the details for all hollow-bearing trees, trees containing threatened fauna and threatened flora, including (where applicable): i. GPS location. ii. Species. iii. Type of habitat feature (eg nest, bushrock). iv. Size of hollow (eg small, medium, large). v. Type of hollows (eg branch, limb, trunk). e. Mark habitat features to be protected during construction. Use suitable methods (eg flagging tape) to mark: i. All hollow-bearing trees or habitat features. ii. Any trees found to contain threatened fauna. iii. The location of any threatened flora. f. Confirm the location of pre-determined habitat identified for the release of any fauna encountered on site. g. Submit any updated maps/plans, pre-determined habitat for the release of fauna, habitat features and recommended clearing procedures to the project manager and/or environment manager (or equivalent). • The following procedure should be followed 24 hours before clearing: a. Licensed wildlife carers and/or ecologists should capture and/or remove fauna that have the potential to be disturbed, injured or killed as a result of clearing activities. b. Relocate captured fauna into pre-determined habitat identified for fauna release. c. The project manager and/or environment manager should inform clearing contractors of any changes to the sequence of clearing if required. d. Carr y out staged habitat removal as outlined in *Guide 4: Clearing of vegetation and removal of bushrock* where fauna habitat features (such as hollow-bearing trees, habitat trees and bushrock) have been identified and marked.

Impact	Proposed mitigation measure	Description of actions
	Exclusion zones will be established to mark clearing limits according to *Guide 2: Exclusion zones* of the *Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects* (NSW Roads and Traffic Authority, 2011).	An exclusion zone is a designated 'no-go' area that is clearly identified and appropriately fenced to prevent damage to native vegetation and fauna habitats and prevent the distribution of pests, weeds and disease. Exclusion zones will be used to define approved clearing limits for the project. Exclusion zones will be implemented as follows: • Review background documents such as environmental assessments and accompanying flora and fauna reports, conditions of approval, project or CEMP, project or contract specifications and updated maps/plans that were developed as part of the pre-clearing process. • Select appropriate exclusion fence type based on the risk of the excluded area being intruded upon, the area to be fenced, and the risk of fauna being trapped, injured or isolated. • Mark exclusion zones on a suitable plan. Plans should: a. Be based on up to date plans for the project. b. Include construction chainages or similar distance markers used in construction. c. Be clearly labelled. d. State what is being excluded. e. Be displayed in prominent places in the site shed. f. outline any procedures that must be followed for access into exclusion zones. • Mark out exclusion zones with temporary markings such as pegs or paint. • Ensure that any trees to be felled to establish exclusion zones are felled so as to fall away from the exclusion zone. • Place exclusion zone fencing outside tree protection zones. • Erect signs to inform personnel of the purpose of exclusion zone fencing. • Store materials or equipment outside exclusion zones. • Avoid stockpiling materials and equipment and parking vehicles and machinery within the dripline of any tree. • Ensure all exclusion zones are regularly inspected and repairs to fencing are made where required. • Carry out regular assessments of the adequacy and location of exclusion zones by including this as an auditable item in the project audit schedule. • Maintain exclusion fencing until the risk to disturbance within the excluded zone has been eliminated through other means. Removal of fencing should be under taken in consultation with environmental staff. • Communicate the importance of exclusion zones, and any changes to the zones, to all site staff and visitors (eg in toolbox talks and inductions). • Ensure that any breaches of the exclusion zone are reported through the RTA's environmental incident reporting procedure.

Impact	Proposed mitigation measure	Description of actions
	Vegetation removal will be undertaken in accordance with *Guide 4: Clearing of vegetation and removal of bushrock* of the *Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects* (NSW Roads and Traffic Authority, 2011).	The pre-clearing process should be completed before any clearing begins (see *Guide 1: Pre-clearing process*). After pre-clearing has been undertaken, vegetation removal will follow this procedure: • Develop a clearing and grubbing plan with reference to the Biodiversity Guidelines and communicate the requirements of the plan to site staff regularly. • document the selection of suitable work methods in a clearing and grubbing plan. • Ensure clearing of vegetation and/or removal of bushrock does not go beyond the approved clearing limits for the project. • Follow the unexpected threatened species finds procedure if a threatened species is encountered that has not previously been identified and assessed in the environmental assessment. • Carefully clear vegetation so as not to mix topsoil with debris and to avoid impacts to surrounding native vegetation. • Retain stumps in riparian zones and aquatic habitats to reduce the potential for bank erosion. • Separate woody vegetation to identify suitable items for secondary re-use (see Guide 5: Re-use of woody debris and bushrock) or exotic (non-native) vegetation. keep stockpiles of cleared vegetation under two metres high in accordance with the Roads and Maritime Stockpile Site Management Guideline. • Non-woody vegetation (typically grasses and groundcover species) should be incorporated into the stripping of topsoil to retain any organic materials and nutrients within the topsoil layer. • The staged habitat removal process is to be used when identified habitat (eg hollow-bearing trees, habitat trees or bushrock) is to be removed: a. Make contact with vets and wildlife carers before works start to ensure they are willing to assist treating injured animals if necessary. b. An experienced and licensed wildlife carer and/or ecologist will be present on site during all habitat removal activities to capture and relocate fauna that may be encountered. c. Progressive habitat removal will take place around habitat identified and marked during the pre-clearing process. Remove non-hollow-bearing trees, undergrowth, feed-trees, regrowth and grass. do not fell trees towards exclusion zones. d. Identified habitat (eg hollow-bearing trees) will be left for at least 24 hours after removing non-habitat vegetation to allow fauna to escape. A licensed wildlife carer and/or ecologist will check hollow-bearing trees are not being used by fauna before felling. If necessary, fauna may need to be trapped and relocated to pre-determined habitat identified for fauna release. e. Fell habitat trees as carefully as possible to avoid injury to any fauna still remaining in trees. Use equipment that would allow the habitat trees to be lowered to the ground with minimal impact (eg claw extension). do not fell trees towards exclusion zones. f. An experienced and licensed wildlife carer and/or ecologist will inspect habitat once it is removed eg after a tree is felled. Animals that emerge should be captured, inspected for injury then relocated to pre-determined habitat identified for fauna release. g. All hollows have the potential to support fauna and will be placed in adjacent habitat until the following day for further inspection by a licensed wildlife carer and/or ecologist to verify no fauna is present. If possible, the hollows could be permanently relocated in adjacent areas in accordance with *Guide 5: Re-use of woody debris and bushrock*. Inspect woody debris for fauna immediately before chipping to avoid injury or death to fauna that may be present. • The project manager and/or environment manager should ensure that the outcomes of the clearing process are recorded. Reporting is usually the responsibility of an ecologist or environment officer. Reports are to be submitted to relevant personnel eg environment manager or RTA regional environmental staff. • Consider the seasonal impact of clearing on species identified in the environmental assessment or pre-clearing process or that are known to occur in the area. • Under take bushrock removal in a way that minimises damage to the bushrock, avoids excessive soil disturbance and avoids climatic seasons when species are utilising this resource. • Record the outcomes of the clearing process. • The Australian Standard AS 4373 Pruning of amenity trees should be followed for all pruning works.

Impact	Proposed mitigation measure	Description of actions
	Native vegetation will be re-established in accordance with *Guide 3: Re-establishment of native vegetation* of the *Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects* (NSW Roads and Traffic Authority, 2011).	An urban design and landscape concept has been developed for the project as documented in the EIS, based on the project objectives and principles, to achieve an integrated design for the project. It incorporates the urban and landscape design concept plans for the project and a landscape planting concept including recommended species. As identified in the EIS, this would be adopted and further developed during detailed design and implemented as part of the Urban Design Landscape Plan (UDLP) for the project which is currently ongoing. This plan would be developed in consultation with Council. Native vegetation will be re-established using the following procedure: • Retain native vegetation by minimising the road construction footprint where possible rather than clearing and revegetating the area. • Ecologists and landscape architects will work together on the preparation of revegetation plans and specifications that clearly identify the locations of areas to be revegetated. • Allocate sufficient time for the collection of seed to be used in revegetation. • Carry out all seed collection in accordance with RTA Seed Collection QA Specification R176 and the Florabank Guidelines and Model Code of Practice. • Use experienced and licensed seed collectors to carry out seed collection. • Where possible, procured plants should be grown from local provenance seed. • Consideration should be given to a range of characteristics such as species, height and drought tolerance when procuring native plants. • Planting operations should be in accordance with RTA Landscape Planting QA Specification R179. • Use only plants that have been certified disease free for revegetation works (refer to Guide 7: Pathogen management). • Collect local native topsoils and leaf litter and store for use in revegetation works. • Soils in areas to be revegetated should match surrounding soil conditions as closely as possible unless adjacent areas are weedy or contaminated. • Ensure areas to be revegetated have an appropriate level of natural drainage. • Avoid compaction of soils in areas identified for revegetation. Where compaction has occurred, the soil should be loosened. • There are several seeding techniques that deal with moisture requirements in different ways. For further details refer to Construction Quality Technical Direction 007, Quality Alert 7 – Hydroseeding, hydromulching and other slope stabilisation methods. • When planting consider seasonal risks of frost, drought, flooding and sun exposure to avoid damaging plants and to encourage growth. • Ensure plant spacing and diversity follows the landscaping plan for the project, reflects local conditions and is dense enough to ensure plants achieve a timely coverage of the ground. • Consider appropriate shade and drainage conditions when planting. Provide mulching around plants for dry or potentially weedy sites to help retain moisture and suppress weeds. • Inspection, monitoring and maintenance of revegetated areas should be conducted in accordance with the landscape management plan. Outline the roles and responsibilities in landscape management and revegetation plans including the schedule for monitoring and maintenance activities.

Impact	Proposed mitigation measure	Description of actions
	The unexpected species find procedure is to be followed under *Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects* (NSW Roads and Traffic Authority, 2011) if threatened ecological communities, not assessed in the biodiversity assessment, are identified on the project.	The procedure is as follows: • Threatened flora or fauna species unexpectedly encountered • Stop work • Notify the environment manager • Environmental manager would arrange for an ecologist to conduct an assessment of significance of the likely impact, develop management options and notify OEH, DPI and DoEE as appropriate • If a significant impact is not likely to occur, recommence work and maintain regular inspections • If a significant impact is likely to occur: a. Consult with OEH, DPI and DoEE as appropriate b. Obtain approvals, licenses or permits as required c. Recommence works once advice is sought and necessary approvals, licences and permits are obtained • Include species in subsequent inductions, toolbox talks and update the CEMP.
Removal of threatened species habitat and habitat features	Habitat removal will be minimised through detailed design.	Removal of habitat for threatened species has been minimised during detailed design. Impacts to habitat of the Cumberland Plain Land Snail have been reduced by 0.96 ha. Impacts to habitat of species including Grey-headed Flying-fox, Regent Honeyeater, Swift Parrot and Large-eared Pied Bat has been reduced by 2.15 ha.
	Habitat removal will be undertaken in accordance with *Guide 4: Clearing of vegetation and removal of bushrock* of the *Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects* (NSW Roads and Traffic Authority, 2011).	The pre-clearing process should be completed before any clearing begins (see *Guide 1: Pre-clearing process*). After pre-clearing has been undertaken, vegetation removal will follow this procedure: • Develop a clearing and grubbing plan with reference to the Biodiversity Guidelines and communicate the requirements of the plan to site staff regularly. • document the selection of suitable work methods in a clearing and grubbing plan. • Ensure clearing of vegetation and/or removal of bushrock does not go beyond the approved clearing limits for the project. • Follow the unexpected threatened species finds procedure if a threatened species is encountered that has not previously been identified and assessed in the environmental assessment. • Carefully clear vegetation so as not to mix topsoil with debris and to avoid impacts to surrounding native vegetation. • Retain stumps in riparian zones and aquatic habitats to reduce the potential for bank erosion. • Separate woody vegetation to identify suitable items for secondary re-use (see Guide 5: Re-use of woody debris and bushrock) or exotic (non-native) vegetation. keep stockpiles of cleared vegetation under two metres high in accordance with the Roads and Maritime Stockpile Site Management Guideline. • Non-woody vegetation (typically grasses and groundcover species) should be incorporated into the stripping of topsoil to retain any organic materials and nutrients within the topsoil layer. • The staged habitat removal process is to be used when identified habitat (eg hollow-bearing trees, habitat trees or bushrock) is to be removed: a. Make contact with vets and wildlife carers before works start to ensure they are willing to assist treating injured animals if necessary. b. An experienced and licensed wildlife carer and/or ecologist will be present on site during all habitat removal activities to capture and relocate fauna that may be encountered. c. Progressive habitat removal will take place around habitat identified and marked during the pre-clearing process. Remove non-hollow-bearing trees, undergrowth, feed-trees, regrowth and grass. do not fell trees towards exclusion zones. d. Identified habitat (eg hollow-bearing trees) will be left for at least 24 hours after removing non-habitat vegetation to allow fauna to escape. A licensed wildlife carer and/or ecologist will check hollow-bearing trees are not being used by fauna before felling. If necessary, fauna may need to be trapped and relocated to pre-determined habitat identified for fauna release. e. Fell habitat trees as carefully as possible to avoid injury to any fauna still remaining in trees. Use equipment that would allow the habitat trees to be lowered to the ground with minimal impact (eg claw extension). do not fell trees towards exclusion zones. f. An experienced and licensed wildlife carer and/or ecologist will inspect habitat once it is removed eg after a tree is felled. Animals that emerge should be

Impact	Proposed mitigation measure	Description of actions
		captured, inspected for injury then relocated to pre-determined habitat identified for fauna release. g. All hollows have the potential to support fauna and will be placed in adjacent habitat until the following day for further inspection by a licensed wildlife carer and/or ecologist to verify no fauna is present. If possible, the hollows could be permanently relocated in adjacent areas in accordance with *Guide 5: Re-use of woody debris and bushrock*. Inspect woody debris for fauna immediately before chipping to avoid injury or death to fauna that may be present. h. The project manager and/or environment manager should ensure that the outcomes of the clearing process are recorded. Reporting is usually the responsibility of an ecologist or environment officer. Reports are to be submitted to relevant personnel eg environment manager or RTA regional environmental staff. • Consider the seasonal impact of clearing on species identified in the environmental assessment or pre-clearing process or that are known to occur in the area. • Under take bushrock removal in a way that minimises damage to the bushrock, avoids excessive soil disturbance and avoids climatic seasons when species are utilising this resource. • Record the outcomes of the clearing process. • The Australian Standard AS 4373 Pruning of amenity trees should be followed for all pruning works.
	Habitat will be replaced or re-instated in accordance with *Guide 5: Re-use of woody debris and bushrock* and *Guide 8: Nest boxes* of the *Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects* (NSW Roads and Traffic Authority, 2011)	An urban design and landscape concept has been developed for the project as documented in the EIS, based on the project objectives and principles, to achieve an integrated design for the project. It incorporates the urban and landscape design concept plans for the project and a landscape planting concept including recommended species. As identified in the EIS, this would be adopted and further developed during detailed design and implemented as part of the Urban Design Landscape Plan (UDLP) for the project which is currently ongoing. This plan would be developed in consultation with Council. The following will be undertaken to maximise the re-use of woody debris and bushrock to minimise loss and/or damage to native flora and fauna habitats: • Contract specifications should state that woody debris and bushrock is to be re-used on site (eg for habitat improvement) where possible. • Engage an ecologist to provide advice on the re-use of woody debris and bushrock to ensure it does not have a negative impact on the receiving environment. • Separate weeds from native vegetation. • Do not extend the amount of clearing and grubbing to make up for mulch shortfalls. • Carry out removal, stockpiling, transportation and relocation of woody debris and/or bushrock in a manner that minimises disturbance to native vegetation (including the canopy, shrubs, dead trees, fallen timber and groundcover species) or bushrock. • Avoid the spread of any weeds or pathogens that may be in the soil when relocating woody debris and bushrock from stockpiles. • Engage an ecologist to provide advice on positioning woody debris and bushrock in designated relocation areas • Keep topsoil disturbance to a minimum. • When relocating woody debris, place it evenly across the site. • Manage stockpiles in accordance with the Roads and Maritime Stockpile Site Management Guideline, Environmental Protection (Management System) QA Specification G36 and Vegetation QA Specification R178. • Prepare a mulch tannin management plan for the project where tannins are likely to be generated. To minimise the impact of hollow loss, supplementary fauna habitat in the form of artificial hollows (nest boxes) will be installed as follows: • Where nest boxes are required, an ecologist will be engaged to develop a nest box strategy. • Consult with an ecologist to assist in the implementation of the nest box strategy including installation and monitoring of nest boxes. • An ecologist should certify that the nest boxes are designed and built to suit the target species in accordance with the nest box strategy. • The entrance size of nest boxes should be no bigger than that required for the target species. • The nest box lid should overhang the front and sides of the nest box by at least 25 millimetres to prevent water damage. For monitoring and maintenance purposes, consider using a hinged lid. do not use metal lids or plates on the roof of the nest box lid. • Paint the outside of the nest box with non-toxic, dark-coloured, outdoor, water-based acrylic paint. Avoid toxic substances. • To assist with drainage, drill three small holes in the base of the nest box. • Non-toxic woodchips, wood shavings or sawdust could be placed into possum, glider and bird nest boxes to provide extra insulation in cold climates.

Impact	Proposed mitigation measure	Description of actions
		• An ecologist should be on site during the installation of nest boxes. • The preferred method of attaching nest boxes to trees is the Habisure© system. Bolting nest boxes to trees is not recommended. • The density and quantity of each nest box type should reflect the proportion of tree hollow types being removed, the proportion of tree hollow types to be retained in adjacent habitat, the availability of adjacent food resources and the assemblage of hollow-dependant fauna known or likely to occur in the project locality. • The location of nest boxes should be as close as possible to the original hollow-bearing tree, consider the type of bark preferred by the target species, be in close proximity to food or other resources, not be installed on trees with existing hollows or where there is a high density of Common Mynas (*Acridotheres tristis*). • Orientate nest boxes between northwest and east and so they are not facing lights from adjacent development. • Install approximately 70 per cent of nest boxes up to one month before the star t of any clearing. The remainder of nest boxes would be installed before completion of the project. • Record the nest box identification number, nest box type, GPS location, species and diameter at breast height of the host tree, nest box height and orientation. • Under take ongoing monitoring and maintenance of nest boxes in accordance with the nest box management strategy for the project. • If a nest box needs to be removed from the site for repair, then an alternative nest box should be installed in the same location upon removal of the damaged nest box.
	The unexpected species find procedure is to be followed under *Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects* (NSW Roads and Traffic Authority, 2011) if threatened fauna, not assessed in the biodiversity assessment, are identified on the project.	The procedure is as follows: • Threatened flora or fauna species unexpectedly encountered • Stop work • Notify the environment manager • Environmental manager would arrange for an ecologist to conduct an assessment of significance of the likely impact, develop management options and notify OEH, DPI and DoEE as appropriate • If a significant impact is not likely to occur, recommence work and maintain regular inspections • If a significant impact is likely to occur: a. Consult with OEH, DPI and DoEE as appropriate b. Obtain approvals, licenses or permits as required c. Recommence works once advice is sought and necessary approvals, licences and permits are obtained • Include species in subsequent inductions, toolbox talks and update the CEMP.
Removal of threatened plants	Pre-clearing surveys will be undertaken in accordance with *Guide 1: Pre-clearing process* of the Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects (NSW Roads and Traffic Authority, 2011).	The pre-clearing process involves: • Review the environmental assessment and associated documentation for the project to identify known locations of biodiversity features such as threatened flora and fauna (and their habitat), threatened populations and communities that need to be considered during the pre-clearing process. • identify nearby habitat that would be suitable for the release of fauna that may be encountered during the pre-clearing process or habitat removal. Consult with an ecologist to determine suitable habitat. Mark the pre-determined habitat identified for fauna release on a map. • The project manager and/or environment manager will develop an unexpected threatened species finds procedure for projects and maintenance works. This should be part of the CEMP, flora and fauna management sub-plan or EWMS. Follow the unexpected threatened species finds procedure if additional threatened species or communities are identified that have not been considered in the environmental assessment. • The project manager and/or environment manager will incorporate biodiversity management measures identified during the pre-clearing process into the project CEMP and/or designs. • The project manager and/or environment manager should engage an ecologist to undertake the following procedure in the weeks before clearing begins: a. Confirm the locations of biodiversity features identified in the environmental assessment. b. Identify any fauna that have the potential to be disturbed, injured or killed as a result of clearing activities (eg nesting birds). c. Check for the presence of threatened flora and fauna species that were identified in the environmental assessment as likely to occur. This check should be: i. Conducted by licensed ecologists experienced in fauna handling and the identification of local flora and fauna species

Impact	Proposed mitigation measure	Description of actions
		ii. If possible, under taken during optimal weather conditions, season and time of day/night for identifying targeted flora and fauna species. d. If not already available, record the details for all hollow-bearing trees, trees containing threatened fauna and threatened flora, including (where applicable): i. GPS location ii. Species iii. Type of habitat feature (eg nest, bushrock) iv. Size of hollow (eg small, medium, large) v. Type of hollows (eg branch, limb, trunk). e. Mark habitat features to be protected during construction. Use suitable methods (eg flagging tape) to mark: i. All hollow-bearing trees or habitat features. ii. Any trees found to contain threatened fauna. iii. The location of any threatened flora. f. Confirm the location of pre-determined habitat identified for the release of any fauna encountered on site. g. Submit any updated maps/plans, pre-determined habitat for the release of fauna, habitat features and recommended clearing procedures to the project manager and/or environment manager (or equivalent). • The following procedure should be followed 24 hours before clearing: a. Licensed wildlife carers and/or ecologists should capture and/or remove fauna that have the potential to be disturbed, injured or killed as a result of clearing activities. b. Relocate captured fauna into pre-determined habitat identified for fauna release. c. The project manager and/or environment manager should inform clearing contractors of any changes to the sequence of clearing if required. d. Carr y out staged habitat removal as outlined in *Guide 4: Clearing of vegetation and removal of bushrock* where fauna habitat features (such as hollow-bearing trees, habitat trees and bushrock) have been identified and marked.
	The unexpected species find procedure is to be followed under Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects (RTA 2011) if threatened flora species, not assessed in the biodiversity assessment, are identified on the project.	The procedure is as follows: • Threatened flora or fauna species unexpectedly encountered • Stop work • Notify the environment manager • Environmental manager would arrange for an ecologist to conduct an assessment of significance of the likely impact, develop management options and notify OEH, DPI and DoEE as appropriate • If a significant impact is not likely to occur, recommence work and maintain regular inspections • If a significant impact is likely to occur: a. Consult with OEH, DPI and DoEE as appropriate b. Obtain approvals, licenses or permits as required c. Recommence works once advice is sought and necessary approvals, licences and permits are obtained • Include species in subsequent inductions, toolbox talks and update the CEMP.

Impact	Proposed mitigation measure	Description of actions
Aquatic impacts	Aquatic habitat will be protected in accordance with *Guide 10: Aquatic habitats and riparian zones* of the *Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects* (NSW Roads and Traffic Authority, 2011) and Section 3.3.2 *Standard precautions and mitigation measures* of the *Policy and guidelines for fish habitat conservation and management Update 2013* (Department of Primary Industries, 2013).	This procedure is applicable to all construction and maintenance sites where works are in an aquatic habitat or within the riparian zone (50 metres from the highest bank of a waterway or the edge of a wetland). • Avoid activities in aquatic habitats and riparian zones as much as practicable. • The sensitivity of aquatic habitats and riparian zones and the measures in place to protect them should be regularly communicated to all staff eg during inductions and toolbox talks. • Protect aquatic habitats and riparian zones where works are not required with exclusion zones. Exclusion fencing should be used outside sensitive areas. • The location of aquatic habitat features within or adjacent to the footprint should be clearly identified on environmental management plans. • Access the waterway so that riparian vegetation removal is minimised and restricted to the minimum amount of bank length required for the construction activity. • Keep vehicles and machinery away from the banks of a waterway where possible. • Refuelling of vehicles and plant, and chemical storage and decanting should not take place within 50 metres of aquatic habitats. • Avoid clearing within the riparian zone during periods when flooding is likely to occur. • Ensure that any clearing under taken does not allow the vegetation/trees to fall into the waterway. • Retain the roots of trees on the bank of a waterway in order to maintain bank stability. • Consult with department of Primary industries (DPI) (Fisheries) before clearing to identify any trees proposed to be removed that could potentially be used for re-snagging of a waterway. • Only the minimum number of snags should be disturbed. • DPI (Fisheries) must be consulted before works commence where snags require lopping, realignment, relocation and/or removal. • During rehabilitation, stabilise the banks of the waterway through revegetation and/or armouring according to available landscape plans. • Protect banks from stock and/or human access using appropriate fencing during the rehabilitation and maintenance period of the work site. • Remove all temporary works, flow diversion barriers and sediment control barriers within aquatic habitats as soon as practicable and in a manner that does not promote future channel erosion.
Removal of woody debris	All large woody debris or snags will be relocated instream.	The process involves: • Consult with department of Primary industries (DPI) (Fisheries) before clearing to identify any trees proposed to be removed that could potentially be used for re-snagging of a waterway. • Only the minimum number of snags should be disturbed. • DPI (Fisheries) must be consulted before works commence where snags require lopping, realignment, relocation and/or removal.
Changes to hydrology	Changes to existing surface water flows will be minimised through detailed design.	A flood culvert PXD2 is proposed at the key connectivity point at Surveyors Creek. Scour protection measures or energy dissipation measures will be used along the bed and banks upstream and downstream of any bridge crossing or culvert where high velocities of surface water runoff cannot be minimised by design or by energy dissipaters. This may include flow velocity management measures to minimise erosion and scour in watercourses, or collection and management of runoff waters.
Fragmentation of identified biodiversity links and habitat corridors	Connectivity measures will be implemented in accordance with the *Wildlife Connectivity Guidelines for Road Projects* (RMS in prep).	Connectivity measures are being considered during detailed design in accordance with the Wildlife Connectivity Guidelines for Road Projects (RMS in prep). In particular, maintenance of current connectivity and potential future connectivity has been considered in culvert design, lighting and fencing. Connectivity between the Mulgoa Nature Reserve, Badgery's Creek and the DEOH via Regional Corridor 17 (Surveyors Creek Corridor) will be planned for in the future with construction of a fauna crossing to allow for future connectivity to the DEOH land. The proposed fauna crossing is a 2.4 metre tall dry passage underpass. This should be suitable for larger species such as the Eastern Grey Kangaroo based on monitoring results from Pacific Highway projects. The culvert will lead from the Surveyors Creek corridor under the road and will exit at the new DEOH fencing. For DEOH security reasons and traffic safety, the underpass will be blocked until the DEOH fencing is removed in the future. This is to prevent the public from gaining unauthorised access to the DEOH land through the underpass and to prevent animals from exiting the culvert onto the roadway.

Impact	Proposed mitigation measure	Description of actions
Edge effects on adjacent native vegetation and habitat	Exclusion zones will be set up at the limit of clearing in accordance with *Guide 2: Exclusion zones* of the *Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects* (NSW Roads and Traffic Authority, 2011).	An exclusion zone is a designated 'no-go' area that is clearly identified and appropriately fenced to prevent damage to native vegetation and fauna habitats and prevent the distribution of pests, weeds and disease. Exclusion zones will be used to define approved clearing limits for the project. Exclusion zones will be implemented as follows: • Review background documents such as environmental assessments and accompanying flora and fauna reports, conditions of approval, project or CEMP, project or contract specifications and updated maps/plans that were developed as part of the pre-clearing process. • Select appropriate exclusion fence type based on the risk of the excluded area being intruded upon, the area to be fenced, and the risk of fauna being trapped, injured or isolated. • Mark exclusion zones on a suitable plan. Plans should: a. Be based on up to date plans for the project. b. Include construction chainages or similar distance markers used in construction. c. Be clearly labelled. d. State what is being excluded. e. Be displayed in prominent places in the site shed. f. outline any procedures that must be followed for access into exclusion zones. • Mark out exclusion zones with temporary markings such as pegs or paint. • Ensure that any trees to be felled to establish exclusion zones are felled so as to fall away from the exclusion zone. • Place exclusion zone fencing outside tree protection zones. • Erect signs to inform personnel of the purpose of exclusion zone fencing. • Store materials or equipment outside exclusion zones. • Avoid stockpiling materials and equipment and parking vehicles and machinery within the dripline of any tree. • Ensure all exclusion zones are regularly inspected and repairs to fencing are made where required. • Carr y out regular assessments of the adequacy and location of exclusion zones by including this as an auditable item in the project audit schedule. • Maintain exclusion fencing until the risk to disturbance within the excluded zone has been eliminated through other means. Removal of fencing should be under taken in consultation with environmental staff. • Communicate the importance of exclusion zones, and any changes to the zones, to all site staff and visitors (eg in toolbox talks and inductions). • Ensure that any breaches of the exclusion zone are reported through the RTA's environmental incident reporting procedure.
Injury and mortality of fauna	Fauna will be managed in accordance with *Guide 9: Fauna handling* of the *Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects* (NSW Roads and Traffic Authority, 2011).	To minimise impacts on fauna as a result of being handled by humans and prevent injury to people handling fauna the following procedures will be implemented: • Allow fauna to leave an area without intervention as much as possible. • Use a licensed fauna ecologist or wildlife carer with specific animal handling experience to carry out any fauna handling. • Contact an animal rescue agency/wildlife care group or vet before works start to ensure they are willing and available to be involved in fauna rescue and assist with injured animals. • The contact details of the animal rescue agency/wildlife care group or vet should be provided to the site manager, displayed in the site office and included in the CEMP or other relevant management plans for the project. • Include the procedures to follow if fauna is found or injured on site in project inductions. • Follow the best practice methods outlined below in circumstances where the handling of fauna is completely unavoidable: a. Contact the nominated animal rescue agency/wildlife care group or vet if an animal is injured. b. Keep the injured animal in a box in a quiet, warm, dark place until transferred. If an injured animal is dangerous, carefully place a box over the top of it if possible, or section off the area and wait for an experienced and licensed fauna ecologist or wildlife carer to arrive. c. Never deliberately kill a snake as all snakes are protected under the *National Parks and Wildlife Act 1974* (NSW). If a snake must be handled to remove the risk of harm to the snake or people then handling should only be done by a licensed fauna ecologist or wildlife carer with skills and experience in snake

Impact	Proposed mitigation measure	Description of actions
		handling. d. Follow the Hygiene Protocol for the control of disease in frogs for all frog handling. e. Fish should only be handled by experienced aquatic ecologists. f. Wear gloves when handling mammals (including bats) to protect against bites and scratches. If handling bats, the handler must be vaccinated against the Australian Bat Lyssavirus (ABI) which is a form of rabies. g. Release fauna into pre-determined habitat identified for fauna release. h. Release fauna into similar habitats, as near as possible to their capture location. Release nocturnal fauna at dusk.
Invasion and spread of weeds	Weed species will be managed in accordance with *Guide 6: Weed management* of the *Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects* (NSW Roads and Traffic Authority, 2011).	To prevent or minimise the spread of weed species on site and during roadside maintenance the following procedure will be followed: • Use an ecologist or person trained in weed management and identification to undertake a site weed assessment to identify and describe or map weed infested areas within the site and adjacent areas. • Identify and manage any Weeds of National Significance (WoNS), National Environmental Alert Weeds and/or noxious weeds located within the site or adjacent areas in consultation with the weeds officer at the relevant local council. • Identify surrounding land uses and consult with surrounding landholders where required. • Develop a weed management plan for the site. • The application of herbicide should ensure the safety of users and other people, and minimise risks to the broader environment. • Roads and Maritime has obligations to notify the community of proposed pesticide use (including herbicides) in accordance with the NSW Pesticides Regulation 2009. • Map and mark areas that are infested with weeds as an exclusion zone with fencing and signage to limit access by personnel and vehicles. • Use mechanical weed control methods such as slashing or mowing, as well as a range of herbicides to avoid the development of herbicide resistance (eg glyphosate resistance). • Mow/slash areas infested with weeds before they seed. This may reduce the propagation of new plants. • Program works from least to most weed infested areas. • Clean machinery, vehicles and footwear before moving to a new location. • Securely cover loads of weed-contaminated material to prevent weed plant material falling or blowing off vehicles. • Dispose of weed-contaminated soil at an appropriate waste management facility. • Remove weeds immediately onto suitable trucks and dispose of without stockpiling. • Separate weeds from native vegetation where native vegetation is to be used for mulch. do not use weeds for mulch. • Send samples of topsoil being imported onto site to a national Association of Testing Authorities (nATA) approved soil laboratory to ensure it contains no weed seeds or propagules (vegetative parts of plants such as buds or offshoots that can grow into new individuals). • Minimise soil disturbance within weed infested areas. Topsoil recovered from areas of low weed infestation can be re-used onsite with treatment but should be stockpiled separately. • All weed plant material and topsoil containing weed plant material should be disposed of to an appropriate waste management facility.
Invasion and spread of pests	Pest species will be managed within the project site according to the *Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects* (NSW Roads and Traffic Authority, 2011).	Roads and Maritime will work with the Greater Sydney Local Land Services to determine if the site is suitable for pre-clearing pest control.

Impact	Proposed mitigation measure	Description of actions
Invasion and spread of pathogens and disease	Pathogens will be managed in accordance with *Guide 7: Pathogen management* of the *Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects* (NSW Roads and Traffic Authority, 2011).	Where pathogens are known or suspected to occur on or adjacent to projects and during maintenance works the following procedure will be implemented: • Pathogen management is ongoing throughout the period in which works are being carried out. • Check the department of Primary industries (DPI) website (www.industry.nsw.gov.au) for the most up-to-date hygiene protocols for each pathogen and for the most recent locations of contamination. • Ensure the risk of spreading pathogens and the mitigation measures required on site are regularly communicated to staff and contractors eg during inductions and toolbox talks. • Advice from DPI or the Office of Environment and Heritage (OEH) regarding the most practical hygiene management measures may be required if pathogens are present. • Programming of works should move from uninfected areas to infected areas. • Ensure vehicles and footwear are free of soil before entering or exiting the site (ie directed to wash down area before entering or exiting the site). • Provide vehicle and boot wash down facilities. • Testing from a national Association of Testing Authorities (nATA) approved laboratory may be required to confirm the presence of pathogens in the soil and/or water. • Set up exclusion zones with fencing and signage to restrict access into contaminated areas. • Restrict vehicles to designated tracks, trails and parking areas.
Noise, light and vibration	Shading and artificial light impacts will be minimised through detailed design.	Street lighting would be provided along the full length of the project to light the carriageway and shared path, and is required to support the safe functioning of the road and paths. Street lighting would be designed to ensure relevant guidelines are adhered to. Where installed, nest boxes will be orientated so they are not facing lights from adjacent development. Some localised impacts from noise and light spill will remain.

4.9 Impacts to threatened species in the extension of Vineyard Road

Submission number(s)

27

Issue description

The respondent raised the following issues:

- Concern regarding the impact if the Vineyard Road extension on an east-west terrestrial corridor, which has been identified to contain threatened plants including *Pultenaea parviflora* and *Marsdenia viridiflora*
- Request that further detail on the timing of 'ground truthing' in the area is provided
- Loss of identified threatened plants must be offset by the permanent conservation of a nearby population.

An additional targeted survey for *Pultenaea parviflora* and *Marsdenia viridiflora* subsp. *viridiflora* was undertaken in an expanded study area around the Vineyard Road extension on the 7th August 2017. This area was not able to be accessed during the fieldwork undertaken for the original assessment. An area of habitat of approximately 4.7 hectares was surveyed by an experienced botanist following the methods described in the *NSW Guide to Surveying Threatened Plants* (Office of Environment and Heritage, 2016). Traverses of this habitat were undertaken over a three-hour period for a distance of 3.131 kilometres (3,131 metres) (see Figure 3.1). The survey located a further six *Pultenaea parviflora* plants (two of which were in the development footprint, and four outside of the footprint). No additional *Marsdenia viridiflora* subsp. *viridiflora* plants were recorded during the survey.

This data has been used in the amended assessment of impacts and calculation of offset requirement for the project (refer to Section 3).

Offsetting is also discussed in Section 4.2.

4.10 Impacts to the *Marsdenia viridiflora* subps. Viridiflora endangered population

Submission number(s)

29

Issue description

Further justification is needed regarding the impact of the project on *Marsdenia viridiflora* subsp. *viridiflora* in the context of "red flag" status.

The *Marsdenia viridiflora* subsp. *viridiflora* population has been identified in the BAR as a species credit species that cannot withstand further loss which has informed the assessment. The BAR has been undertaken in accordance with the FBA, and a BOS has been developed for the project. The BOS does not refer to the 'Red Flag' status of any species. 'Red Flag' areas are a concept from the BioBanking Assessment Methodology and do not apply to Major Projects assessed under the FBA.

4.11 Updating the Plant Community Type (PCT) selection and benchmarks for the assessment of Vegetation Zone 8 plot data

Submission number(s)

35

Issue description

OEH requests information supporting the view that PCT 850 is the likely original PCT. Following this, OEH can advise on the next steps with respect to PCT selection and benchmarks for the assessment of Vegetation Zone 8 plot data.

Vegetation Zone 8 was originally described in the BAR and entered into the Credit Calculator as Plant Community Type (PCT) 806 (HN627) 'Derived grasslands on shale hills of the Cumberland Plain (50-300m asl)'. This vegetation is derived native grassland that has resulted from the removal of the original tree canopy and shrub layer. In some parts the shrub layer is regenerating although no tree canopy remains. This native grassland vegetation is considered most likely derived from a former cover of PCT 850 (HN529) ‘Grey Box - Forest Red Gum grassy woodland on shale of the southern Cumberland Plain, Sydney Basin Bioregion’ given the landscape position, location adjacent to PCT 850, and species composition of the ground layer.

In accordance with the FBA, an assessor must only identify PCTs on the development site that are described in the VIS Classification Database as derived or secondary vegetation communities where the assessor cannot determine the original PCT (FBA, s.5.2.1.11). As such Vegetation Zone 8 has been reassigned to PCT 850, as reflected in the revised assessment included in this Memorandum (refer to Section 3).

4.12 Updating benchmarks for ‘Number of Trees with Hollows' and 'Fallen Logs' for HN528 and HN529

Submission number(s)

35

Issue description

The respondent raised the following issues:

- Benchmarks for HN528 and HN529 should be 1 and 50 m for 'Number of Trees with Hollows' and 'Fallen Logs' respectively. These benchmarks should be updated manually in the Credit Calculator with a note made in the BAR. It should be noted these updates are based on OEH advice and do not constitute the use of 'More Appropriate Local Data'.

For HN528 and HN529, the benchmark data for the site attributes ‘Number of Trees with Hollows' and 'Fallen Logs' do not have any values assigned to them in the credit calculator. The OEH have advised that these value should be 1 and 50 m for 'Number of Trees with Hollows' and 'Fallen Logs' respectively.

These benchmarks have been manually updated in the credit calculator and the data has been used in the revised assessment included in this Memorandum (refer to Section 3 of this Memorandum).

4.13 Correcting inconsistencies with plot/transect data entered in the Credit Calculator when compared to the values provided in Appendix A of the BAR

Submission number(s)

35

Issue description

The respondent raised the following issues:

- There are inconsistencies between the plot/transect data in the Credit Calculator and Appendix A of the BAR.
- OEH recommends a copy of all raw field data sheets be provided to OEH for review and to determine whether the values in Appendix A (or the Credit Calculator) are correct.

There were some inconsistencies identified with the plot/transect data entered in the Credit Calculator when compared to the values provided in Appendix A of the BAR. All data entered into the Credit Calculator has been checked and amended as necessary.

All data entered into the credit calculator has been checked for consistency with the field sheets. A copy of all raw field data sheets is provided with this memorandum (refer to Appendix A).

4.14 Removing reference to Plot 31 from the BAR as it was not used in the assessment

Submission number(s)

35

Issue description

OEH recommends that the Credit Calculator be corrected to include Plot 31 or 'Grey Box- Forest Red Gum grassy woodland on shale of the southern Cumberland Plain, Sydney Basin Bioregion - Moderate/Good' or reference be removed from the BAR.

Plot 31 was an original Rapid Biodiversity Assessment plot undertaken on the roadside along Willowdene Avenue. This plot was not used in the revised assessment as presented in this Memorandum as it was located outside of the revised construction footprint and landscape assessment area.

4.15 Updating the legend of Figure 3.1 in the BAR to remove errors

Submission number(s)

35

Issue description

OEH recommends updating the legend of Figure 3.1 in the BAR to remove errors.

The legend of Figure 3.1 (Vegetation survey locations) in the BAR incorrectly refers to HN528 as being in 'low' condition. There also seems to be some duplication of PCT names in the legend of Figure 3.1.

The legend of Figure 3.1 has been amended to show the correct classification of HN528 as Moderate/Good_Poor and the duplication with labelling has been removed. Refer to Appendix B.

4.16 Updating Table 6.1 of the BAR to include the area of impact (4.68 ha) for vegetation zone 4 (PCT 849)

Submission number(s)

35

Issue description

OEH recommends that Table 6.1 of the BAR be updated to include the area of impact (4.68 ha) for vegetation zone 4 (PCT 849).

The impacts to Vegetation Zone 4 have been included in Table 3.3 above to provide an overview of all impacts to native vegetation. Due to the manual override of the 'Number of Trees with Hollows' and 'Fallen Logs' for HN 528, Vegetation Zone 4 now has a site score of 29.17 and requires an offset to be calculated.

4.17 Species credit species *Pultenaea pedunculata* (Matted Bush-pea) was predicted by the Credit Calculator for survey but has not been included in the BAR

Submission number(s)

35

Issue description

OEH recommends that *Pultenaea pedunculata* (Matted Bush-pea) be included in the BAR.

Species credit species *Pultenaea pedunculata* (Matted Bush-pea) was predicted by Credit Calculator for survey but has not been included in the BAR.

Pultenaea pedunculata has recently been found in Mulgoa Nature Reserve and there is a record of *Pultenaea pedunculata* from October 2015 approximately 10-11km south of the study area made from Wivenhoe Conservation area at Cobbity. Prior to this record, the nearest record of *Pultenaea pedunculata* was from Prestons from 1998, located about about 16km to the south east of the study area.

The habitat assessment table for the BAR was created in September 2015 before the bulk of the ecological surveys were undertaken from 2/9/2015 to 10/9/2015. The survey was based off the survey matrix generated by the Credit Calculator in September 2015. *Pultenaea pedunculata* was not identified as a species for targeted survey in the original survey matrix so this species was not targeted in the detailed field surveys for the BAR. The Credit Calculator is linked to a threatened species database that is constantly being updated. It is likely that the distribution data for *Pultenaea pedunculata* was edited causing it to appear in the Credit Calculator after the September 2015 surveys had been completed.

Despite its omission from the credit calculator at the time, the targeted surveys for other threatened plants (including *Pultenaea parviflora*) undertaken for the BAR were undertaken from September to February within the flowering period and optimal survey period for *Pultenaea pedunculata*. *Pultenaea pedunculata* was not found on site during the surveys but there is a high likelihood that *Pultenaea pedunculata* would have been encountered during the surveys if the species was present in the habitat at that time.

A summary of the assessment for *Pultenaea pedunculata* is provided in Table 4.2.

Table 4.2 : Habitat assessment for *Pultenaea pedunculata*

Common name (*Scientific name*)	TSC Act	EPBC Act	Habitat	Minimum survey requirements (Office of Environment and Heritage 2016)	Survey completed
Matted Bush-Pea (*Pultenaea pedunculata*)	E	-	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. Associated habitat includes PCT 849 and PCT 850 which are present on site.	The recommended approach is the parallel field traverse (i.e. parallel Transects) as used by Cropper (1993). As a sub-shrub the maximum distance between transects in open vegetation is 15 m, in dense vegetation is 10 m. In open vegetation, field traverse length is 0.63 km per hectare of potential habitat in open vegetation. With about 60 hectares of potential habitat in the study area, survey time is at least 9.38 hours in open vegetation.	Particular survey effort was expended in the in the vegetation on the Defence Establishment Orchard Hills. Surveys targeted PCT 849 and PCT 850. Derived grasslands were also surveyed. Parallel field traverses undertaken by two observers were used to survey for this species in areas which appeared to provide suitable habitat. Surveys for this species can be undertaken year round. The field surveys were undertaken over a period of 11 days from 2 September 2015 to 4 February 2016 (not inclusive). Floristic plots were undertaken in PCT 849 (14 plots), PCT 850 (16 plots) and PCT 806 (4 plots) which lasted on average 1 hour each with two observers. This equates to 68 person hours of detailed floristic survey in potential habitat. Each floristic plot was accompanied by a traverse throughout the adjacent habitat lasting a minimum of 0.5 hours' duration undertaken by two observers. This resulted in an additional 34 person hours of traverse-based survey in the habitat. In total, 102 person hours were expended on survey within the study area in 2015. The Vineyard Road extension on the 7th August 2017. While this survey was undertaken slightly before the September survey period, most species were flowering earlier than usual in August 2017. This species is known to flower from August to December. This area was not able to be accessed during the fieldwork undertaken for the original assessment. An area of habitat of approximately 4.7 hectares was surveyed. Traverses of this habitat were undertaken over a three-hour period for a distance of 3.131 kilometres (3,131 metres).

4.18 Updating the habitat assessment table for threatened fauna species in Appendix B to include the number of Atlas records

Submission number(s)

35

Issue description

OEH recommends that the habitat assessment table for threatened fauna species in Appendix B be updated to include the number of Atlas records in the 'Number or records' column.

The habitat assessment table for threatened fauna species in the BAR did not include the number of Atlas records in the 'Number or records' column.

This information is now included in Appendix C.

4.19 Updating the BAR to refer to the Grey-headed Flying-fox as an Ecosystem credits species and a Species Credit Species

Submission number(s)

35

Issue description

OEH requested that the BAR and BOS be updated to clarify that the Grey-headed Flying-fox is both an ecosystem and species credit species, no impact to camps (species credits) have been identified and no species credits are required.

The BAR and BOS refer to the Grey-headed Flying-fox as an ecosystem credit species. It is, however, both an ecosystem and species credit species. The Grey-headed Flying-fox is a dual credit species because foraging habitat is broad ranging but breeding camps are localised and, if impacted, must be offset by protecting and enhancing another breeding camp.

As no breeding camps would be impacted by the project and only foraging habitat was present, the Grey-headed Flying-fox was only identified as an ecosystem credit species. No species credits are required for the Grey-headed Flying-fox.

4.20 Revision of the Percentage Vegetation Cover calculations and associated GIS shapefile

Submission number(s)

35

Issue description

The respondents raised the following issues:

- It is unclear why areas of native vegetation identified as moderate to good condition have been excluded from GIS shapefile (CD_TNREISVegetationZonesJacobs_20170110_V03) for native vegetation.
- OEH recommends justification for the exclusion of these areas in accordance with the FBA, or the GIS shapefile be amended and appropriate recalculations be made to address the missing areas in the revised BAR.

The revised percent extent of native vegetation cover in the landscape and area to perimeter ratio calculations were undertaken using ESRI ArcGIS software. To undertake the assessment of landscape values, a 550 metre buffer was established from the outside edge of the construction

footprint as while this is a linear road project there are some detached construction compounds which made using a buffer from the centreline impossible.

Once the native vegetation cover had been digitised, the extent of native vegetation in the landscape before and after the development was recalculated (see Table 4.3). Current percent native vegetation cover is estimated at 12.26 per cent (score 2.5 as outlined in Table 16 of Appendix 5 of the FBA). After the development, percent native vegetation cover is estimated at 11.13 per cent (score 2.5 as outlined in Table 16 of Appendix 5 of the FBA). The score for percent native vegetation cover is 0.

Table 4.3 : Percent native vegetation cover in the landscape before and after development

Assessment buffer	Before development		After development		Score for % native vegetation cover
	Native vegetation cover (ha)	Cover (%)	Native vegetation cover (ha)	Cover (%)	
550m from the edge of the construction footprint	326.51	12.26	296.25	11.13	0

4.21 Avoidance of impacts

Submission number(s)

35

Issue description

OEH recommends that the BAR be updated to include adequate detail regarding the measures taken to avoid impacts to Cumberland Plain Woodland and River-flat Eucalypt Forest as well as areas of habitat for the *Marsdenia viridiflora* subsp. *viridiflora* endangered population, *Pultenaea parviflora*, Regent Honeyeater and Cumberland Plain Land Snail in accordance with the FBA.

The BAR details the measures taken to avoid impacts to Cumberland Plain Woodland and River-flat Eucalypt Forest as well as areas of habitat for the *Marsdenia viridiflora* subsp. *viridiflora* endangered population, *Pultenaea parviflora*, Regent Honeyeater and Cumberland Plain Land Snail.

Section 8.3.1.3 of the FBA states that the proponent must seek to avoid the direct impacts of the Major Project on all biodiversity values at the development site including impacts on:

a) endangered ecological communities (EECs) and critically endangered ecological communities (CEECs), and

b) PCTs that contain threatened species habitat, and

c) areas that contain habitat for vulnerable, endangered or critically endangered threatened species or populations, as determined in accordance with Step 5 in Section 6.5.

Section 7.1 of the BAR outlines the measures that were taken to avoid impacts to EECs, CEECs, PCTs that contain threatened species habitat, and areas that contain habitat for vulnerable, endangered or critically endangered threatened species or populations. Chapter 4 of the EIS describes the alternatives to the project that were considered as part of the project development process and explains how and why the project was selected as the preferred option. Chapter 4 of the EIS also outlines how particular elements of the project have been refined.

All of the *Pultenaea parviflora* and *Marsdenia viridiflora* subsp. *viridiflora* records within the study area were made from habitat directly adjacent to the existing Northern Road and Kings Hill Road within Segment 1 that would be subject to road widening. There were no options for avoiding impacts to these species, as the existing road would be widened in this area instead of realigning the road.

Avoiding impacts to these species would require realignment of the existing Northern Road which would have greater impact than the widening.

For Segment 2 of the project, a Rapid Biodiversity Assessment (RBA) was undertaken in the area of the four short listed options under consideration. The aim of the RBA was to make an initial preliminary assessment of significant ecological values potentially affected by the Segment 2 short listed options to inform decision-making for a preferred route and thus inform the concept design and Environmental Assessment. The RBA involved desktop analysis and field surveys and included plot-based vegetation condition assessment, fauna habitat assessment and targeted searches for threatened species. An analysis of the biodiversity data was undertaken with reference to the short listed route options proposed (i.e. east vs west options). The analysis was undertaken within a GIS by overlaying the short listed options onto the vegetation mapping layer that showed TECs and known or potential habitat for threatened species. Potential worst-case impacts were quantified based on a 100-metre-wide corridor and considered impacts to TECs, further fragmentation of woodland, and the direct loss of vegetation / habitat. Impacts to TECs (i.e. Cumberland Plain Woodland and River-flat Eucalypt Forest) were estimated to be greater for the eastern option. The total loss of vegetation and habitat (including habitat for Regent Honeyeater, Cumberland Plain Land Snail) would be greatest with the eastern option. The Western Option was chosen for the project as there were predicted to be lesser impact to TECs and habitats.

4.21.1 Avoidance with the detailed design

The impact calculations as part of the BAR were based on a worst case scenario involving clearing of all vegetation and habitat within the construction boundary based on the EIS design. The detailed design shows the revised areas where construction will take place and where the final operational footprint would be positioned.

The detailed design has resulted in the following reduction of impact:

- Impact to native vegetation has decreased by 3.50 hectares over the original design.
- Impact to 4 *Marsdenia viridiflora* subsp. *viridiflora* plants along the DEOH fence has been avoided as this area won't be used for construction or operation.
- The impact to *Pultenaea parviflora* has increased to six plants after the additional targeted survey for *Pultenaea parviflora* and *Marsdenia viridiflora* subsp. *viridiflora* was undertaken in an expanded study area around the Vineyard Road extension on the 7th August 2017. Six *Pultenaea parviflora* plants were found in the area of the Vineyard Road extension of which four would be avoided as they are outside of the construction footprint.
- The impact to habitat for the EPBC Act listed species' Grey-headed Flying-fox, Regent Honeyeater, Swift Parrot and Large-eared Pied Bat has been reduced by 2.15 hectares.
- The impact to the TSC Act listed critically endangered Cumberland Plain Woodland in the Sydney Basin Bioregion ecological community has reduced by 2.96 hectares.
- The impact to the TSC Act listed River-Flat Eucalypt Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions endangered ecological community has been reduced by 0.43 hectares
- The impact to the EPBC Act listed critically endangered Cumberland Plain Shale Woodlands and Shale-Gravel Transition Forest ecological community has been reduced by 1.29 hectares.

4.22 Additional offsets for impacts to Cumberland Plain Woodland

Submission number(s)

27, 35

Issue description

- A respondent commented on the ineffectiveness of BioBanking as the only vehicle for offsetting losses
- OEH considers the loss of approximately 29.15 ha of moderate/good condition Cumberland Plain Woodland (including 1.25 ha in high condition), and associated indirect impacts resulting from fragmentation, to be unacceptable without the implementation of additional offsets (above those already calculated), supplementary measures or other actions.

Roads and Maritime are currently working in consultation with OEH to address this matter and determine the quantum of offsets or supplementary measures that are required. Supplementary measures at a landscape scale are being investigated in conjunction with the OEH.

Following recent discussions with Roads and Maritime, DoEE and OEH, it was decided that an additional supplementary measures package would be developed in consultation with OEH and DoEE with a focus on landscape scale measures within the local area. The package may include measures such as weed eradication programs within Cumberland Plain Woodland.

4.23 Measures to secure offsets

Submission number(s)

27, 35

Issue description

- Requests that Roads and Maritime procure land to be managed for conservation
- OEH recommends further information be provided detailing the measures that will be taken to secure the required credits for the Regent Honeyeater and *Marsdenia viridiflora* subsp. *viridiflora*.

The BOS identifies that no credits are available to meet the offset requirements for the Regent Honeyeater and *Marsdenia viridiflora* subsp. *viridiflora* - endangered population, but that land may be available (for future creation of credits) via an expression of interest on the BioBanking Public Register.

If credits for Regent Honeyeater and *Marsdenia viridiflora* subsp. *viridiflora* (or any other required credit) are unavailable for purchase on the market, the first step is that Roads and Maritime would work with public and private landholders to enter a BioBanking Agreement on their land and then purchase the credits issued.

4.24 Clearing of vegetation within the DEOH fence line for an access track

Submission number(s)

35

Issue description

OEH is aware that the Department of Defence will need to clear vegetation to provide vehicle access along the inside of the new fenceline in some parts of the project. OEH considers any clearing of vegetation required a consequence of the project should be addressed in the assessment of impacts. It is unclear if this has occurred. If not, an adjustment to the calculations of offset credits will be necessary prior to the approval of the BOS.

The potential loss of vegetation and habitat associated with the project is summarised in Table 3.3. The construction footprint would impact on up to about 40.79 hectares of native vegetation (see Table 3.3). This is a decrease of 3.50 hectares over the original design (the original impact to all Vegetation Zones was 44.29 hectares). These impacts have been quantified based on the development footprint after detailed design and take into consideration potential temporary disturbance during construction including compound sites and upgrading of drainage (refer to Section 3).

This revised design and associated re-calculation also takes into account the clearing that the Department of Defence will need to clear vegetation to provide vehicle access along the inside of the new fence line in some parts of the project.

4.25 Surveys constrained by property access

Submission number(s)

35

Issue description

The respondent noted that threatened species surveys for areas which were constrained by property access would need to be completed (and new calculations performed, if necessary) prior to finalisation of the BOS.

An additional targeted survey for *Pultenaea parviflora* and *Marsdenia viridiflora* subsp. *viridiflora* was undertaken in an expanded study area around the Vineyard Road extension on the 7th August 2017. This area was not able to be accessed during the fieldwork undertaken for the original assessment. An area of habitat of approximately 4.7 hectares was surveyed by an experienced botanist following the methods described in the *NSW Guide to Surveying Threatened Plants* (Office of Environment and Heritage, 2016). Traverses of this habitat were undertaken over a three-hour period for a distance of 3.131 kilometres (3,131 metres) (see Figure 3.1).

The survey located a further six *Pultenaea parviflora* plants (two of which were in the development footprint, and four outside of the footprint). No additional *Marsdenia viridiflora* subsp. *viridiflora* were recorded. The additional impact to *Pultenaea parviflora* has been included in the reassessment of impacts.

4.26 Watercourse crossings over key fish habitat

Submission number(s)

38

Issue description

DPI raised the following issues:

- Recommends that the design of any upgraded and/or new culverts incorporates naturalised bases and a combination of elevated "dry" cells to encourage terrestrial movement, and recessed "wet" cells to facilitate fish passage
- Recommends that the EIS include a mitigation measure and condition of approval to outline that all works on waterfront land would be carried out in accordance with the DPI Water Guidelines.

Watercourse crossings over key fish habitat (as mapped by DPI Fisheries) should be designed and constructed to maintain fish passage, in accordance with the DPI Fisheries Policy and guidelines for fish habitat conservation and management.

Five waterway crossings in the study area, including the revised footprint, have been identified as Type 1 – Key Fish Habitats (DPI 2013), as they contain a combination of native aquatic plants and/or woody snags. These watercourses are impacted, intermittently flowing waterways which are also

identified as Class 2 – Moderate Key Fish Habitat (Fairfull and Witheridge, 2003) due to the presence of limited in stream aquatic vegetation.

All watercourse crossings are to be designed in accordance with Policy and Guidelines for Fish Friendly Waterway Crossings and Fish Passage Requirements for Waterway Crossings (Fairfull and Witheridge 2003).

4.27 A Vegetation Management Plan should be developed in consultation with DPI Water.

Submission number(s)

38

Issue description

- DPI requested that a Vegetation Management Plan be developed in consultation with DPI Water
- DPI require the identification and mapping of riparian corridors and associated setbacks in accordance with the DPI Water *Guidelines for controlled activities on waterfront land* (2012), and measures for rehabilitation and/or riparian offsets as required.

A new mitigation measure would be added to the revised environmental management measures for the project as follows (refer to Section 5):

A Vegetation Management Plan would be prepared in consultation with DPI Water prior to construction commencing, including details on:

- The riparian corridor widths along the watercourses in proximity to the project (so that these areas can be avoided where possible)
- Riparian areas potentially temporarily or permanently impacted by the project
- The rehabilitation of riparian areas temporarily impacted
- Riparian offsets as required in accordance with DPI guidelines for the riparian areas permanently impacted.

The Vegetation Management Plan will include a scaled map should be provided which identifies:

- The riparian corridor widths in proximity to the project so that these areas can be avoided where possible
- Riparian areas potentially temporarily or permanently impacted by the project
- Rehabilitation and/or riparian offset areas as required. Where the project encroaches on the outer riparian corridor (outer 50% of the vegetated riparian zone) the activity will be offset by connecting an equivalent area to the riparian corridor to ensure the average width of the vegetated riparian zone can be achieved over the length of the watercourse.

4.28 Macroinvertebrate survey monitoring

Submission number(s)

38

Issue description

DPI requested clarification regarding why the EIS does not propose macroinvertebrate survey monitoring along the tributaries of Blaxland Creek on the DEOH lands (Commonwealth land), Badgerys Creek, and Cosgrove Creek.

Site inspections undertaken for the aquatic assessment were visual only, no fish surveys or macroinvertebrate surveys were undertaken. Due to the low likelihood of threatened fish species

being present, limited water availability and limited aquatic habitat, fish and macroinvertebrate surveys were deemed unnecessary at the EIS stage.

4.29 Revegetation of riparian areas

Submission number(s)

11, 29, 38

Issue description

The respondents raised the following issues:

- The Surveyors Creek Corridor should be capped with suitable Cumberland Plain Woodland substrate via soil translocation at the conclusion of earthworks
- The site should be restored to BAM/FBA-criteria functional Cumberland Plain Woodland, preferably through 'Grassy Groundcover' or similar techniques
- Penrith City Council commented that mitigation measures are not identified in detail. Three additional mitigation measures regarding seeding and reuse of topsoil were identified as follows:

- 1. Use of local provenance seed in all plantings.
- 2. All areas that are to be grassed are to use direct seeding of native grasses and herbs as per Greening Australia's Grassy Groundcover Restoration.
- 3. Reuse of topsoil from high quality bushland patches in vegetated fauna crossings and other areas to be revegetated.

- DPI recommends the following:

- 1. Topsoil (and seedbank) should be removed from native vegetation areas that are to be permanently cleared and relocated and used in the revegetation of riparian areas
- 2. Native plants should be transplanted from the areas to be permanently cleared to riparian land that is to be revegetated.

An urban design and landscape concept has been developed for the project as documented in the EIS, based on the project objectives and principles, to achieve an integrated design for the project. It incorporates the urban and landscape design concept plans for the project and a landscape planting concept including recommended species. As identified in the EIS, this would be adopted and further developed during detailed design and implemented as part of the Urban Design Landscape Plan (UDLP) for the project which is currently ongoing. There may be scope to include transplanting native species from areas to be cleared into revegetation areas but this would depend on the type of species being removed and the likely success of transplanting.

Plants to be used in revegetation would be sourced from local provenance seed where available and seed collection would be undertaken before clearing. There may be the opportunity for reuse of topsoil from cleared areas depending on the quality of the vegetation to be removed as the topsoil could contain a significant load of seed from exotic species and may not be suitable for reuse. Roads and Maritime would consider reuse of topsoil as part of the Urban Design Landscape Plan (UDLP) for the project.

5 Mitigation measures

Additional mitigation measures have been developed in response to the assessment of design refinements and in response to submissions. These are included in Table 5.1 and would be incorporated into the revised environmental management measures for the project.

Table 5.1: Revised environmental management measures – Biodiversity

Impact	Environmental management measures	Responsibility	Timing
Impacts to riparian corridors	Vegetation Management Plan would be prepared in consultation with DPI Water prior to construction commencing, including details on: • The riparian corridor widths along the watercourses in proximity to the project (so that these areas can be avoided where possible) • Riparian areas potentially temporarily or permanently impacted by the project • The rehabilitation of riparian areas temporarily impacted • Riparian offsets for the riparian areas permanently impacted. The Vegetation Management Plan would include a scaled map should be provided which identifies: • The riparian corridor widths in proximity to the project so that these areas can be avoided where possible • Riparian areas potentially temporarily or permanently impacted by the project • Riparian offset areas.	Construction contractor	Prior to construction
Revegetation	Roads and Maritime would consider reuse of topsoil as part of the Urban Design Landscape Plan (UDLP) for the project.	Roads and Maritime	Prior to construction
Revegetation	Roads and Maritime would consider transplanting native species from areas to be cleared into revegetation areas, depending on the type of species being removed and the likely success of transplanting. Plants to be used in revegetation would be sourced from local provenance seed where appropriate and available, and associated seed collection would be undertaken prior to clearing.	Roads and Maritime	Prior to construction

Impact	Environmental management measures	Responsibility	Timing
Impacts to *Marsdenia viridiflora* subsp. *viridiflora* and *Pultenaea parviflora*	Exclusion zones would be established around *Marsdenia viridiflora* subsp. *viridiflora* plants proposed to be retained in the area of the DEOH fence between Kings Hill Road and Longview Road, in accordance with standard Roads and Maritime procedure. Exclusion zones would be established around the four *Pultenaea parviflora* plants to be retained in the area of the Vineyard Road extension in accordance with Roads and Maritime procedure. Roads and Maritime will investigate options for salvage of genetic material and/or translocation of *Marsdenia viridiflora* subsp. *viridiflora* and *Pultenaea parviflora* plants that are to be impacted prior to construction.	Construction contractor	Construction

6 Conclusions and recommendations

6.1 Design refinements

There have been a number of design refinements during detailed design of the project, as outlined in Chapter 5 of the Submissions and Preferred Infrastructure Report. These design refinements have resulted in changes to the construction and operational footprints which have affected the calculated impacts of the project as assessed and presented within the Biodiversity Assessment Report (BAR) and subsequently presented within the environmental impact statement (EIS).

This Memorandum has provided a revised assessment of these impacts under the Framework for Biodiversity Assessment (FBA) including recalculation of landscape values, impacts to native vegetation (including threatened ecological communities), impacts to threatened species, and impacts to Matters of National Environmental Significance (MNES).

Overall, the design refinements during detailed design would result in a reduction of impacts to biodiversity and have resulted in further avoidance of impacts to ecological values. Indeed, the direct impact to threatened ecological communities and threatened species would also be reduced from those presented in the BAR assuming the implementation of all relevant revised environmental management measures for the project.

6.2 Issues raised by Stakeholders and the community

A number of submissions were received from stakeholder and the community during the EIS exhibition, including issues related to biodiversity.

The main comments made by community respondents related to:

- Dewatering and backfilling of dams and impacts to biodiversity
- Impacts on wildlife corridors and habitat connectivity
- Impacts to large remnant trees
- Impacts due to landscaping and lighting
- Impacts to Cumberland Plain Woodland
- The details of mitigation measures such as underpasses and staging of works
- Impacts to threatened species with the extension of Vineyard Road.

Government agency submissions were also received from the Office of Environment and Heritage (OEH) and the Department of Primary Industries (DPI) regarding a range of biodiversity related issues.

These have been addressed and responded to within this Memorandum, including further impact assessment and revised environmental management measures where required. These responses would be incorporated into the relevant sections of the Submissions and Preferred Infrastructure Report.

Appendix A – Raw field data sheets

RNS26 Mod/Good

BioBanking Field Sheet

Entered

Alluvial - Good

JACOBS

Survey Site Form - BioBanking		Site ID: P12-2		Vegetation zone: CRFF		
Date	18/11/2015	Surveyor(s):	LC			
Waypoint ID	076	Photo numbers	7353	→		7356
Coordinates	E 0286959	Photo direction	N	E	S	W
	N 6257714					
Mapped Vegetation type: CRFF		Condition:		Low	Mod/good	
Slope: Gentle, Mod, Steep	Aspect (degrees or cardinal): flat	Altitude: 66m				
Topography: crest, ridge, upper slope, mid slope, down slope, gully, flat, depression, watercourse, escarpment, terrace						
Geology: basalt, granite, conglomerate, sandstone, siltstone/mudstone, shale, alluvium, limestone, metamorphics, gravel, ?						
Soil type: sand, loam, clay, organic, gravel, skeletal, ?		Soil disturbance: intact, topsoil removed, fill				
Remnant / Old growth (uncleared): Yes / No / Undecided?						
Vegetative Structure (formation) =		Ecologically Dominant Layer (EDL) - most biomass =				

Strata	Height interval	Median	Est. cover	Dominant Species & Dominance
E	-			
T1	15-35m			Eucalyptus tereticornis
T2	8-10m			Eucalyptus tereticornis
T3	-			
S1	-			Eucalypt regen.
S2	-			
G	-			Sida, Microlaena (d), Bidens

Tree height (clino) level ground or top of slope = distance from tree x (top% + bottom%)

Tree height (clino) from bottom of slope = distance from tree x (top% - bottom%)

Definitions

Dominance d = dominant; c = co-dominant; s = subdominant; a = associated

Estimated cover i = isolated (0.2-2%); v = very sparse (2-20%); s = sparse (20-50%); m = mid dense (50-80%); d = dense (80-100%)

Walker & Hopkins height classes: 1-3m = dwarf; 3-8m = low; 6-12m = mid-high; 12-20m = tall; 20-35m = very tall; >35m = extremely tall

W&H Crown cover: <0.2% = isolated trees or clumps; 0.2-20% = open woodland; 20-50% = woodland; 50-80% = open forest; 80-100% = closed forest

50m Transect	10 Points - Foliage Projective Cover		
Point	Canopy % (photos)	Midstorey %	Exotic %
5m	30	0	0
10m	30		
15m	5		
20m	20		
25m	10		
30m	10		
35m	40		
40m	30		
45m	40		
50m	0		
Total (sum / 10) =	21.5	0	0

Ground cover tally sheet, 50 points along 50m transect - every 1m record if plant intersects (hits) point

	Total (hits/50)
Native grass tally - 𝍸 𝍸 𝍸 𝍸 𝍸	60%
Native other (herb, fern, sedge, etc) tally -	0%
Native shrub tally -	0%
Exotic tally - 𝍸 𝍸 𝍸 𝍸	40%

100%

Larger 50 x 20m plot	
Length of woody debris >10cm wide & >0.5m long	0
Proportion of canopy sp. regeneration	100%
Number of trees with hollows >5cm	2

JACOBS

Site ID: P12-2	Survey type: Quadrat 20m x 20m

	Species	Cover	Abund.		Species	Cover	Abund.
1	Eucalyptus tereticornis	+ 6	49	41			
2	Sida rhombifolia	4	20+	42			
3	Microlaena stipoides	+ 5	20+	43			
4	Bidens pilosa	3	20+	44	Dam/wetland - out of plot		
5	Araujia sericifera	2	20+	45			
6	Oxalis latifolia	1	1	46	Typha orientalis		
7	Cirsium vulgare	1	1	47	Juncus acutus		
8	Plantago lanceolata	1	1	48	cyclosperum leptophyllum		
9	Cyperus gracilis	+ 1	1	49	Blackberry		
10	Alternanthera pungens	+ 3	20+	50	Conyza		
11	Hypochaeris radicata	1	1	51	Trialochin		
12	Senecio madagascariensis	2	20+	52	Fireweed		
13	Anagallis arvensis	2	20+	53	Conyza		
14	Evolvulus sphaericus	+ 1	1	54	Centella		
15	Cyclosperum leptophyllum	2	20+	55	Eragrostis tenuifolia		
16	Conyza bonariensis	1	1	56	Juncus usitatus		
17	Glycine tabacina	+ 2	20+	57	Ludwigia - small		
18	Eriochloa pseudoacrotricha	+ 2	20+	58	Myriophyllum		
19	Rumex	1	1	59	Persicaria - purple splotch		
20	Opuntia stricta	1	2	60	Paspalum distichum		
21				61	Persicaria - shield leaf		
22				62	Sagittaria ?		
23				63	Rumex		
24				64	Sonchus		
25				65	Epilobium		
26				66	Nymphaea - pink		
27				67	Nardoo		
28				68			
29				69			
30				70			
31				71			
32				72			
33				73	Hakea sericea at road edge.		
34				74			
35				75			
36				76	678 - Angophora subvelutina - 1m dbh		
37				77			
38				78			
39				79			
40				80			

Sp. Richness	Native	Exotic
Tree	7	
Shrub		
Grass (annual)		
Grass (perennial)		
Other (annual)		
Other (perennial)		

Ground layer % 1x1 plots	Q1	Q2	Q3	Q4	Q5
Native perennial grass					
Native other grass					
Native forb & other					
Native shrub (<1m)					
Exotic grass					
Exotic forb & other					
Leaf & stick litter					
Rocks					
Bare ground					
Cryptogams					
Total	100	100	100	100	100

Cover abundance scale
Modified Braun-blanquet 6 scale

1	<5% - rare
2	<5% - common
3	5 - 25%
4	25 - 50%
5	50 - 75%
6	75 - 100%

Plot Disturbance	Fire damage:
Clearing (inc. logging):	Storm damage:
Cultivation (inc. pasture):	Trampling:
Soil erosion:	Flood damage:
Firewood collection:	Feral herbivores:
Stock grazing:	Other:

HN 526 Mod/Good Entered ✓

BioBanking Field Sheet

JACOBS

Alluvial - Good

Survey Site Form - BioBanking		Site ID: P12 - 1		Vegetation zone: ~~CRFF~~ CRFF - alluvial	
Date	18/11/2015	Surveyor(s):	LC		
Waypoint ID	673	Photo numbers	2345	→	2348
Coordinates	E 0286947 N 6257885	Photo direction	N	E	S	W
Mapped Vegetation type:	~~CRFF~~ CRFF	Condition:		Low	Mod/good
Slope: Gentle, Mod, Steep	Aspect (degrees or cardinal): flat	Altitude:	64m		

Topography: crest, ridge, upper slope, mid slope, down slope, gully, flat, depression, watercourse, escarpment, terrace

Geology: basalt, granite, conglomerate, sandstone, siltstone/mudstone, shale, alluvium, limestone, metamorphics, gravel, ?

Soil type: sand, loam, clay, organic, gravel, skeletal, ?

Soil disturbance: intact, topsoil removed, fill

Remnant / Old growth (uncleared): Yes / No / Undecided?

Vegetative Structure (formation) = Open forest

Ecologically Dominant Layer (EDL) - most biomass =

Strata	Height interval	Median	Est. cover	Dominant Species & Dominance
E	-			
T1	15-25m			Eucalyptus amplifolia Eucalyptus crebra
T2	-			
T3	1-8m			eucalyptus crebra
S1	-			
S2	-			
G	-			Sida rhombifolia, Eragrostis curvula Cobbitty Bidens, Moth Vine, Microlaena

Tree height (clino) level ground or top of slope = distance from tree x (top% + bottom%)

Tree height (clino) from bottom of slope = distance from tree x (top% - bottom%)

Definitions

Dominance d = dominant; c = co-dominant; s = subdominant; a = associated

Estimated cover i = isolated (0.2-2%); v = very sparse (2-20%); s = sparse (20-50%); m = mid dense (50-80%); d = dense (80-100%)

Walker & Hopkins height classes: 1-3m = dwarf; 3-6m = low; 6-12m = mid-high; 12-20m = tall; 20-35m = very tall; >35m = extremely tall

W&H Crown cover: <0.2% = isolated trees or clumps; 0.2-20% = open woodland; 20-50% = woodland; 50-80% = open forest; 80-100% = closed forest

50m Transect	10 Points - Foliage Projective Cover		
Point	Canopy % (photos)	Midstorey %	Exotic %
5m	10	0	0
10m	25	0	0
15m	20	0	0
20m	15	0	0
25m	0	0	0
30m	5	0	0
35m	40	0	0
40m	50	0	0
45m	30	0	0
50m	40	0	0
Total (sum / 10) =	23.5%	0	0

Larger 50 x 20m plot

Length of woody debris >10cm wide & >0.5m long: 47m

Proportion of canopy sp. regeneration: 100%

Number of trees with hollows >5cm: 3

Ground cover tally sheet, 50 points along 50m transect

- every 1m record if plant intersects (hits) point

	Total (hits/50)
Native grass tally - |||	6%
Native other (herb, fern, sedge, etc) tally - 𝍸 𝍸 𝍸 |	32%
Native shrub tally -	0%
Exotic tally - 𝍸 𝍸 𝍸 𝍸 𝍸 ||	54%

92%

JACOBS

Site ID: A12 - 1	Survey type: Quadrat 20m x 20m				
Species	Cover	Abund.	Species	Cover	Abund.
1 Eucalyptus amplifolia -	3	7	41		
2 Eucalyptus moluccana -	5	42	42		
3 Eragrostis curvula	3	12	43		
4 Araujia sericifera	2	20+	44		
5 Sida	3	20+	45		
6 Centella asiatica -	3	20+	46		
7 Plantago lanceolata	2	20+	47		
8 Microlaena stipoides -	4	20+	48		
9 Cymbopogon refractus -	1	1	49		
10 Senecio madagascariensis	2	20+	50		
11 Bidens pilosa	2	20+	51		
12 Cyperus gracilis -	2	20+	52		
13 Cyclospermum leptophyllum	2	20+	53		
14 Flowerbit	2	20+	54		
15 Cirsium vulgare	1	2	55		
16 Briza subaristata	2	20+	56		
17 Hypochaeris radicata	2	20+	57		
18 Pine	1	2	58		
19 Juncus usitatus -	1	1	59		
20 Brunoniella australis -	1	1	60		
21			61		
22			62		
23			63		
24			64		
25			65		
26			66		
27			67 GPS 674 & 675		
28			68		
29			69 large E. ~~amplifolia~~	2m	dbh
30			70 E. tereticornis		
31			71		
32			72		
33			73		
34			74		
35			75		
36			76		
37			77		
38			78		
39			79		
40			80		

Sp. Richness	Native	Exotic
Tree	8	
Shrub		
Grass (annual)		
Grass (perennial)		
Other (annual)		
Other (perennial)		

Ground layer % 1x1 plots	Q1	Q2	Q3	Q4	Q5
Native perennial grass					
Native other grass					
Native forb & other					
Native shrub (<1m)					
Exotic grass					
Exotic forb & other					
Leaf & stick litter					
Rocks					
Bare ground					
Cryptogams					
Total	100	100	100	100	100

Cover abundance scale
Modified Braun-blanquet 6 scale

1	<5% - rare
2	<5% - common
3	5 - 25%
4	25 - 50%
5	50 - 75%
6	75 - 100%

Plot Disturbance	Fire damage:
Clearing (inc. logging):	Storm damage:
Cultivation (inc. pasture):	Trampling:
Soil erosion:	Flood damage:
Firewood collection:	Feral herbivores:
Stock grazing:	Other:

HN526 Mod/Good

BioBanking Field Sheet

Alluvial - Good

Entered ✓

JACOBS

Survey Site Form - BioBanking		Site ID: P12-3	Vegetation zone: CPW			
Date	18/11/2015	Surveyor(s):	LC			
Waypoint ID	677	Photo numbers	2375	→		2378
Coordinates E / N		Photo direction	N	E	S	W
Mapped Vegetation type: CPW		Condition:			Low	Mod-good
Slope: Gentle, Mod, Steep (Flat)	Aspect (degrees or cardinal): Flat	Altitude: 68m				
Topography: crest, ridge, upper slope, mid slope, down slope, gully, flat, depression, watercourse, escarpment, terrace						
Geology: basalt, granite, conglomerate, sandstone, siltstone/mudstone, shale, alluvium, limestone, metamorphics, gravel, ?						
Soil type: sand, loam, clay, organic, gravel, skeletal, ?		Soil disturbance: intact, topsoil removed, fill				
Remnant / Old growth (uncleared): Yes (No) Undecided?						
Vegetative Structure (formation) = Open Forest		Ecologically Dominant Layer (EDL) - most biomass = canopy				

Strata	Height interval	Median	Est. cover	Dominant Species & Dominance
E	-			
T1	15-20m			Eucalyptus moluccana (d)
T2	6-8m			Angophora floribunda
T3	-			
S1	1-2m			Acacia parramattensis African olive Melia azedarach ?!
S2	-			
G	-			Microlaena stipoides Sida rhombifolia Cynodon dactylon

Tree height (clino) level ground or top of slope = distance from tree x (top% + bottom%)

Tree height (clino) from bottom of slope = distance from tree x (top% - bottom%)

Definitions

Dominance d = dominant; c = co-dominant; s = subdominant; a = associated

Estimated cover ! = isolated (0.2-2%); v = very sparse (2-20%); s = sparse (20-50%); m = mid dense (50-80%); d = dense (80-100%)

Walker & Hopkins height classes: 1-3m = dwarf; 3-6m = low; 6-12m = mid-high; 12-20m = tall; 20-35m = very tall; >35m = extremely tall

W&H Crown cover: <0.2% = isolated trees or clumps; 0.2-20% = open woodland; 20-50% = woodland; 50-80% = open forest; 80-100% = closed forest

50m Transect	10 Points - Foliage Projective Cover		
Point	Canopy % (photos)	Midstorey %	Exotic %
5m	0	0	0
10m	0	0	0
15m	50	0	0
20m	0	0	0
25m	0	0	0
30m	0	0	0
35m	60	0	0
40m	30	0	0
45m	10	0	0
50m	10	0	0
Total (sum / 10) =	16	0	0

Ground cover tally sheet, 50 points along 50m transect - every 1m record if plant intersects (hits) point

	Total (hits/50)
Native grass tally - 𝍸 𝍸 𝍸 𝍸	40%
Native other (herb, fern, sedge, etc) tally - 𝍸	10%
Native shrub tally -	0%
Exotic tally - 𝍸 𝍸 𝍸 𝍸 𝍸	50%

100%

Larger 50 x 20m plot	
Length of woody debris >10cm wide & >0.5m long	0m
Proportion of canopy sp. regeneration	100%
Number of trees with hollows >5cm	1

JACOBS

Site ID: P12-3	Survey type:Quadrat 20m x 20m

Species	Cover	Abund.	Species	Cover	Abund.
1 Eucalyptus melliodora	+ 3	3	41		
2 Angophora floribunda	+ 1	1	42		
3 Acacia parramattensis	+ 1	1	43		
4 Hakea sericea	+ 1	1	44		
5 Daviesia ulicifolia	+ 1	1	45		
6 Arthropodium minus	2	20+	46		
7 Microlaena stipoides	+ 4	20+	47		
8 Sida rhombifolia	2	20+	48		
9 Bidens pilosa	2	20+	49		
10 Brunoniella australis	+ 2	20+	50		
11 Anagallis arvensis	2	20+	51		
12 Senecio madagascariensis	2	20+	52		
13 Cirsium vulgare	1	1	53		
14 Glycine tabacina	+ 2	20+	54		
15 Plantago lanceolata	1	1	55		
16 Dichondra repens	+ 3	20+	56		
17 Conyza bonariensis	1	1	57		
18 Cyclospermum leptophyllum	1	20+	58		
19 Briza subaristata	1	1	59		
20 Centaurium	1	1	60		
21 Hypochaeris radicata	1	1	61		
22 Trifolium dichotomum	+ 2	20+	62		
23 Cymbopogon refractus	+ 2	5	63		
24 Oxalis corniculata	2	20+	64		
25 Richardia stellaris	1	1	65		
26 Phyllanthus / Euphorbia	+ 1	1	66		
27 Bursaria spinosa	+ 1	1	67 Glossocardia ?		
28 Olea europaea	1	1	68		
29 Oxalis - hairy	1	1	69		
30 Tiny Wahlenbergia	+ 1	C	70		
31 Vittadinia ?	+ 1	1	71		
32 Cynodon dactylon	+ 1	1	72		
33 Lomandra gracilis	+ 1	1	73		
34 large Wahlenbergia	+ 1	1	74		
35 Acaena novae-zelandiae	+ 1	1	75		
36			76		
37			77		
38			78		
39			79		
40			80		

Sp. Richness	Native	Exotic
Tree		
Shrub		
Grass (annual)	18	
Grass (perennial)		
Other (annual)		
Other (perennial)		

Ground layer % 1x1 plots	Q1	Q2	Q3	Q4	Q5
Native perennial grass					
Native other grass					
Native forb & other					
Native shrub (<1m)					
Exotic grass					
Exotic forb & other					
Leaf & stick litter					
Rocks					
Bare ground					
Cryptogams					
Total	100	100	100	100	100

Cover abundance scale
Modified Braun-blanquet 6 scale

1	<5% - rare
2	<5% - common
3	5 - 25%
4	25 - 50%
5	50 - 75%
6	75 - 100%

Plot Disturbance	Fire damage:
Clearing (inc. logging):	Storm damage:
Cultivation (inc. pasture):	Trampling:
Soil erosion:	Flood damage:
Firewood collection:	Feral herbivores:
Stock grazing:	Other:

HN 526 Mod/Good

JACOBS

BioBanking Field Sheet

Entered ✓

Alluvial - Good

Survey Site Form - BioBanking		Site ID: P13 - 4		Vegetation zone: CRFF		
Date	18/11/2014	Surveyor(s): LC				
Waypoint ID	679	Photo numbers	2382	→		2385
Coordinates	E N	Photo direction	N	E	S	W

Mapped Vegetation type: CRFF	Condition:	Low / Mod-good (circled)
Slope: Gentle (circled), Mod, Steep	Aspect (degrees or cardinal): flat	Altitude: 71m
Topography: crest, ridge, upper slope, mid slope, down slope, gully, flat, depression, watercourse (circled), escarpment, terrace		
Geology: basalt, granite, conglomerate, sandstone, siltstone/mudstone, shale, alluvium (circled), limestone, metamorphics, gravel, ?		
Soil type: sand, loam (circled), clay (circled), organic, gravel, skeletal, ?	Soil disturbance: intact (circled), topsoil removed, fill	
Remnant / Old growth (uncleared): Yes / No / Undecided? (No circled)		
Vegetative Structure (formation) = Open forest	Ecologically Dominant Layer (EDL) - most biomass = Canopy	

Strata	Height interval	Median	Est. cover	Dominant Species & Dominance
E	-			
T1	10 15m			E. tereticornis E. albens A. subvelutina E. moluccana
T2	-			
T3	-			Acacia parramattensis
S1	1 2m			Bursaria spinosa
S2	-			
G	-			Dichondra repens Glycine

Tree height (clino) level ground or top of slope = distance from tree x (top% + bottom%)

Tree height (clino) from bottom of slope = distance from tree x (top% - bottom%)

Definitions

Dominance d = dominant; c = co-dominant; s = subdominant; a = associated

Estimated cover i = isolated (0.2-2%); v = very sparse (2-20%); s = sparse (20-50%); m = mid dense (50-80%); d = dense (80-100%)

Walker & Hopkins height classes: 1-3m = dwarf; 3-6m = low; 6-12m = mid-high; 12-20m = tall; 20-35m = very tall; >35m = extremely tall

W&H Crown cover: <0.2% = isolated trees or clumps; 0.2-20% = open woodland; 20-50% = woodland; 50-80% = open forest; 80-100% = closed forest

50m Transect	10 Points - Foliage Projective Cover		
Point	Canopy % (photos)	Midstorey %	Exotic %
5m	30	10	0
10m	20	10	0
15m	20	10	0
20m	40	0	0
25m	40	10	0
30m	30	0	0
35m	30	0	0
40m	10	0	0
45m	5	10	0
50m	20	0	0
Total (sum / 10) =	24.5%	5%	0%

Larger 50 x 20m plot	
Length of woody debris >10cm wide & >0.5m long	7m
Proportion of canopy sp. regeneration	100%
Number of trees with hollows >5cm	1

Ground cover tally sheet, 50 points along 50m transect - every 1m record if plant intersects (hits) point

Tally	Total (hits/50)
Native grass tally - 𝍸 ||||	18%
Native other (herb, fern, sedge, etc) tally - 𝍸 𝍸 𝍸 𝍸 𝍸 𝍸 𝍸 |	72%
Native shrub tally -	0%
Exotic tally - ||||	8%

98%

JACOBS

Site ID: P12-4	Survey type: Quadrat 20m x 20m

	Species	Cover	Abund.		Species	Cover	Abund.
1	Angophora subvelutina	3	4	41			
2	Eucalyptus fastigata	5	20	42			
3	Eucalyptus ochrophloia	2	3	43			
4	Eucalyptus molluccana	1	2	44			
5	Banksia spinulosa	3	20+	45			
6	Dichondra repens	4	20+	46			
7	Microlaena stipoides	3	20+	47			
8	Glycine tabacina	2	20+	48			
9	Chrysocephalum	1	20+	49			
10	Acacia parramattensis	1	1	50			
11	Hovea linearis	1	1	51			
12	Cirsium, Carduaceae	2	20+	52			
13	Lomatia silaifolia	2	20+	53			
14	Senecio madagascariensis	1	1	54			
15	Cymbopogon refractus	1	1	55			
16	Acacia falcata	2	20+	56			
17	Opercularia diphylla	1	1	57			
18	Jacaranda	1	1	58			
19	Stackhousia	1	1	59			
20	Euphorbia	1	3	60			
21	Cirsium vulgare	1	1	61			
22				62			
23				63			
24				64			
25				65			
26				66			
27				67			
28				68			
29				69			
30				70			
31				71			
32				72			
33				73			
34				74			
35				75			
36				76			
37				77			
38				78			
39				79			
40				80			

Sp. Richness	Native	Exotic
Tree	17	
Shrub		
Grass (annual)		
Grass (perennial)		
Other (annual)		
Other (perennial)		

Ground layer % 1x1 plots	Q1	Q2	Q3	Q4	Q5
Native perennial grass					
Native other grass					
Native forb & other					
Native shrub (<1m)					
Exotic grass					
Exotic forb & other					
Leaf & stick litter					
Rocks					
Bare ground					
Cryptogams					
Total	100	100	100	100	100

Cover abundance scale
Modified Braun-blanquet 6 scale

1	<5% - rare
2	<5% - common
3	5 - 25%
4	25 - 50%
5	50 - 75%
6	75 - 100%

Plot Disturbance	Fire damage:
Clearing (inc. logging):	Storm damage:
Cultivation (inc. pasture):	Trampling:
Soil erosion:	Flood damage:
Firewood collection:	Feral herbivores:
Stock grazing:	Other:

HN526 Mod/Good-Poor

Entered ✓

BioBanking Field Sheet

JACOBS

site 46. Alluvial Mod/Good - Poor

Survey Site Form - BioBanking		Site ID: 200 Willowdene	Vegetation zone:			
Date	2/9/2015	Surveyor(s):	Lukas Clews			
Waypoint ID	46	Photo numbers	1243	1244	1242	
Coordinates	E N	Photo direction	N	E	S	W
Mapped Vegetation type:	CRW	Condition:			Low	Mod-good
Slope: Gentle, Mod, Steep		Aspect (degrees or cardinal): W	Altitude: 74m			

Topography: crest, ridge, upper slope, mid slope, down slope, gully, flat, depression, watercourse, escarpment, terrace

Geology: basalt, granite, conglomerate, sandstone, siltstone/mudstone, shale, alluvium, limestone, metamorphics, gravel, ?

Soil type: sand, loam, clay, organic, gravel, skeletal, ?

Soil disturbance: intact, topsoil removed, fill

Remnant / Old growth (uncleared): Yes / No / Undecided? Young trees grazed.

Vegetative Structure (formation) = Open forest

Ecologically Dominant Layer (EDL) - most biomass = Canopy

Strata	Height interval	Median	Est. cover	Dominant Species & Dominance
E	-			
T1	15-20m			Eucalyptus molluccana Eucalyptus tectricornis E. [illegible]? eugenioides
T2	-			
T3	-			
S1	-			Bursaria spinosa Olea europaea
S2	-			
G	-			Dichondra repens Cynodon dactylon Microlaena Solanum pinnatifidum

Tree height (clino) level ground or top of slope = distance from tree x (top% + bottom%)

Tree height (clino) from bottom of slope = distance from tree x (top% - bottom%)

Definitions

Dominance d = dominant; c = co-dominant; s = subdominant; a = associated

Estimated cover i = isolated (0.2-2%); v = very sparse (2-20%); s = sparse (20-50%); m = mid dense (50-80%); d = dense (80-100%)

Walker & Hopkins height classes: 1-3m = dwarf; 3-6m = low; 6-12m = mid-high; 12-20m = tall; 20-35m = very tall; >35m = extremely tall

W&H Crown cover: <0.2% = isolated trees or clumps; 0.2-20% = open woodland; 20-50% = woodland; 50-80% = open forest; 80-100% = closed forest

50m Transect	10 Points - Foliage Projective Cover		
Point	Canopy % (photos)	Midstorey %	Exotic %
5m	20	20	0
10m	10	0	0
15m	5	0	0
20m	30	0	0
25m	30	0	0
30m	20	0	0
35m	40	0	0
40m	50	0	0
45m	50	0	0
50m	25.5	2%	0%
Total (sum / 10) =	28.5	2.7	6%

Larger 50 x 20m plot

Length of woody debris >10cm wide & >0.5m long: 0

Proportion of canopy sp. regeneration: 100%

Number of trees with hollows >5cm: 0

Ground cover tally sheet, 50 points along 50m transect - every 1m record if plant intersects (hits) point

	Total (hits/50)
Native grass tally - IIII	8%
Native other (herb, fern, sedge, etc) tally - IIII IIII I	22%
Native shrub tally -	0%
Exotic tally - IIII IIII IIII III	36%

66%

JACOBS

Site ID: 46	Survey type:Quadrat 20m x 20m

Species	Cover	Abund.	Species	Cover	Abund.
1 Cymbonotus	2	6	41		
2 Solanum pinophyllum	2	20+	42		
3 Modiola caroliniana	2	20+	43		
4 Chickweed	2	20+	44		
5 Dichondra repens	3	20+	45		
6 Einadia hastata	2	20+	46		
7 Cirsium vulgare	2	20+	47		
8 Eucalyptus moluccana	5	40	48		
9 Eucalyptus tereticornis	2	4	49		
10 Bursaria spinosa	3	20	50		
11 Oxalis yellow	2	20+	51		
12 Conyza	2	20+	52		
13 Urtica incisa	2	20+	53		
14 Anagallis arvensis	2	20+	54		
15 Cyperus gracilis	2	20+	55		
16 Panicum dadostium	4	20+	56		
17 Casuarina glauca	1	1	57		
18 Olea europaea	2	20+	58		
19 Solanum prickly apple	1	1	59		
20 Plantago lanceolata	2	20+	60		
21 Glycine tabacina	2	20+	61		
22 Senecio madagascariensis	2	20+	62		
23 Lotus	2	20+	63		
24 Sida rhombifolia	2	20+	64		
25 Richardia	2	20+	65		
26 Poa annua	2	20+	66		
27 Lomandra confertifolia	1	3	67		
28 Sonchus oleraceus	1	1	68		
29 Arrhenatherum sericeum	1	1	69		
30 Cerastium	1	1	70		
31 Brassica	1	1	71		
32			72		
33			73		
34			74		
35			75		
36			76		
37			77		
38			78		
39			79		
40			80		

Sp. Richness	Native	Exotic
Tree	14	
Shrub		
Grass (annual)		
Grass (perennial)		
Other (annual)		
Other (perennial)		

Ground layer % 1x1 plots	Q1	Q2	Q3	Q4	Q5
Native perennial grass					
Native other grass					
Native forb & other					
Native shrub (<1m)					
Exotic grass					
Exotic forb & other					
Leaf & stick litter					
Rocks					
Bare ground					
Cryptogams					
Total	100	100	100	100	100

Cover abundance scale
Modified Braun-blanquet 6 scale

1	<5% - rare
2	<5% - common
3	5 - 25%
4	25 - 50%
5	50 - 75%
6	75 - 100%

Plot Disturbance	Fire damage:
Clearing (inc. logging):	Storm damage:
Cultivation (inc. pasture):	Trampling:
Soil erosion:	Flood damage:
Firewood collection:	Feral herbivores:
Stock grazing:	Other:

HN526 - Mod/Good - Poor

BioBanking Field Sheet

Entered ✓

JACOBS

Alluvial - Poor

Survey Site Form - BioBanking		Site ID: 39 - 1		Vegetation zone: CPW / RFEF		
Date	2/1/2015	Surveyor(s):				
Waypoint ID	39 - 1	Photo numbers	1245			
Coordinates	E N	Photo direction	N	E	S	W
Mapped Vegetation type: RFEF / CPW		Condition:			Low	Mod-good
Slope: Gentle, Mod, Steep	Aspect (degrees or cardinal): S	Altitude: 91 m				
Topography: crest, ridge, upper slope, mid slope, down slope, gully, flat, depression, watercourse, escarpment, terrace						
Geology: basalt, granite, conglomerate, sandstone, siltstone/mudstone, shale, alluvium, limestone, metamorphics, gravel, ?						
Soil type: sand, loam, clay, organic, gravel, skeletal, ?		Soil disturbance: intact, topsoil removed, fill				
Remnant / Old growth (uncleared): Yes / No / Undecided?		large trees				
Vegetative Structure (formation) = Open forest		Ecologically Dominant Layer (EDL) - most biomass = canopy				

Strata	Height interval	Median	Est. cover	Dominant Species & Dominance
E	-			
T1	20-25m			Eucalyptus moluccana Eucalyptus tereticornis Angophora floribunda
T2	-			
T3	-			
S1	2-6m			Acacia melanoxylon Olea europaea
S2	-			
G	-			Persicaria clandestinum Malva parviflora Themeda Fireweed Solanum, Vetch cruciata

Tree height (clino) level ground or top of slope = distance from tree x (top% + bottom%)

Tree height (clino) from bottom of slope = distance from tree x (top% - bottom%)

Definitions

Dominance d = dominant; c = co-dominant; s = subdominant; a = associated

Estimated cover i = isolated (0.2-2%); v = very sparse (2-20%); s = sparse (20-50%); m = mid dense (50-80%); d = dense (80-100%)

Walker & Hopkins height classes: 1-3m = dwarf; 3-6m = low; 6-12m = mid-high; 12-20m = tall; 20-35m = very tall; >35m = extremely tall

W&H Crown cover: <0.2% = isolated trees or clumps; 0.2-20% = open woodland; 20-50% = woodland; 50-80% = open forest; 80-100% = closed forest

50m Transect	10 Points - Foliage Projective Cover		
Point	Canopy % (photos)	Midstorey %	Exotic %
5m	40	0	0
10m	40	0	0
15m	20	0	0
20m	0	0	0
25m	0	0	0
30m	0	0	0
35m	0	0	0
40m	0	0	0
45m	20	10	0
50m	20	20	40
Total (sum / 10) =	15	3	4

Larger 50 x 20m plot

Length of woody debris >10cm wide & >0.5m long: 0m

Proportion of canopy sp. regeneration: 100%

Number of trees with hollows >5cm: 0

Ground cover tally sheet, 50 points along 50m transect - every 1m record if plant intersects (hits) point

Native grass tally - ||||| ||||| ||||| ||| — Total (hits/50): 36%

Native other (herb, fern, sedge, etc) tally - | — Total (hits/50): 2%

Native shrub tally - — Total (hits/50): 0%

Exotic tally - ||||| ||||| ||||| ||||| ||||| ||||| | — Total (hits/50): 62%

100%

JACOBS

Site ID: 39 - 1	Survey type:Quadrat 20m x 20m

	Species	Cover	Abund.		Species	Cover	Abund.
1	Eucalyptus maidurena	4	2	41			
2	Eucalyptus tereticornis	4	2	42			
3	Malva parviflora	3	20+	43			
4	Sonchus	3	20+	44			
5	Rumex crispus	2	20+	45			
6	Pennisetum clandestinum	5	20+	46			
7	Microlaena stipoides	3	20+	47			
8	Vicia sativa	2	20+	48			
9	Tetragonia tetragonoides	2	20+	49			
10	Cirsium vulgare	2	20+	50			
11	Medicago polymorpha	2	20+	51			
12	Solanum nigrum	1	1	52			
13	Senecio madagascariensis	2	20+	53			
14	Solanum prickly apple	1	1	54			
15	Plantago lanceolata	2	20+	55			
16	Acacia melanoxylon	3	3	56			
17	Lycium ferocissimum	1	1	57			
18	Bidens pilosa	1	1	58			
19	Ehrharta erecta	3	20+	59			
20	Taraxacum officinale	1	1	60			
21	Foeniculum vulgare	1	1	61			
22	Solanum pseudocapsicum	1	1	62			
23	chickweed	2	20+	63			
24	Chloris gayana	2	20+	64			
25	Cyperus sp.	1	1	65			
26	Romulea rosea	2	20+	66			
27	Geranium	1	1	67			
28	Hypochaeris radicata	2	20+	68			
29	Verbena bonariensis	1	1	69			
30	Eragrostis curvula	1	1	70			
31	Aristida sp. vagans	2	20+	71			
32	Chloris ventricosa	2	20+	72			
33	Themeda triandra	2	20+	73			
34	Cyperus gracilis	2	20+	74			
35	Conyza bonariensis	1	1	75			
36	Bromus catharticus	2	20+	76			
37				77			
38				78			
39				79			
40				80			

Sp. Richness	Native	Exotic
Tree		
Shrub		
Grass (annual)	11	
Grass (perennial)		
Other (annual)		
Other (perennial)		

Ground layer % 1x1 plots	Q1	Q2	Q3	Q4	Q5
Native perennial grass					
Native other grass					
Native forb & other					
Native shrub (<1m)					
Exotic grass					
Exotic forb & other					
Leaf & stick litter					
Rocks					
Bare ground					
Cryptogams					
Total	100	100	100	100	100

Cover abundance scale
Modified Braun-Blanquet 6 scale

1	<5% - rare
2	<5% - common
3	5 - 25%
4	25 - 50%
5	50 - 75%
6	75 - 100%

Plot Disturbance	Fire damage:
Clearing (inc. logging):	Storm damage:
Cultivation (inc. pasture):	Trampling:
Soil erosion:	Flood damage:
Firewood collection:	Feral herbivores:
Stock grazing:	Other:

HN 526 Mod/Good-Poor

BioBanking Field Sheet

Entered ✓

JACOBS

Alluvial- Poor

Survey Site Form - BioBanking		Site ID: 39-2	Vegetation zone: Gully CPW			
Date	2/9/2015	Surveyor(s): Lukas Clews				
Waypoint ID	39-2	Photo numbers	1259	1260	1261	
Coordinates	E N	Photo direction	N	E	S	W
Mapped Vegetation type: CPW ?		Condition:			Low	Mod-good
Slope: Gentle, Mod, Steep	Aspect (degrees or cardinal): NW	Altitude: 83m				
Topography: crest, ridge, upper slope, mid slope, down slope, gully, flat, depression, watercourse, escarpment, terrace						
Geology: basalt, granite, conglomerate, sandstone, siltstone/mudstone, shale, alluvium, limestone, metamorphics, gravel, ?						
Soil type: sand, loam, clay, organic, gravel, skeletal, ?		Soil disturbance: intact, topsoil removed, fill				
Remnant / Old growth (uncleared): Yes / No / Undecided?						
Vegetative Structure (formation) = Open Forest		Ecologically Dominant Layer (EDL) - most biomass = Canopy				

Strata	Height interval	Median	Est. cover	Dominant Species & Dominance
E	-			
T1	10-30m			Eucalyptus tereticornis Casuarina glauca
T2	-			
T3	2-8m			Olea europaea
S1	-			Bursaria spinosa Dillwynia sieberi
S2	-			
G	-			Aristida, Themeda, Didiandra clenatis

Tree height (clino) level ground or top of slope = distance from tree x (top% + bottom%)

Tree height (clino) from bottom of slope = distance from tree x (top% - bottom%)

Definitions

Dominance d = dominant; c = co-dominant; s = subdominant; a = associated

Estimated cover i = isolated (0.2-2%); v = very sparse (2-20%); s = sparse (20-50%); m = mid dense (50-80%); d = dense (80-100%)

Walker & Hopkins height classes: 1-3m = dwarf; 3-6m = low; 6-12m = mid-high; 12-20m = tall; 20-35m = very tall; >35m = extremely tall

W&H Crown cover: <0.2% = isolated trees or clumps; 0.2-20% = open woodland; 20-50% = woodland; 50-80% = open forest; 80-100% = closed forest

50m Transect	10 Points - Foliage Projective Cover		
Point	Canopy % (photos)	Midstorey %	Exotic %
5m	30	30	30
10m	0	0	100
15m	0	0	90
20m	20	10	0
25m	50	50	10
30m	30	5	60
35m	20	10	60
40m	30	10	70
45m	60	0	40
50m			
Total (sum / 10) =	24	11.5	46
Larger 50 x 20m plot			
Length of woody debris >10cm wide & >0.5m long			2m
Proportion of canopy sp. regeneration			100%
Number of trees with hollows >5cm			0

Ground cover tally sheet, 50 points along 50m transect

- every 1m record if plant intersects (hits) point

	Total (hits/50)
Native grass tally - 𝍸 𝍸 𝍸 𝍸 |	42%
Native other (herb, fern, sedge, etc) tally - 𝍸 𝍸 |||	26%
Native shrub tally -	0%
Exotic tally - 𝍸	10%

78%

JACOBS

Site ID: 39-2	Survey type:Quadrat 20m x 20m

Species	Cover	Abund.	Species	Cover	Abund.
1 Asparagus asparagoides -	2	20+	41		
2 Dillwynia sieberi -	4	20+	42		
3 Olea europaea	5	20+	43		
4 Eucalyptus tereticornis -	5	20+	44		
5 Bursaria spinosa -	3	20+	45		
6 Indigofera australis -	1	1	46		
7 Acacia floribunda -	1	1	47	- 3 main veins	
8 Dicondra repens -	2	20+	48		
9 Thereda -	3	20+	49		
10 Clematis -	2	20+	50		
11 Brunoniella australis -	2	20+	51		
12 Verbena	2	20+	52		
13 Glycine tabacina -	2	20+	53		
14 Aristida vagans -	4	20+	54		
15 Senecio madagascariensis	1	1	55		
16 Cirsium vulgare	1	1	56		
17 Desmodium varians -	1	1	57		
18 Glycine clandestina -	2	20+	58		
19 Convolvulus erubescens -	1	1	59		
20 Cyperus spp. -	1	1	60		
21 Centella asiatica -	1	1	61		
22 Casuarina glauca -	2	6	62		
23 Oplismenus aemulus -	1	R	63		
24 Ajuga australis -	1	1	64		
25 Lantana	1	1	65		
26 Geranium -	R	20+	66		
27 Cotula -	1	1	67		
28 Plectranthus parviflorus -	1	1	68		
29 Pratia purpurascens -	R	20+	69		
30 Bidens pilosa	1	1	70		
31 Ehrharta erecta	2	20+	71		
32 Taraxacum officinale	1	1	72		
33 Acacia falcata -	1	1	73		
34 Daviesia squarrosa -	1	1	74		
35 Eremophila debilis -	1	1	75		
36			76		
37			77		
38			78		
39			79		
40			80		

Sp. Richness	Native	Exotic
Tree	27	
Shrub		
Grass (annual)		
Grass (perennial)		
Other (annual)		
Other (perennial)		

Ground layer % 1x1 plots	Q1	Q2	Q3	Q4	Q5
Native perennial grass					
Native other grass					
Native forb & other					
Native shrub (<1m)					
Exotic grass					
Exotic forb & other					
Leaf & stick litter					
Rocks					
Bare ground					
Cryptogams					
Total	100	100	100	100	100

Cover abundance scale
Modified Braun-blanquet 6 scale

1	<5% - rare
2	<5% - common
3	5 - 25%
4	25 - 50%
5	50 - 75%
6	75 - 100%

Plot Disturbance	Fire damage:
Clearing (inc. logging):	Storm damage:
Cultivation (inc. pasture):	Trampling:
Soil erosion:	Flood damage:
Firewood collection:	Feral herbivores:
Stock grazing:	Other:

HNS26 Moderate / Good - Poor

BioBanking Field Sheet

Entered ✓

JACOBS

Alluvial - Poor

Survey Site Form - BioBanking		Site ID: 59	Vegetation zone: RFEF			
Date	2/9/2015	Surveyor(s):	Lukas clews			
Waypoint ID	59	Photo numbers				
Coordinates	E N	Photo direction	N	E	S	W
Mapped Vegetation type: RFEF		Condition:			Low	Mod-good
Slope: Gentle, Mod, Steep	Aspect (degrees or cardinal): SSW	Altitude: 82M				
Topography: crest, ridge, upper slope, mid slope, down slope, gully, flat, depression, watercourse, escarpment, terrace						
Geology: basalt, granite, conglomerate, sandstone, siltstone/mudstone, shale, alluvium, limestone, metamorphics, gravel, ?						
Soil type: sand, loam, clay, organic, gravel, skeletal, ?		Soil disturbance: intact, topsoil removed, fill				
Remnant / Old growth (uncleared): Yes / No / Undecided?						
Vegetative Structure (formation) =		Ecologically Dominant Layer (EDL) - most biomass =				

Strata	Height interval	Median	Est. cover	Dominant Species & Dominance
E	-			
T1	20 28m			Eucalyptus Eucalyptus nubilcan? Angophora
T2	-			
T3	-			
S1	1-2m			Bursaria spinosa Olea europea
S2	-			
G	-			Microlaena stipoides Cynodon dactylon Senecio madagascariensis Cirsium vulgare

Tree height (clino) level ground or top of slope = distance from tree x (top% + bottom%)

Tree height (clino) from bottom of slope = distance from tree x (top% - bottom%)

Definitions

Dominance d = dominant; c = co-dominant; s = subdominant; a = associated

Estimated cover i = isolated (0.2-2%); v = very sparse (2-20%); s = sparse (20-50%); m = mid dense (50-80%); d = dense (80-100%)

Walker & Hopkins height classes: 1-3m = dwarf; 3-6m = low; 6-12m = mid-high; 12-20m = tall; 20-35m = very tall; >35m = extremely tall

W&H Crown cover: <0.2% = isolated trees or clumps; 0.2-20% = open woodland; 20-50% = woodland; 50-80% = open forest; 80-100% = closed forest

50m Transect	10 Points - Foliage Projective Cover		
Point	Canopy % (photos)	Midstorey %	Exotic %
5m	5	10	0
10m	0	20	0
15m	5	10	0
20m	5	20	0
25m	40	15	0
30m	30	10	0
35m	20	10	0
40m	5	20	0
45m	10	5	0
50m	10	0	0
Total (sum / 10) =	13%	12%	0%

Larger 50 x 20m plot

Length of woody debris >10cm wide & >0.5m long: 5M

Proportion of canopy sp. regeneration: 100%

Number of trees with hollows >5cm: 0

Ground cover tally sheet, 50 points along 50m transect

- every 1m record if plant intersects (hits) point

Native grass tally - 𝍸 𝍸 𝍸 𝍸 𝍸 𝍸 𝍸 III — Total (hits/50): 76%

Native other (herb, fern, sedge, etc) tally - 𝍸 — Total (hits/50): 10%

94%

Native shrub tally - II — Total (hits/50): 4%

Exotic tally - II — Total (hits/50): 4%

JACOBS

Site ID: 59	Survey type:Quadrat 20m x 20m

Species	Cover	Abund.	Species	Cover	Abund.
1 Indigofera australis -	2	2	41		
2 chickweed	2	20+	42		
3 Microlaena stipoides -	4	20+	43		
4 Oxalis yellow -	2	20+	44		
5 Dichondra repens -	2	20+	45		
6 Glycine dadistina -	2	20+	46		
7 Senecio madagascariensis	2	20+	47		
8 Hypochaeris radicata	2	20+	48		
9 Cirsium vulgare	2	20+	49		
10 Asperula conferta -	2	20+	50		
11 Glycine tabacina -	2	20+	51		
12 Plantago lanceolata	2	20+	52		
13 Bursaria spinosa -	4	20+	53		
14 Eucalyptus melliodora -	5	24	54		
15 Eucalyptus tereticornis -	3	3	55		
16 Geranium sp. -	3	20+	56		
17 Convolvulus erubescens -	1	1	57		
18 Trifolium repens	2	20+	58		
19 Oxalis yellow -	1	20+	59		
20 Brunoniella australis -	2	20+	60		
21 Sida rhombifolia	1	2	61		
22 Arrapleva sp. -	1	1	62		
23 Rumex crispus	1	1	63		
24 Plectranthus parviflorus -	1	2	64		
25 Olea europaea	3	20+	65		
26 Modiola caroliniana	1	1	66		
27 Hypochaeris radicata	1	20+	67		
28 Cotula -	1	20+	68		
29 Aristida -	3	20+	69		
30 Lotus sp.	1	1	70		
31 Blackberry	2	2	71		
32 Solanum / spiky apple	1	1	72		
33			73		
34			74		
35			75		
36			76		
37			77		
38			78		
39			79		
40			80		

Sp. Richness	Native	Exotic
Tree	18	
Shrub		
Grass (annual)		
Grass (perennial)		
Other (annual)		
Other (perennial)		

Ground layer % 1x1 plots	Q1	Q2	Q3	Q4	Q5
Native perennial grass					
Native other grass					
Native forb & other					
Native shrub (<1m)					
Exotic grass					
Exotic forb & other					
Leaf & stick litter					
Rocks					
Bare ground					
Cryptogams					
Total	100	100	100	100	100

Cover abundance scale
Modified Braun-blanquet 6 scale

1	<5% - rare
2	<5% - common
3	5 - 25%
4	25 - 50%
5	50 - 75%
6	75 - 100%

Plot Disturbance		Fire damage:	
Clearing (inc. logging):		Storm damage:	
Cultivation (inc. pasture):		Trampling:	
Soil erosion:		Flood damage:	
Firewood collection:		Feral herbivores:	
Stock grazing:		Other:	

HN526 Mod/Good - Poor

BioBanking Field Sheet

Alluvial - Poor

JACOBS

Survey Site Form - BioBanking		Site ID: 60		Vegetation zone: RFEF		
Date	3/9/2015	Surveyor(s): Lukas Clews				
Waypoint ID	60	Photo numbers	1276	1277		
Coordinates	E N	Photo direction	N	E	S	W
Mapped Vegetation type: RFEF		Condition:			Low	Mod-good
Slope: Gentle, Mod, Steep	Aspect (degrees or cardinal)	Altitude: 73m				
Topography: crest, ridge, upper slope, mid slope, down slope, gully, flat, depression, watercourse, escarpment, terrace						
Geology: basalt, granite, conglomerate, sandstone, siltstone/mudstone, shale, alluvium, limestone, metamorphics, gravel, ?						
Soil type: sand, loam, clay, organic, gravel, skeletal, ?		Soil disturbance: intact, topsoil removed, fill				
Remnant / Old growth (uncleared): Yes / No / Undecided?						
Vegetative Structure (formation) = Open Forest		Ecologically Dominant Layer (EDL) - most biomass = Canopy				

Strata	Height interval	Median	Est. cover	Dominant Species & Dominance
E	-			
T1	20 25m			Eucalyptus tereticornis (d) Eucalyptus eugenioides
T2	-			
T3	-			
S1	-			Acacia implexa Acacia parramattensis Bursaria spinosa
S2	-			Olea europaea
G	-			Microlaena stipoides Dichondra repens Sonchus oleraceus

Tree height (clino) level ground or top of slope = distance from tree x (top% + bottom%)

Tree height (clino) from bottom of slope = distance from tree x (top% - bottom%)

Definitions

Dominance d = dominant; c = co-dominant; s = subdominant; a = associated

Estimated cover i = isolated (0.2-2%); v = very sparse (2-20%); s = sparse (20-50%); m = mid dense (50-80%); d = dense (80-100%)

Walker & Hopkins height classes: 1-3m = dwarf; 3-6m = low; 6-12m = mid-high; 12-20m = tall; 20-35m = very tall; >35m = extremely tall

W&H Crown cover: <0.2% = isolated trees or clumps; 0.2-20% = open woodland; 20-50% = woodland; 50-80% = open forest; 80-100% = closed forest

50m Transect	10 Points - Foliage Projective Cover		
Point	Canopy % (photos)	Midstorey %	Exotic %
5m	5	40	0
10m	0	60	0
15m	30	90	0
20m	40	25	0
25m	60	25	0
30m	30	20	0
35m	0	0	0
40m	0	0	0
45m	5	20	0
50m	0	50	0
Total (sum / 10) =	17	33	0

Ground cover tally sheet, 50 points along 50m transect - every 1m record if plant intersects (hits) point

	Total (hits/50)
Native grass tally - 38	76%
Native other (herb, fern, sedge, etc) tally - 5	10%
Native shrub tally -	0%
Exotic tally - 6	12%

98%

Larger 50 x 20m plot	
Length of woody debris >10cm wide & >0.5m long	0m
Proportion of canopy sp. regeneration	100%
Number of trees with hollows >5cm	0

JACOBS

Site ID: 60	Survey type: Quadrat 20m x 20m

	Species	Cover	Abund.		Species	Cover	Abund.
1	Eucalyptus tereticornis -	4	3	41			
2	Acacia implexa -	3	8	42			
3	Acacia pravramattensis -	2	4	43			
4	Bursaria spinosa -	3	20+	44			
5	Olea europaea	4	20+	45			
6	~~Carduus~~ sp. ? Scaevola -	1	5	46	Scaevola albida		
7	Sida rhombifolia	2	20+	47			
8	Senecio madagascariensis	2	20+	48			
9	Microlaena stipoides -	6	20+	49			
10	Plantago lanceolata	2	20+	50			
11	Cirsium vulgare	1	1	51			
12	Rubus fruticosus	1	1	52			
13	Dichondra repens -	2	20+	53			
14	Araujia sericifera	2	20+	54			
15	Geitonoplesium -	1	1	55			
16	Clematis -	2	20+	56			
17	Oplismenus aemulus -	3	20+	57			
18	Oxalis - hairy	2	20+	58			
19	Convolvulus erubescens -	2	20+	59			
20	Hypochaeris radicata	1	1	60			
21	Native Blackberry -	1	1	61			
22	Bidens pilosa	1	1	62			
23	Verbena	1	1	63			
24	Galium fat -	2	20+	64			
25	Cliche weed	1	1	65			
26	Trifolium repens	1	1	66			
27	Geranium -	2	20+	67			
28	Glycine clandestina -	1	1	68			
29	Vicia sativa	1	1	69			
30	Glycine tabacina -	1	1	70			
31	Hypericum	1	1	71			
32	Lonicera -	1	1	72			
33				73			
34				74			
35				75			
36				76			
37				77			
38				78			
39				79			
40				80			

Sp. Richness	Native	Exotic
Tree		
Shrub		
Grass (annual)		
Grass (perennial)		
Other (annual)		
Other (perennial)		

Ground layer % 1x1 plots	Q1	Q2	Q3	Q4	Q5
Native perennial grass					
Native other grass					
Native forb & other					
Native shrub (<1m)					
Exotic grass					
Exotic forb & other					
Leaf & stick litter					
Rocks					
Bare ground					
Cryptogams					
Total	100	100	100	100	100

Cover abundance scale
Modified Braun-blanquet 6 scale

1	<5% - rare
2	<5% - common
3	5 - 25%
4	25 - 50%
5	50 - 75%
6	75 - 100%

Plot Disturbance	Fire damage:
Clearing (inc. logging):	Storm damage:
Cultivation (inc. pasture):	Trampling:
Soil erosion:	Flood damage:
Firewood collection:	Feral herbivores:
Stock grazing:	Other:

HN 528 Mod/Good

Shale Plains Mod/Good

BioBanking Field Sheet

Entered ✓

JACOBS

1655 Northern Rd

Survey Site Form - BioBanking		Site ID: [redacted] 16	Vegetation zone: RFEF roadside			
Date	3/9/2015	Surveyor(s):	Lukas Clews			
Waypoint ID	[redacted] 16	Photo numbers	1267			
Coordinates	E / N	Photo direction	N	E	S	W
Mapped Vegetation type: RFEF		Condition:			Low	Mod-good
Slope: Gentle, Mod, Steep	**Aspect (degrees or cardinal):** flat	**Altitude:** 80m				

Topography: crest, ridge, upper slope, mid slope, down slope, gully, flat, depression, watercourse, escarpment, terrace

Geology: basalt, granite, conglomerate, sandstone, siltstone/mudstone, shale, alluvium, limestone, metamorphics, gravel, ?

Soil type: sand, loam, clay, organic, gravel, skeletal, ?

Soil disturbance: intact, topsoil removed, fill

Remnant / Old growth (uncleared): Yes / No / Undecided?

Vegetative Structure (formation) = Open Forest

Ecologically Dominant Layer (EDL) - most biomass = canopy

Strata	Height interval	Median	Est. cover	Dominant Species & Dominance
E	-			
T1	15-20m			Eucalyptus tricornis (d) Eucalyptus moluccana (cd)
T2	-			
T3	-			
S1	1-6m			olea europaea
S2	-			
G	-			Aristida chloris gayana Ehrharta erecta Hordeum sp. Commelina Kikuyu

Tree height (clino) level ground or top of slope = distance from tree x (top% + bottom%)

Tree height (clino) from bottom of slope = distance from tree x (top% - bottom%)

Definitions

Dominance d = dominant; c = co-dominant; s = subdominant; a = associated

Estimated cover i = isolated (0.2-2%); v = very sparse (2-20%); s = sparse (20-50%); m = mid dense (50-80%); d = dense (80-100%)

Walker & Hopkins height classes: 1-3m = dwarf; 3-6m = low; 6-12m = mid-high; 12-20m = tall; 20-35m = very tall; >35m = extremely tall

W&H Crown cover: <0.2% = isolated trees or clumps; 0.2-20% = open woodland; 20-50% = woodland; 50-80% = open forest; 80-100% = closed forest

50m Transect	10 Points - Foliage Projective Cover		
Point	Canopy % (photos)	Midstorey %	Exotic %
5m	40	10	30
10m	40	0	0
15m	20	0	0
20m	60	0	0
25m	60	0	0
30m	40	0	0
35m	40	0	0
40m	50	0	0
45m	20	0	0
50m	40	0	0
Total (sum / 10) =	41	1	3

Larger 50 x 20m plot

Length of woody debris >10cm wide & >0.5m long: 1m

Proportion of canopy sp. regeneration: 100%

Number of trees with hollows >5cm: 0

Ground cover tally sheet, 50 points along 50m transect - every 1m record if plant intersects (hits) point

	Total (hits/50)
Native grass tally -	0%
Native other (herb, fern, sedge, etc) tally - 1	2% (98%)
Native shrub tally -	0%
Exotic tally - ||||| ||||| ||||| ||||| ||||| ||||| ||||| |||	96%

JACOBS Narrow Linear Plot to get Roadside veg.

Site ID: ~~529~~ 16

Survey type: Quadrat ~~20m x 20m~~ 10 x 40m

Species	Cover	Abund.	Species	Cover	Abund.
1 Eucalyptus tereticornis –	1	20	41		
2 Eucalyptus moluccana –	1	2	42		
3 Olea europaea	5	20+	43		
4 Hardenbergia violacea –	2	20+	44		
5 Bidens pilosa	2	20+	45		
6 Ehrharta erecta	4	20+	46		
7 Plantago lanceolata	2	20+	47		
8 Dichondra repens –	2	20+	48		
9 Commelina cyanea –	2	20+	49		
10 Modiola	2	20+	50		
11 Solanum pinnatifolium –	2	20+	51		
12 Eragrostis curvula	3	20+	52		
13 Araujia sericifera	2	20+	53		
14 Carrot tops	2	20+	54		
15 Wahlenbergia –	1	1	55		
16 Cirsium vulgare	1	1	56		
17 Einadia nutans –	1	1	57		
18 Pennisetum clandestinum	4	20+	58		
19 Einadia hastata –	1	1	59		
20 Sida rhombifolia	2	20+	60		
21 Rumex crispus	1	4	61		
22 Chloris gayana	2	20+	62		
23 Cyperus gracilis –	1	1	63		
24 Setaria	2	20+	64		
25 Chickweed	2	20+	65		
26 Verbena bonariensis	1	1	66		
27 Aristida vagans –	3	20+	67		
28 Senecio madagascariensis	1	1	68		
29 Sonchus oleraceus	1	2	69		
30 Alternanthera dent –	1	2	70		
31 Fumaria muralis	1	1	71		
32 Solanum sp. prickly apple	1	1	72		
33			73		
34			74		
35			75		
36			76		
37			77		
38			78		
39			79		
40			80		

Sp. Richness	Native	Exotic
Tree	12	
Shrub		
Grass (annual)		
Grass (perennial)		
Other (annual)		
Other (perennial)		

Ground layer % 1x1 plots	Q1	Q2	Q3	Q4	Q5
Native perennial grass					
Native other grass					
Native forb & other					
Native shrub (<1m)					
Exotic grass					
Exotic forb & other					
Leaf & stick litter					
Rocks					
Bare ground					
Cryptogams					
Total	100	100	100	100	100

Cover abundance scale
Modified Braun-blanquet 6 scale

1	<5% - rare
2	<5% - common
3	5 - 25%
4	25 - 50%
5	50 - 75%
6	75 - 100%

Plot Disturbance	
Clearing (inc. logging):	Fire damage:
Cultivation (inc. pasture):	Storm damage:
Soil erosion:	Trampling:
Firewood collection:	Flood damage:
Stock grazing:	Feral herbivores:
	Other:

HN528 Mod/good

BioBanking Field Sheet

Entered ✓

JACOBS

Shale Plains – Mod/good

Survey Site Form - BioBanking		Site ID: Defence 2	Vegetation zone: SHW CPW			
Date	1/10/2015	Surveyor(s):	Lukas Jones			
Waypoint ID	658	Photo numbers	2240	→		2244
Coordinates	E 285626 N 6254457	Photo direction	N	E	S	W
Mapped Vegetation type: CPW		Condition:		Low	(Mod/good)	
Slope: Gentle, Mod, Steep	Aspect (degrees or cardinal): NE	Altitude: 92m				
Topography: crest, ridge, upper slope, mid slope, down slope, gully, flat, depression, watercourse, escarpment, terrace						
Geology: basalt, granite, conglomerate, sandstone, siltstone/mudstone, shale, alluvium, limestone, metamorphics, gravel, ?						
Soil type: sand, loam, clay, organic, gravel, skeletal, ?		Soil disturbance: intact, topsoil removed, fill				
Remnant / Old growth (uncleared): Yes / No / Undecided?						
Vegetative Structure (formation) = Open forest		Ecologically Dominant Layer (EDL) - most biomass = Canopy				

Strata	Height interval	Median	Est. cover	Dominant Species & Dominance
E	-			
T1	15-25m			Eucalyptus moluccana Eucalyptus fibrosa
T2	-			
T3	-			
S1	-			Acacia falcata Dillwynia sieberi Daviesia
S2	-			
G	-			Chloris gayana Themeda triandra Eragrostis curvula

Tree height (clino) level ground or top of slope = distance from tree x (top% + bottom%)

Tree height (clino) from bottom of slope = distance from tree x (top% - bottom%)

Definitions

Dominance d = dominant; c = co-dominant; s = subdominant; a = associated

Estimated cover i = isolated (0.2-2%); v = very sparse (2-20%); s = sparse (20-50%); m = mid dense (50-80%); d = dense (80-100%)

Walker & Hopkins height classes: 1-3m = dwarf; 3-6m = low; 6-12m = mid-high; 12-20m = tall; 20-35m = very tall; >35m = extremely tall

W&H Crown cover: <0.2% = isolated trees or clumps; 0.2-20% = open woodland; 20-50% = woodland; 50-80% = open forest; 80-100% = closed forest

50m Transect	10 Points - Foliage Projective Cover		
Point	Canopy % (photos)	Midstorey %	Exotic %
5m	10	0	0
10m	0	20	0
15m	0	20	0
20m	5	30	0
25m	0	30	0
30m	0	20	0
35m	0	10	0
40m	0	0	0
45m	0	40	0
50m	20	0	0
Total (sum / 10) =	3.5	17	0

Larger 50 x 20m plot

Length of woody debris >10cm wide & >0.5m long	0m
Proportion of canopy sp. regeneration	100%
Number of trees with hollows >5cm	0

Ground cover tally sheet, 50 points along 50m transect - every 1m record if plant intersects (hits) point

	Total (hits/50)
Native grass tally - 𝍸 𝍸 𝍸 𝍸 𝍸 𝍸 𝍸 |	72%
Native other (herb, fern, sedge, etc) tally - ||	4%
Native shrub tally -	0%
Exotic tally - 𝍸 𝍸 ||	24%

100%

JACOBS

Site ID: Defence 2	Survey type:Quadrat 20m x 20m						
	Species	**Cover**	**Abund.**		**Species**	**Cover**	**Abund.**
1	Eucalyptus moluccana	3	2	41			
2	Acacia falcata	4	20+	42			
3	Dillwynia sieberi	3	10	43			
4	Eragrostis curvula	3	20+	44			
5	Themeda triandra	4	20+	45			
6	Chloris gayana	3	20+	46			
7	Senecio madagascariensis	1	4	47			
8	Plantago lanceolata	2	20+	48			
9	Dichondra repens	2	20+	49			
10	Cheilanthes sieberi	1	2	50			
11	Goodenia hederacea	2	20+	51			
12	Hypericum gramineum	1	1	52			
13	Hardenbergia violacea	1	4	53			
14	Glycine tabacina	1	1	54			
15	Verbena	1	1	55			
16	Briza subaristata	3	20+	56			
17	Centella asiatica	2	20+	57			
18	Bidens pilosa	1	1	58			
19				59			
20				60			
21				61			
22				62			
23	670 - E. fibrosa x2 - outside plot			63			
24				64			
25				65			
26				66			
27				67			
28				68			
29				69			
30				70			
31				71			
32				72			
33				73			
34				74			
35				75			
36				76			
37				77			
38				78			
39				79			
40				80			

Sp. Richness	Native	Exotic
Tree	11	
Shrub		
Grass (annual)		
Grass (perennial)		
Other (annual)		
Other (perennial)		

Ground layer % 1x1 plots	Q1	Q2	Q3	Q4	Q5
Native perennial grass					
Native other grass					
Native forb & other					
Native shrub (<1m)					
Exotic grass					
Exotic forb & other					
Leaf & stick litter					
Rocks					
Bare ground,					
Cryptogams					
Total	100	100	100	100	100

Cover abundance scale
Modified Braun-blanquet 6 scale

1	<5% - rare
2	<5% - common
3	5 - 25%
4	25 - 50%
5	50 - 75%
6	75 - 100%

Plot Disturbance	
Clearing (inc. logging):	Fire damage:
Cultivation (inc. pasture):	Storm damage:
Soil erosion:	Trampling:
Firewood collection:	Flood damage:
Stock grazing:	Feral herbivores:
	Other:

HN528 Mod/Good

BioBanking Field Sheet

Entered ✓

JACOBS

Shale Plains - Mod/Good

Survey Site Form - BioBanking		Site ID: Marsdenia 1	Vegetation zone: CPW			
Date	1/10/2015	Surveyor(s):	Lukas Clews			
Waypoint ID	656	Photo numbers	2203	→		2229
Coordinates	E 285709	Photo direction	N	E	S	W
	N 6254892					

2232
2234

Mapped Vegetation type: CPW		Condition:	Low	Mod-good
Slope: Gentle, Mod, Steep	Aspect (degrees or cardinal): flat	Altitude: 93m		

Topography: crest, ridge, upper slope, mid slope, down slope, gully, flat, depression, watercourse, escarpment, terrace

Geology: basalt, granite, conglomerate, sandstone, siltstone/mudstone, shale, alluvium, limestone, metamorphics, gravel, ?

Soil type: sand, loam, clay, organic, gravel, skeletal, ?	Soil disturbance: intact, topsoil removed, fill	

Remnant / Old growth (uncleared): Yes / No / Undecided?

Vegetative Structure (formation) =

Ecologically Dominant Layer (EDL) - most biomass =

Strata	Height interval	Median	Est. cover	Dominant Species & Dominance
E	-			
T1	-			Eucalyptus melliodora
T2	-			
T3	-			
S1	-			Acacia parramattensis Acacia falcata
S2	-			
G	-			Eragrostis curvula Themeda triandra Chloris gayana Aristida

Tree height (clino) level ground or top of slope = distance from tree x (top% + bottom%)

Tree height (clino) from bottom of slope = distance from tree x (top% - bottom%)

Definitions

Marsdenia viridiflora habitat.

Dominance d = dominant; c = co-dominant; s = subdominant; a = associated

Estimated cover i = isolated (0.2-2%); v = very sparse (2-20%); s = sparse (20-50%); m = mid dense (50-80%); d = dense (80-100%)

Walker & Hopkins height classes: 1-3m = dwarf; 3-8m = low; 8-12m = mid-high; 12-20m = tall; 20-35m = very tall; >35m = extremely tall

W&H Crown cover: <0.2% = isolated trees or clumps; 0.2-20% = open woodland; 20-50% = woodland; 50-80% = open forest; 80-100% = closed forest

50m Transect	10 Points - Foliage Projective Cover		
Point	Canopy % (photos)	Midstorey %	Exotic %
5m	20	0	0
10m	10	5	0
15m	5	0	0
20m	10	0	0
25m	5	0	0
30m	0	0	0
35m	40	0	0
40m	40	0	0
45m	10	0	0
50m			
Total (sum / 10) =	14%	0.5	0%

Ground cover tally sheet, 50 points along 50m transect - every 1m record if plant intersects (hits) point

	Total (hits/50)
Native grass tally - 𝍸 𝍸 𝍸 𝍸 |	22%
Native other (herb, fern, sedge, etc) tally - 𝍸	10%
Native shrub tally -	0%
Exotic tally - 𝍸 𝍸 𝍸 𝍸	20%

42%

Larger 50 x 20m plot	
Length of woody debris >10cm wide & >0.5m long	0m
Proportion of canopy sp. regeneration	100%
Number of trees with hollows >5cm	1

JACOBS

Site ID: Marsdenia 1

Survey type: Quadrat 20m x 20m

Species	Cover	Abund.	Species	Cover	Abund.
1 Eucalyptus moluccana -	5	9	41		
2 Marsdenia viridiflora +	1	5?	42 als 657 - E. tereticornis		
3 Araujia sericifera	1	2	43		
4 Themeda triandra -	4	20+	44		
5 Chloris gayana	4	20+	45		
6 Eragrostis curvula	4	20+	46		
7 Bidens pilosa	1	1	47		
8 Senecio madagascariensis	2	10	48		
9 Brunoniella australis +	3	20+	49		
10 Dichondra repens +	3	20+	50		
11 Plantago lanceolata	2	20+	51		
12 Hypochaeris radicata	2	20+	52		
13 Sonchus oleraceus	1	2	53		
14 Dianella longifolia +	1	1	54		
15 Einadia nutans +	1	1	55		
16 Glycine tabacina +	2	20+	56		
x2 17 Vittadinia sp. +	1	1	57		
18 Arthropodium milleflorum +	1	1	58		
19 Acacia parramattensis +	1	2	59		
20 Succulent sedum	1	1	60		
21 Acacia falcata +	1	1	61		
22 Aristida vagans +	1	1	62		
23 Hardenbergia violacea +	1	1	63		
24 Eremophila debilis +	1	1	64		
25			65		
26			66		
27			67		
28			68		
29			69		
30			70		
31			71		
32			72		
33			73		
34			74		
35			75		
36			76		
37			77		
38			78		
39			79		
40			80		

Sp. Richness	Native	Exotic
Tree	15	
Shrub		
Grass (annual)		
Grass (perennial)		
Other (annual)		
Other (perennial)		

Ground layer % 1x1 plots	Q1	Q2	Q3	Q4	Q5
Native perennial grass					
Native other grass					
Native forb & other					
Native shrub (<1m)					
Exotic grass					
Exotic forb & other					
Leaf & stick litter					
Rocks					
Bare ground					
Cryptogams					
Total	100	100	100	100	100

Cover abundance scale

Modified Braun-blanquet 6 scale

1	<5% - rare
2	<5% - common
3	5 - 25%
4	25 - 50%
5	50 - 75%
6	75 - 100%

Plot Disturbance	
Clearing (inc. logging):	Fire damage:
Cultivation (inc. pasture):	Storm damage:
Soil erosion:	Trampling:
Firewood collection:	Flood damage:
Stock grazing:	Feral herbivores:
	Other:

HN528 Mod/Good

BioBanking Field Sheet Entered ✓

JACOBS

Shale Plains - Mod/Good

Survey Site Form - BioBanking		Site ID: Defence P2	Vegetation zone: CPW			
Date	1/10/2015	Surveyor(s):	Lukas Clews			
Waypoint ID	636	Photo numbers	2200	2201	2202	
Coordinates	E 285752	Photo direction	N	E	S	W
	N 6255949					
Mapped Vegetation type: CPW		Condition:		Low	Mod/good	
Slope: Gentle, Mod, Steep	Aspect (degrees or cardinal): Flat	Altitude: 92m				
Topography: crest, ridge, upper slope, mid slope, down slope, gully, flat, depression, watercourse, escarpment, terrace						
Geology: basalt, granite, conglomerate, sandstone, siltstone/mudstone, shale, alluvium, limestone, metamorphics, gravel, ?						
Soil type: sand, loam, clay, organic, gravel, skeletal, ?		Soil disturbance: intact, topsoil removed, fill				
Remnant / Old growth (uncleared): Yes / No / Undecided?		Same larger trees 60-65cm dbh				
Vegetative Structure (formation) =		Ecologically Dominant Layer (EDL) - most biomass =				

Strata	Height interval	Median	Est. cover	Dominant Species & Dominance
E	-			
T1	15-20m			Eucalyptus moluccana
T2	-			
T3	-			
S1	-			Dodonaea viscosa Daviesia Olea europaea
S2	-			
G	-			Eragrostis curvula Chloris gayana Aristida

Tree height (clino) level ground or top of slope = distance from tree x (top% + bottom%)

Tree height (clino) from bottom of slope = distance from tree x (top% - bottom%)

Definitions

Dominance d = dominant; c = co-dominant; s = subdominant; a = associated

Estimated cover i = isolated (0.2-2%); v = very sparse (2-20%); s = sparse (20-50%); m = mid dense (50-80%); d = dense (80-100%)

Walker & Hopkins height classes: 1-3m = dwarf; 3-8m = low; 6-12m = mid-high; 12-20m = tall; 20-35m = very tall; >35m = extremely tall

W&H Crown cover: <0.2% = isolated trees or clumps; 0.2-20% = open woodland; 20-50% = woodland; 50-80% = open forest; 80-100% = closed forest

50m Transect	10 Points - Foliage Projective Cover		
Point	Canopy % (photos)	Midstorey %	Exotic %
5m	40	0	0
10m	40	0	0
15m	10	0	0
20m	20	5	0
25m	30	10	0
30m	5	0	0
35m	30	0	0
40m	10	10	0
45m	50	25	0
50m	30	0	0
Total (sum / 10) =	26.5	5	0

Ground cover tally sheet, 50 points along 50m transect - every 1m record if plant intersects (hits) point

	Total (hits/50)
Native grass tally - 𝍸 𝍸 ||||	28%
Native other (herb, fern, sedge, etc) tally - ||||	8%
Native shrub tally -	0%
Exotic tally - 𝍸 𝍸 ||||	28%

64%

Larger 50 x 20m plot	
Length of woody debris >10cm wide & >0.5m long	0M
Proportion of canopy sp. regeneration	100%
Number of trees with hollows >5cm	2

JACOBS

Site ID: Defence P2	Survey type:Quadrat 20m x 20m				
Species	**Cover**	**Abund.**	**Species**	**Cover**	**Abund.**
1 Eucalyptus moluccana	5	4	41		
2 Eragrostis curvula	5	20+	42		
3 Daviesia ulicifolia	1	1	43		
4 Dodonaea viscosa	1	3	44		
5 Olea europaea	1	1	45		
6 Senecio madagascariensis	2	8	46		
7 Pennisetum clandestinum	2	20+	47		
8 Chloris gayana	4	20+	48		
9 Plantago lanceolata	1	2	49		
10 Aristida vagans	1	4	50		
11 Dichondra repens	2	20+	51		
12 Lachnagrostis filiformis	1	1	52		
13 Araujia sericifera	1	1	53		
14 Taraxacum officinale	1	2	54		
15 Linum - yellow	1	1	55		
16 Cyclospermum	1	4	56		
17 Lolium perenne	1	1	57		
18 Briza subaristata	1	4	58		
19 lilly - [illegible]	1	5	59		
20 Calochaeta	1	1	60		
21 Cynodon dactylon	2	20+	61		
22 Bursaria spinosa	1	1	62		
23			63		
24			64		
25			65		
26			66		
27			67		
28			68		
29			69		
30			70		
31			71		
32			72		
33			73		
34			74		
35			75		
36			76		
37			77		
38			78		
39			79		
40			80		

Sp. Richness	Native	Exotic
Tree	9	
Shrub		
Grass (annual)		
Grass (perennial)		
Other (annual)		
Other (perennial)		

Ground layer % 1x1 plots	Q1	Q2	Q3	Q4	Q5
Native perennial grass					
Native other grass					
Native forb & other					
Native shrub (<1m)					
Exotic grass					
Exotic forb & other					
Leaf & stick litter					
Rocks					
Bare ground					
Cryptogams					
Total	100	100	100	100	100

Cover abundance scale

Modified Braun-blanquet 6 scale

1	<5% - rare
2	<5% - common
3	5 - 25%
4	25 - 50%
5	50 - 75%
6	75 - 100%

Plot Disturbance	Fire damage:
Clearing (inc. logging):	Storm damage:
Cultivation (inc. pasture):	Trampling:
Soil erosion:	Flood damage:
Firewood collection:	Feral herbivores:
Stock grazing:	Other:

HN528 Mod/Good.

Entered ✓

BioBanking Field Sheet

JACOBS

Shale Plains – Mod / Good

Survey Site Form - BioBanking				Site ID: 2183 NR	Vegetation zone: CPW			
Date	1/10/2015			Surveyor(s):				
Waypoint ID	635			Photo numbers	2182		→	~~2190~~ 2191
Coordinates	E 286404			Photo direction	N	E	S	W
	N 6256329							
Mapped Vegetation type: CPW				Condition:			Low	Mod-good
Slope: Gentle, Mod, Steep		Aspect (degrees or cardinal): Flat		Altitude: 91m				
Topography: crest, ridge, upper slope, mid slope, down slope, gully, flat, depression, watercourse, escarpment, terrace								
Geology: basalt, granite, conglomerate, sandstone, siltstone/mudstone, shale, alluvium, limestone, metamorphics, gravel, ?								
Soil type: sand, loam, clay, organic, gravel, skeletal, ?				Soil disturbance: intact, topsoil removed, fill				
Remnant / Old growth (uncleared): Yes / No / Undecided?				Easement Power Line				
Vegetative Structure (formation) = Open forest				Ecologically Dominant Layer (EDL) - most biomass = Canopy				

Strata	Height interval	Median	Est. cover	Dominant Species & Dominance
E	-			
T1	15-20m			Eucalyptus melliodora (d) Eucalyptus tereticornis
T2	-			
T3	-			
S1	-			Olea europaea Bursaria spinosa
S2	-			Hardenbergia violacea
G	-			Themeda triandra Dichondra repens Eragrostis curvula

Tree height (clino) level ground or top of slope = distance from tree x (top% + bottom%)

Tree height (clino) from bottom of slope = distance from tree x (top% - bottom%)

Definitions

Dominance d = dominant; c = co-dominant; s = subdominant; a = associated

Estimated cover i = isolated (0.2-2%); v = very sparse (2-20%); s = sparse (20-50%); m = mid dense (50-80%); d = dense (80-100%)

Walker & Hopkins height classes: 1-3m = dwarf; 3-6m = low; 6-12m = mid-high; 12-20m = tall; 20-35m = very tall; >35m = extremely tall

W&H Crown cover: <0.2% = isolated trees or clumps; 0.2-20% = open woodland; 20-50% = woodland; 50-80% = open forest; 80-100% = closed forest

50m Transect	10 Points - Foliage Projective Cover		
Point	Canopy % (photos)	Midstorey %	Exotic %
5m	30	0	0
10m	0	0	0
15m	0		
20m	0		
25m	0		
30m	0		
35m	0		
40m	0		
45m	10		
50m	60		
Total (sum / 10) =	10%	0%	0%

Larger 50 x 20m plot

Length of woody debris >10cm wide & >0.5m long	0m
Proportion of canopy sp. regeneration	100%
Number of trees with hollows >5cm	2

Ground cover tally sheet, 50 points along 50m transect

- every 1m record if plant intersects (hits) point

	Total (hits/50)
Native grass tally - 𝍸 𝍸 𝍸 | | |	36%
Native other (herb, fern, sedge, etc) tally - 𝍸 | | |	16%
Native shrub tally -	0%
Exotic tally - 𝍸 𝍸 |	22%

74%

JACOBS

Site ID: 2183 NR	Survey type:Quadrat 20m x 20m

Species	Cover	Abund.	Species	Cover	Abund.
1 Eucalyptus molluccana	5	36	41		
2 Eucalyptus tereticornis	3	2	42		
3 Bursaria spinosa	1	1	43		
4 Sida rhombifolia	1	5	44		
5 Senecio madagascariensis	2	20+	45		
6 Eragrostis curvula	4	20+	46		
7 Thelycda australis	4	20+	47		
8 Dichondra repens	2	20+	48		
9 Bonamicella australis	2	20+	49		
10 Aristida vagans	1	2	50		
11 Sonchus oleraceus	1	1	51		
12 Glycine tabacina	2	20+	52		
13 Plantago lanceolata	2	20+	53		
14 Lily	2	20+	54		
15 Chloris gayana	2	20+	55		
16 Lomandra filifolia	1	2	56		
17 Hardenbergia violacea	1	1	57		
18 Einadia nutans	1	1	58		
19 Opuntia stricta	1	2	59		
20 Lactuca serriola	1	1	60		
21 Dianella longifolia	1	4	61		
22 Avena europea	1	2	62		
23 Taraxacum officinale	1	6	63		
24 Hypochaeris radicata	1	2	64		
25 Cirsium vulgare	1	2	65		
26 Cynoglossum australe	1	1	66		
27 Arthropodium milleflorum	1	1	67		
28 Araujia sericifera	1	1	68		
29 Wahlenbergia - large	1	3	69		
30 Cyclospermum leptophyllum	1	6	70		
31 Medicago polymorpha	2	20+	71		
32 Anagallis arvensis	2	20+	72		
33 Vulpia bromoides	1	1	73		
34			74		
35			75		
36			76		
37			77		
38			78		
39			79		
40			80		

Sp. Richness	Native	Exotic
Tree	15	
Shrub		
Grass (annual)		
Grass (perennial)		
Other (annual)		
Other (perennial)		

Ground layer % 1x1 plots	Q1	Q2	Q3	Q4	Q5
Native perennial grass					
Native other grass					
Native forb & other					
Native shrub (<1m)					
Exotic grass					
Exotic forb & other					
Leaf & stick litter					
Rocks					
Bare ground					
Cryptogams					
Total	100	100	100	100	100

Cover abundance scale
Modified Braun-blanquet 6 scale

1	<5% - rare
2	<5% - common
3	5 - 25%
4	25 - 50%
5	50 - 75%
6	75 - 100%

Plot Disturbance	Fire damage:
Clearing (inc. logging):	Storm damage:
Cultivation (inc. pasture):	Trampling:
Soil erosion:	Flood damage:
Firewood collection:	Feral herbivores:
Stock grazing:	Other:

HN528 Mod/Good

Entered ✓

JACOBS

BioBanking Field Sheet

Shale Plains – Mod/Good

Survey Site Form - BioBanking				Site ID: 2 Bradley		Vegetation zone: CPW		
Date	30/9/2015			Surveyor(s): Lukas Clews				
Waypoint ID	633			Photo numbers	2165	2166		
Coordinates	E 281706			Photo direction	N	E	S	W
	N 6257025							
Mapped Vegetation type: CPW				Condition:			Low	Mod-good
Slope: Gentle/Mod, Steep		Aspect (degrees or cardinal): ESE		Altitude: 68m				
Topography: crest, ridge, upper slope, mid slope, down slope, gully, flat, depression, watercourse, escarpment, terrace								
Geology: basalt, granite, conglomerate, sandstone, siltstone/mudstone, shale, alluvium, limestone, metamorphics, gravel, ?								
Soil type: sand, loam, clay, organic, gravel, skeletal, ?				Soil disturbance: intact, topsoil removed, fill				
Remnant / Old growth (uncleared): Yes / No / Undecided?								
Vegetative Structure (formation) = Open forest				Ecologically Dominant Layer (EDL) - most biomass = canopy				

Strata	Height interval	Median	Est. cover	Dominant Species & Dominance
E	-			
T1	-			Eucalyptus tereticornis Eucalyptus crebra
T2	-			
T3	-			
S1	-			Bursaria spinosa Lycium ferocissimum Acacia parramattensis
S2	-			
G	-			Eragrostis curvula Setaria nadagascariensis Dichondra repens Microlaena

Tree height (clino) level ground or top of slope = distance from tree x (top% + bottom%)

Tree height (clino) from bottom of slope = distance from tree x (top% - bottom%)

Definitions

Dominance d = dominant; c = co-dominant; s = subdominant; a = associated

Estimated cover i = isolated (0.2-2%); v = very sparse (2-20%); s = sparse (20-50%); m = mid dense (50-80%); d = dense (80-100%)

Walker & Hopkins height classes: 1-3m = dwarf; 3-6m = low; 6-12m = mid-high; 12-20m = tall; 20-35m = very tall; >35m = extremely tall

W&H Crown cover: <0.2% = isolated trees or clumps; 0.2-20% = open woodland; 20-50% = woodland; 50-80% = open forest; 80-100% = closed forest

50m Transect	10 Points - Foliage Projective Cover		
Point	Canopy % (photos)	Midstorey %	Exotic %
5m	40	60	0
10m	40	20	0
15m	5	0	0
20m	40	10	0
25m	40	25	0
30m	20	60	0
35m	30	60	0
40m	60	10	0
45m	0	0	0
50m	0	0	0
Total (sum / 10) =	27.5	19.5	0

Larger 50 x 20m plot

Length of woody debris >10cm wide & >0.5m long: 1m

Proportion of canopy sp. regeneration: 00%

Number of trees with hollows >5cm: 1

Ground cover tally sheet, 50 points along 50m transect

- every 1m record if plant intersects (hits) point

Native grass tally - |||| || — Total (hits/50): 14%

Native other (herb, fern, sedge, etc) tally - |||| |||| |||| — Total (hits/50): 30%

78%

Native shrub tally - ||| — Total (hits/50): 6%

Exotic tally - |||| |||| |||| — Total (hits/50): 28%

JACOBS

Site ID: 2 Bradley

Survey type: Quadrat 20m x 20m

	Species	Cover	Abund.		Species	Cover	Abund.
1	Eucalyptus tereticornis -	4	4	41			
2	Eucalyptus crebra -	4	3	42			
3	Brunoniella australis -	2	20+	43			
4	Bursaria spinosa -	3	20+	44			
5	Bothriochloa macra -	3	20+	45			
6	Lycium ferocissimum	2	3	46			
7	Acacia sieberiana	2	20+	47			
8	Dichondra repens -	3	20+	48			
9	Plantago lanceolata	2	20+	49			
10	Senecio madagascariensis	2	20+	50			
11	Aristida Vagans -	2	20+	51			
12	Oplismenus aemulus -	2	10+	52			
13	Hardenbergia violacea -	1	1	53			
14	Sida rhombifolia	2	20+	54			
15	Glycine tabacina -	2	20+	55			
16	Lolium perenne	1	1	56			
17	Cyperus gracilis -	2	20+	57			
18	Oxalis hirta	2	20+	58			
19	Briza subaristata	2	20+	59			
20	Acacia parramattensis -	3	3	60			
21	Sonchus oleraceus	1	1	61			
22	Cirsium vulgare	1	+	62			
23	Bromus catharticus	1	1	63			
24	Euphorbia	1	1	64			
25	Chloris truncata -	1	3	65			
26	Hardenbergia -	1	1	66			
27				67			
28				68			
29				69			
30				70			
31				71			
32				72			
33				73			
34				74			
35				75			
36				76			
37				77			
38				78			
39				79			
40				80			

Sp. Richness	Native	Exotic
Tree	14	
Shrub		
Grass (annual)		
Grass (perennial)		
Other (annual)		
Other (perennial)		

Ground layer % 1x1 plots	Q1	Q2	Q3	Q4	Q5
Native perennial grass					
Native other grass					
Native forb & other					
Native shrub (<1m)					
Exotic grass					
Exotic forb & other					
Leaf & stick litter					
Rocks					
Bare ground					
Cryptogams					
Total	100	100	100	100	100

Cover abundance scale
Modified Braun-blanquet 6 scale

1	<5% - rare
2	<5% - common
3	5 - 25%
4	25 - 50%
5	50 - 75%
6	75 - 100%

Plot Disturbance	Fire damage:
Clearing (inc. logging):	Storm damage:
Cultivation (inc. pasture):	Trampling:
Soil erosion:	Flood damage:
Firewood collection:	Feral herbivores:
Stock grazing:	Other:

HW528 Mod / Good

BioBanking Field Sheet

Entered ✓

JACOBS

Shale Plains - Good

Survey Site Form - BioBanking		Site ID: P2-2	Vegetation zone: CPW			
Date	18/11/2015	Surveyor(s): LC				
Waypoint ID	681	Photo numbers	2398	→		2400
Coordinates E / N		Photo direction	N	E	S	W
Mapped Vegetation type: CPW		Condition:			Low	Mod-good
Slope: Gentle, Mod, Steep	Aspect (degrees or cardinal): Flat	Altitude: 88m				
Topography: crest, ridge, upper slope, mid slope, down slope, gully, flat, depression, watercourse, escarpment, terrace						
Geology: basalt, granite, conglomerate, sandstone, siltstone/mudstone, shale, alluvium, limestone, metamorphics, gravel, ?						
Soil type: sand, loam, clay, organic, gravel, skeletal, ?		Soil disturbance: intact, topsoil removed, fill				
Remnant / Old growth (uncleared): Yes / No / Undecided?						
Vegetative Structure (formation) = Open Forest		Ecologically Dominant Layer (EDL) - most biomass = Canopy				

Strata	Height interval	Median	Est. cover	Dominant Species & Dominance
E	-			
T1	10-30m			Eucalyptus moluccana
T2	-			
T3	-			
S1	-			African olive
S2	-			
G	-			Bidens Sida Microlaena Bromus diandra Cirsium vulgare

Tree height (clino) level ground or top of slope = distance from tree x (top% + bottom%)

Tree height (clino) from bottom of slope = distance from tree x (top% - bottom%)

Definitions

Dominance d = dominant; c = co-dominant; s = subdominant; a = associated

Estimated cover i = isolated (0.2-2%); v = very sparse (2-20%); s = sparse (20-50%); m = mid dense (50-80%); d = dense (80-100%)

Walker & Hopkins height classes: 1-3m = dwarf; 3-6m = low; 6-12m = mid-high; 12-20m = tall; 20-35m = very tall; >35m = extremely tall

W&H Crown cover: <0.2% = isolated trees or clumps; 0.2-20% = open woodland; 20-50% = woodland; 50-80% = open forest; 80-100% = closed forest

50m Transect	10 Points - Foliage Projective Cover		
Point	Canopy % (photos)	Midstorey %	Exotic %
5m	30	0	0
10m	40	0	6
15m	50	0	50
20m	40	0	20
25m	40	0	0
30m	10	0	0
35m	40	0	0
40m	20	0	0
45m	10	0	0
50m	40	0	0
Total (sum / 10) =	32%	0%	7%

Ground cover tally sheet, 50 points along 50m transect - every 1m record if plant intersects (hits) point

	Total (hits/50)
Native grass tally - |||	6%
Native other (herb, fern, sedge, etc) tally - 𝍸 𝍸 𝍸 |||	38%
Native shrub tally -	0%
Exotic tally - 𝍸 𝍸 𝍸 𝍸 𝍸 ||||	58%

100%

Larger 50 x 20m plot	
Length of woody debris >10cm wide & >0.5m long	0
Proportion of canopy sp. regeneration	100%
Number of trees with hollows >5cm	1

JACOBS

Site ID: P2-2	Survey type:Quadrat 20m x 20m

	Species	Cover	Abund.		Species	Cover	Abund.
1	Eucalyptus sideroxylon	6	40	41			
2	Olea europaea	3	20+	42			
3	Sida rhombifolia	3	20+	43			
4	Brassicella australis	3	20+	44			
5	Bidens pilosa	4	20+	45			
6	Glycine tabacina	2	20	46			
7	Cyperus gracilis	1	1	47			
8	Richardia roseus	4	20+	48			
9	Juncus usitatus	2	20+	49			
10	Echinopogon caespitosus	1	1	50			
11	Aristida vagans	2	20	51			
12	Oplismenus aemulus	2	20+	52			
13	Cyperus exaltatus	1	1	53			
14	Floscopia gracilis	2	20+	54			
15	Plantago lanceolata	1	1	55			
16	Microlaena stipoides	4	20+	56			
17	Centella asiatica	1	1	57			
18	Einadia nutans	2	20+	58			
19	Dichelachne	1	1	59			
20	Bursaria spinosa	1	1	60			
21	Lycium ferocissimum	1	1	61			
22	Lantana	1	1	62			
23	Cirsium vulgare	1	1	63			
24	Cyclospermum leptophyllum	1	1	64			
25	Asperula conferta	2	20+	65			
26	Briza subaristata	1	1	66			
27	Dichondra sericea	1	1	67			
28	Leguna [illegible]?	1	20+	68	Mentha satureioides		
29	Echium plantagineum	1	1	69			
30				70			
31				71			
32				72			
33				73			
34				74			
35				75			
36				76			
37				77			
38				78			
39				79			
40				80			

Sp. Richness	Native	Exotic
Tree	18	
Shrub		
Grass (annual)		
Grass (perennial)		
Other (annual)		
Other (perennial)		

Ground layer % 1x1 plots	Q1	Q2	Q3	Q4	Q5
Native perennial grass					
Native other grass					
Native forb & other					
Native shrub (<1m)					
Exotic grass					
Exotic forb & other					
Leaf & stick litter					
Rocks					
Bare ground					
Cryptogams					
Total	100	100	100	100	100

Cover abundance scale
Modified Braun-blanquet 6 scale

1	<5% - rare
2	<5% - common
3	5 - 25%
4	25 - 50%
5	50 - 75%
6	75 - 100%

Plot Disturbance	Fire damage:
Clearing (inc. logging):	Storm damage:
Cultivation (inc. pasture):	Trampling:
Soil erosion:	Flood damage:
Firewood collection:	Feral herbivores:
Stock grazing:	Other:

HW 528 Mod/Good

BioBanking Field Sheet

Entered ✓

Shale Plains - Good

JACOBS

Survey Site Form - BioBanking		Site ID: P2-3		Vegetation zone: CPW		
Date	18/11/2015	Surveyor(s):	LC			
Waypoint ID	683	Photo numbers	2405	→		2408
Coordinates E / N		Photo direction	N	E	S	W
Mapped Vegetation type: CPW		Condition:			Low	Mod-good
Slope: Gentle, Mod, Steep	Aspect (degrees or cardinal): flat	Altitude: 90m				
Topography: crest, ridge, upper slope, mid slope, down slope, gully, flat, depression, watercourse, escarpment, terrace						
Geology: basalt, granite, conglomerate, sandstone, siltstone/mudstone, shale, alluvium, limestone, metamorphics, gravel, ?						
Soil type: sand, loam, clay, organic, gravel, skeletal, ?		Soil disturbance: intact, topsoil removed, fill				
Remnant / Old growth (uncleared): Yes / No / Undecided?						
Vegetative Structure (formation) = Open forest		Ecologically Dominant Layer (EDL) - most biomass = canopy				

Strata	Height interval	Median	Est. cover	Dominant Species & Dominance
E	-			
T1	15-25m			Eucalyptus moluccana
T2	-			
T3	-			
S1	1-6m			Eucalyptus moluccana
S2	-			
G	-			Microlaena stipoides, Aristida, Eragrostis curvula, sida, Moth vine, Spear thistle

Tree height (clino) level ground or top of slope = distance from tree x (top% + bottom%)

Tree height (clino) from bottom of slope = distance from tree x (top% - bottom%)

Definitions

Dominance d = dominant; c = co-dominant; s = subdominant; a = associated

Estimated cover i = isolated (0.2-2%); v = very sparse (2-20%); s = sparse (20-50%); m = mid dense (50-80%); d = dense (80-100%)

Walker & Hopkins height classes: 1-3m = dwarf, 3-6m = low; 6-12m = mid-high; 12-20m = tall; 20-35m = very tall; >35m = extremely tall

W&H Crown cover: <0.2% = isolated trees or clumps; 0.2-20% = open woodland; 20-50% = woodland, 50-80% = open forest; 80-100% = closed forest

50m Transect	10 Points - Foliage Projective Cover		
Point	Canopy % (photos)	Midstorey %	Exotic %
5m	10	0	0
10m	5	0	0
15m	0	0	0
20m	10	0	0
25m	0	0	0
30m	0	0	0
35m	0	0	0
40m	0	0	0
45m	40	0	0
50m	50	0	0
Total (sum / 10) =	11.5	0	0
Larger 50 x 20m plot			
Length of woody debris >10cm wide & >0.5m long			1m
Proportion of canopy sp. regeneration			100%
Number of trees with hollows >5cm			2

Ground cover tally sheet, 50 points along 50m transect - every 1m record if plant intersects (hits) point

	Total (hits/50)
Native grass tally - 𝍸 𝍸 𝍸 𝍸 |	42%
Native other (herb, fern, sedge, etc) tally - 𝍸	10%
Native shrub tally -	0%
Exotic tally - 𝍸 𝍸 𝍸 𝍸 ||||	48%

100%

BioBanking Field Sheet

JACOBS

Site ID: P2-3	Survey type: Quadrat 20m x 20m				
Species	**Cover**	**Abund.**	**Species**	**Cover**	**Abund.**
1 Eucalyptus molluccana +	6	20	41		
2 Hypericum gramineum +	2	20+	42		
3 Eragrostis curvula	4	20+	43		
4 Microlaena stipoides +	4	20+	44		
5 Hypochaeris radicata	1	1	45		
6 Sida rhombifolia	4	20+	46		
7 Bidens pilosa	2	20+	47		
8 Cyperus gracilis +	1	1	48		
9 Aristida vagans +	3	20+	49		
10 Themeda +	2	20+	50		
11 Senecio madagascariensis	1	1	51		
12 Cheilanthes sieberi +	2	20+	52		
13 Araujia sericifera	2	20+	53		
14 Cirsium vulgare	2	20+	54		
15 Tiny Wahlenbergia +	1	1	55		
16 Bursaria spinosa +	1	6	56		
17 Oxalis perennans +	2	20+	57		
18 Euphorbia +	1	1	58		
19 Glycine tabacina +	2	20+	59		
20 Solanum pseudocapsicum	1	2	60		
21 Anagallis arvensis	1	1	61		
22 Parsonsia straminea +	1	1	62		
23 Modiola caroliniana	1	1	63		
24 Cynodon dactylon +	3	20+	64		
25 Plantago lanceolata	1	2	65		
26 Briza subaristata	1	1	66		
27 Stackhousia +	1	2	67		
28 ~~Cheilanthes sieberi~~	~~2~~	~~20+~~	68		
29 Verbena bonariensis	1	1	69		
30 Yellow [illegible]	1	1	70		
31 Centella asiatica +	1	1	71		
32			72		
33			73		
34			74		
35			75		
36			76		
37			77		
38			78		
39			79		
40			80		

Sp. Richness	Native	Exotic
Tree	16	
Shrub		
Grass (annual)		
Grass (perennial)		
Other (annual)		
Other (perennial)		

Ground layer % 1x1 plots	Q1	Q2	Q3	Q4	Q5
Native perennial grass					
Native other grass					
Native forb & other					
Native shrub (<1m)					
Exotic grass					
Exotic forb & other					
Leaf & stick litter					
Rocks					
Bare ground					
Cryptogams					
Total	100	100	100	100	100

Cover abundance scale

Modified Braun-blanquet 6 scale

1	<5% - rare
2	<5% - common
3	5 - 25%
4	25 - 50%
5	50 - 75%
6	75 - 100%

Plot Disturbance	
Clearing (inc. logging):	Fire damage:
Cultivation (inc. pasture):	Storm damage:
Soil erosion:	Trampling:
Firewood collection:	Flood damage:
Stock grazing:	Feral herbivores:
	Other:

HN 528 Mod/Good

Entered ✓

BioBanking Field Sheet

JACOBS

Shale Plains - Mod/Good

Survey Site Form - BioBanking		Site ID: Site 29		Vegetation zone: CPW	
Date	20/1/2016	Surveyor(s):	Lukas Clews		
Waypoint ID	767	Photo numbers	2312	2313	2314 / 2315
Coordinates	E 0285921 N 6246596	Photo direction	N	E	S / W
Mapped Vegetation type: CPW			Condition:	Low	Mod-good
Slope: Gentle, Mod, Steep	Aspect (degrees or cardinal):		Altitude:		
Topography: crest, ridge, upper slope, mid slope, down slope, gully, flat, depression, watercourse, escarpment, terrace					
Geology: basalt, granite, conglomerate, sandstone, siltstone/mudstone, shale, alluvium, limestone, metamorphics, gravel, ?					
Soil type: sand, loam, clay, organic, gravel, skeletal, ?		Soil disturbance: intact, topsoil removed, fill			
Remnant / Old growth (uncleared): Yes / No / Undecided?					
Vegetative Structure (formation): Open Forest		Ecologically Dominant Layer (EDL) - most biomass = Canopy			

Strata	Height interval	Median	Est. cover	Dominant Species & Dominance
E	-			
T1	20 25m			Eucalyptus tereticornis Eucalyptus moluccana
T2	-			
T3	-			
S1	1 - 8m			Olea europaea Bursaria spinosa
S2	-			
G	0 1m			Chloris ventricosa Microlaena stipoides Aristida ramosa

Definitions

Tree height (clino) level ground or top of slope = distance from tree x (top% + bottom%)

Tree height (clino) from bottom of slope = distance from tree x (top% - bottom%)

Dominance d = dominant; c = co-dominant; s = subdominant; a = associated

Estimated cover i = isolated (0.2-2%); v = very sparse (2-20%); s = sparse (20-50%); m = mid dense (50-80%); d = dense (80-100%)

Walker & Hopkins height classes: 1-3m = dwarf; 3-6m = low; 6-12m = mid-high; 12-20m = tall; 20-35m = very tall; >35m = extremely tall

W&H Crown cover: <0.2% = isolated trees or clumps; 0.2-20% = open woodland; 20-50% = woodland; 50-80% = open forest; 80-100% = closed forest

50m Transect	10 Points - Foliage Projective Cover		
Point	Canopy % (photos)	Midstorey %	Exotic %
5m	70	0	0
10m	30	0	25
15m	20	15	10
20m	10	25	0
25m	15	10	20
30m	5	20	10
35m	0	0	0
40m	0	0	0
45m	0	0	0
50m	0	0	0
Total (sum / 10) =	10	7	6.5

Larger 50 x 20m plot	
Length of woody debris >10cm wide & >0.5m long	5m
Proportion of canopy sp. regeneration	100%
Number of trees with hollows >5cm	1

Ground cover tally sheet, 50 points along 50m transect - every 1m record if plant intersects (hits) point

Tally	Total (hits/50)
Native grass tally - 𝍸𝍸𝍸𝍸𝍸𝍸𝍸	70%
Native other (herb, fern, sedge, etc) tally - 𝍸 III	16%
Native shrub tally -	0%
Exotic tally - 𝍸	10%

96%

JACOBS

Site ID: Site 29-1	Survey type: Quadrat 20m x 20m

	Species		Cover	Abund.		Species		Cover	Abund.
1	E. tereticornis	–	3	2	41	Plectranthus parv.	+	1	2
2	E. melanophloia	–	3	4	42	Breynia oblongifolia	+	1	1
3	Bursaria spinosa	+	3	5	43	Kraussia australis		1	2
4	Olea europea		4	11	44	Cyperus gracilis	+	1	1
5	Aristida ramosa	+	2	>20	45	Rhadia L-triangnes	+	1	3
6	Microlaena stipoides	+	5	>100	46	Cynoglossum spartioi	+	1	1
7	Paspalum dilatatum		2	>50	47	Solanum pseudocap.		1	1
8	Conyza		1	>30	48				
9	Sida rhombifolia		1	>30	49				
10	Verbena sp.		1	1	50				
11	Echinopsis	+	1	3	51				
12	Plantago lanceolatus		2	>20	52				
13	Dichondra repens	+	2	>20	53				
14	Hypericum gem.	+	2	>20	54				
15	Cirsium vulgare	+	2	>20	55				
16	Brunonia australis	+	2	>20	56				
17	Oxalis pes.	+	1	10	57				
18	Trifolium repens		1	>20	58				
19	Glycine micro.	+	1	1	59				
20	Erenophila debilis	+	2	>20	60				
21	Desmodium varians	+	2	>20	61				
22	Oplismenus aemulus	+	2	>20	62				
23	Phyllanthus	+	1	1	63				
24	Senecio madagascar.		1	1	64				
25	Chloris ventricosa	+	2	>20	65				
26	Panicum simile	+	1	1	66				
27	Sporobolus creber	+	1	1	67				
28	Bothriochloa macra	+	1	5	68				
29	Cirsium vulgare		1	3	69				
30	Galium gaudichaudi	+	2	>25	70				
31	Carex inversa	+	1	1	71				
32	Plantago (native)	+	1	1	72				
33	Wahlenbergia gracilis	+	1	2	73				
34	Sigesbeckia orientalis	+	1	1	74				
35	Scaevola	+	1	2	75				
36	Desmodium brachypodum		1	3	76				
37	Eychilon sphere.	+	1	1	77				
38	Villadenia sp.	+	1	2	78				
39	Solanum pseudophyllum	+	1	4	79				
40	Plantago major	+	1	1	80				

Sp. Richness	Native	Exotic
Tree	36	
Shrub		
Grass (annual)		
Grass (perennial)		
Other (annual)		
Other (perennial)		

Ground layer % 1x1 plots	Q1	Q2	Q3	Q4	Q5
Native perennial grass					
Native other grass					
Native forb & other					
Native shrub (<1m)					
Exotic grass					
Exotic forb & other					
Leaf & stick litter					
Rocks					
Bare ground					
Cryptogams					
Total	100	100	100	100	100

Cover abundance scale
Modified Braun-blanquet 6 scale

1	<5% - rare
2	<5% - common
3	5 - 25%
4	25 - 50%
5	50 - 75%
6	75 - 100%

Plot Disturbance	Fire damage:
Clearing (inc. logging):	Storm damage:
Cultivation (inc. pasture):	Trampling:
Soil erosion:	Flood damage:
Firewood collection:	Feral herbivores:
Stock grazing:	Other:

HN 528 Mod/good

Entered ✓

BioBanking Field Sheet

JACOBS

Shale Plains - mod/good

Survey Site Form - BioBanking		Site ID: Prop. 27	Vegetation zone: CPW		
Date	20/1/2016	Surveyor(s):			
Waypoint ID	766 – 27	Photo numbers	2308	2309	2310	2311
Coordinates	E 028161 N 6246218	Photo direction	N	E	S	W
Mapped Vegetation type:		Condition:		Low	Mod-good
Slope: Gentle, Mod, Steep	**Aspect (degrees or cardinal):**	**Altitude:**			
Topography: crest, ridge, upper slope, mid slope, down slope, gully, flat, depression, watercourse, escarpment, terrace					
Geology: basalt, granite, conglomerate, sandstone, siltstone/mudstone, shale, alluvium, limestone, metamorphics, gravel, ?					
Soil type: sand, loam, clay, organic, gravel, skeletal, ?		**Soil disturbance:** intact, topsoil removed, fill			
Remnant / Old growth (uncleared): Yes / No / Undecided?					
Vegetative Structure (formation) =		Ecologically Dominant Layer (EDL) - most biomass =			

Strata	Height interval	Median	Est. cover	Dominant Species & Dominance
E	-			
T1	20-25m		20%	eucalyptus tesselaris
T2	-			
T3	-			
S1	0.5-1.5m		45%	Bursaria spinosa Solanum prickly apple
S2	-			
G	0-20m		90%	Microlaena stipoides Dichondra repens

Tree height (clino) level ground or top of slope = distance from tree x (top% + bottom%)

Tree height (clino) from bottom of slope = distance from tree x (top% - bottom%)

Definitions

Dominance d = dominant; c = co-dominant; s = subdominant; a = associated

Estimated cover i = isolated (0.2-2%); v = very sparse (2-20%); s = sparse (20-50%); m = mid dense (50-80%); d = dense (80-100%)

Walker & Hopkins height classes: 1-3m = dwarf; 3-6m = low; 6-12m = mid-high; 12-20m = tall; 20-35m = very tall; >35m = extremely tall

W&H Crown cover: <0.2% = isolated trees or clumps; 0.2-20% = open woodland; 20-50% = woodland; 50-80% = open forest; 80-100% = closed forest

50m Transect	10 Points - Foliage Projective Cover		
Point	Canopy % (photos)	Midstorey %	Exotic %
5m	10	0	0
10m	0	0	0
15m	10	0	0
20m	30	0	0
25m	30	0	0
30m	5	0	0
35m	0	0	0
40m	0	0	0
45m	0	0	0
50m	0	0	0
Total (sum / 10) =	8.5%	0	0

Larger 50 x 20m plot	
Length of woody debris >10cm wide & >0.5m long	2m
Proportion of canopy sp. regeneration	100
Number of trees with hollows >5cm	0

Ground cover tally sheet, 50 points along 50m transect

- every 1m record if plant intersects (hits) point

	Total (hits/50)
Native grass tally - 𝍸 𝍸 𝍸 𝍸 𝍸 𝍸 II	84%
Native other (herb, fern, sedge, etc) tally - 𝍸 𝍸 I	22%
Native shrub tally - I	2%
Exotic tally - III	6%

94%

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JACOBS

Site ID: Prop. 27

Survey type: Quadrat 20m x 20m

Species	Cover	Abund.	Species	Cover	Abund.
1 Eucalyptus tereticornis	– 3	4	41		
2 Bursaria spinosa	– 2	30	42		
3 Solanum prickly apple	3	40	43		
4 Solanum prinophyllum	– 2	20	44		
5 [illegible]	– 2	20+	45		
6 Dichondra repens	– 3	>100	46		
7 Microlaena stipoides	– 5	>200	47		
8 Echinopogon caespitosum	– 2	20+	48		
9 Conyza bonariensis	1	1	49		
10 Phyllanthus	– 1	2	50		
11 Desmodium varians	– 1	1	51		
12 Oxalis perennans	– 2	20+	52		
13 Brunoniella australis	– 2	20+	53		
14 Glycine tabacina	– 2	20+	54		
15 Cirsium vulgare	1	1	55		
16 Panicum simile	– 1	1	56		
17 Carex inversa	– 1	1	57		
18 Sporobolus creber	– 4	40+	58		
19 Wahlenbergia	– 1	1	59		
20 Aristida – appressed awn	– 1	2	60		
21 Centaurium erythraea	1	1	61		
22 Austrodanthonia tenuior	– 1	2	62		
23 Olea europaea	1	2	63		
24 Richardia	1	1	64		
25 Asperula conferta	– 2	20+	65		
26 Modiola	1	2	66		
27 Bothriochloa macra	– 1	2	67		
28 Eragrostis brownii	– 1	2	68		
29 Chloris ventricosa	– 1	1	69		
30 Senecio madagascariensis	1	1	70		
31 Sida rhombifolia	2	20+	71		
32 Cyperus gracilis	– 1	10	72		
33 Oplismenus aemulus	– 1	1	73		
34 Plantago lanceolata	1	1	74		
35 Cyclospermum leptophyllum	1	1	75		
36 Tricoryne elatior	– 1	4	76		
37 Gomphocarpus physocarpus	1	1	77		
38 Cheilanthes sieberi	– 2	20+	78		
39			79		
40			80		

Sp. Richness	Native	Exotic
Tree		
Shrub		
Grass (annual)		
Grass (perennial)		
Other (annual)	26	
Other (perennial)		

Ground layer % 1x1 plots	Q1	Q2	Q3	Q4	Q5
Native perennial grass					
Native other grass					
Native forb & other					
Native shrub (<1m)					
Exotic grass					
Exotic forb & other					
Leaf & stick litter					
Rocks					
Bare ground					
Cryptogams					
Total	100	100	100	100	100

Cover abundance scale

Modified Braun-blanquet 6 scale

1	<5% - rare
2	<5% - common
3	5 - 25%
4	25 - 50%
5	50 - 75%
6	75 - 100%

Plot Disturbance	
Clearing (inc. logging):	Fire damage:
Cultivation (inc. pasture):	Storm damage:
Soil erosion:	Trampling:
Firewood collection:	Flood damage:
Stock grazing:	Feral herbivores:
	Other:

HN528 Mod/Good

BioBanking Field Sheet

Shale Plains - Mod/Good

JACOBS Front Paddock 170-2 Entered ✓

Survey Site Form - BioBanking				Site ID: ~~107~~ 170-2	Vegetation zone: CPW?			
Date	3/9/2015			Surveyor(s): Lukas Clews				
Waypoint ID	~~1~~ 170-2			Photo numbers	1299	1300	1301	
Coordinates	E			Photo direction	N	E	S	W
	N							
Mapped Vegetation type: RPW?				Condition:			Low	Mod-good
Slope: Gentle, Mod, Steep		Aspect (degrees or cardinal): N/A		Altitude: 100m				
Topography: crest, ridge, upper slope, mid slope, down slope, gully, flat, depression, watercourse, escarpment, terrace								
Geology: basalt, granite, conglomerate, sandstone, siltstone/mudstone, shale, alluvium, limestone, metamorphics, gravel, ?								
Soil type: sand, loam, clay, organic, gravel, skeletal, ?				Soil disturbance: intact, topsoil removed, fill				
Remnant / Old growth (uncleared): Yes / No / Undecided?								
Vegetative Structure (formation) = Open forest				Ecologically Dominant Layer (EDL) - most biomass = canopy				

Strata	Height interval	Median	Est. cover	Dominant Species & Dominance
E	-			
T1	20-30m			Eucalyptus moluccana Eucalyptus tereticornis
T2	10-15m			Exocarpos cupressiformis Canopy regrowth
T3	-			
S1	1-2m			Lantana Lycium ferocissimum Bursaria spinosa
S2	-			
G	-			Microlaena stipoides Ehrharta erecta

Tree height (clino) level ground or top of slope = distance from tree x (top% + bottom%)

Tree height (clino) from bottom of slope = distance from tree x (top% - bottom%)

Definitions

Dominance d = dominant; c = co-dominant; s = subdominant; a = associated

Estimated cover i = isolated (0.2-2%); v = very sparse (2-20%); s = sparse (20-50%); m = mid dense (50-80%); d = dense (80-100%)

Walker & Hopkins height classes: 1-3m = dwarf; 3-6m = low; 6-12m = mid-high; 12-20m = tall; 20-35m = very tall; >35m = extremely tall

W&H Crown cover: <0.2% = isolated trees or clumps; 0.2-20% = open woodland; 20-50% = woodland; 50-80% = open forest; 80-100% = closed forest

50m Transect	10 Points - Foliage Projective Cover		
Point	Canopy % (photos)	Midstorey %	Exotic %
5m	5	0	0
10m	50	0	0
15m	20	0	0
20m	30	0	0
25m	5	10	0
30m	0	0	0
35m	50	0	0
40m	40	0	40
45m	5	0	0
50m	10	0	0
Total (sum / 10) =	21.5	1	4
Larger 50 x 20m plot			
Length of woody debris >10cm wide & >0.5m long			1.2m
Proportion of canopy sp. regeneration			100%+
Number of trees with hollows >5cm			1

Ground cover tally sheet, 50 points along 50m transect

- every 1m record if plant intersects (hits) point

	Total (hits/50)
Native grass tally - 𝍸 𝍸 𝍸 𝍸 𝍸 𝍸 𝍸 𝍸 𝍸 𝍸 III	96%
Native other (herb, fern, sedge, etc) tally -	0%
Native shrub tally -	0%
Exotic tally - 𝍸	10%

96%

JACOBS Front Paddock

Site ID: ~~701~~ 170-2 | Survey type: Quadrat 20m x 20m

	Species	Cover	Abund.		Species	Cover	Abund.
1	Eucalyptus melliodora	6	22	41			
2	Eucalyptus tricornis	3	3	42			
3	Lantana	3	6	43			
4	Lycium ferocissimum	3	4	44			
5	Solanum scabrum	2	20+	45			
6	Taraxacum	3	30+	46			
7	Cirsium vulgare	3	20+	47			
8	Modiola	2	20+	48			
9	Cirsium vulgare	2	20+	49			
10	Sida rhombifolia	2	20+	50			
11	Ehrharta gracilis	3	20+	51			
12	Cotula	2	20+	52			
13	Solanum prickly apple	2	20+	53			
14	Cyperus gracilis	2	20+	54			
15	Microlaena stipoides	3	20+	55			
16	Romex crispus	1	4	56			
17	Bursaria spinosa	4	4	57			
18	Medicago polymorpha	1	1	58			
19	Oxalis Yellow	2	20+	59			
20	Ehrharta erecta	3	20+	60			
21	Ortica incisa	1	1	61			
22	Phytolacca octadra	1	1	62			
23	Pennisetum clandestinum	2	20+	63			
24				64			
25				65			
26				66			
27				67			
28				68			
29				69			
30				70			
31				71			
32				72			
33				73			
34				74			
35				75			
36				76			
37				77			
38				78			
39				79			
40				80			

Sp. Richness	Native	Exotic
Tree		
Shrub	6	
Grass (annual)		
Grass (perennial)		
Other (annual)		
Other (perennial)		

Ground layer % 1x1 plots	Q1	Q2	Q3	Q4	Q5
Native perennial grass					
Native other grass					
Native forb & other					
Native shrub (<1m)					
Exotic grass					
Exotic forb & other					
Leaf & stick litter					
Rocks					
Bare ground					
Cryptogams					
Total	100	100	100	100	100

Cover abundance scale
Modified Braun-blanquet 6 scale

1	<5% - rare
2	<5% - common
3	5 - 25%
4	25 - 50%
5	50 - 75%
6	75 - 100%

Plot Disturbance	
Clearing (inc. logging):	Fire damage:
Cultivation (inc. pasture):	Storm damage:
Soil erosion:	Trampling:
Firewood collection:	Flood damage:
Stock grazing:	Feral herbivores:
	Other:

AN 528 _ Mod/wood _ Poor

Entered

BioBanking Field Sheet

JACOBS

Shale Plains - Poor

Survey Site Form - BioBanking		Site ID: 209	Vegetation zone: CPW - ~~SHEEN~~ CPW
Date	2/9/2015	Surveyor(s): Lukas Clews	
Waypoint ID	209	Photo numbers	
Coordinates	E / N	Photo direction	N / E / S / W

Mapped Vegetation type: CPW — Condition: Low / **Mod-good** (circled)

Slope: **Gentle**, Mod, Steep — Aspect (degrees or cardinal): SE — Altitude: 98M

Topography: crest, ridge, **upper slope**, mid slope, down slope, gully, flat, depression, watercourse, escarpment, terrace

Geology: basalt, granite, conglomerate, sandstone, siltstone/mudstone, **shale**, alluvium, limestone, metamorphics, gravel, ?

Soil type: sand, loam, **clay**, organic, gravel, skeletal, ? — Soil disturbance: **intact**, topsoil removed, fill

Remnant / Old growth (uncleared): Yes / No / **Undecided?** — old trees

Vegetative Structure (formation) = Open woodland — Ecologically Dominant Layer (EDL) - most biomass = Canopy

Strata	Height interval	Median	Est. cover	Dominant Species & Dominance
E	X	X	X	X
T1	15-20m			Eucalyptus moluccana (d) Eucalyptus tereticornis
T2	X	X	X	X
T3	X	X	X	X
S1	X	X	X	X
S2	X	X	X	X
G	-			Pennisetum clandestinum Paspalum Senecio madagascariensis

Definitions

Tree height (clino) level ground or top of slope = distance from tree x (top% + bottom%)

Tree height (clino) from bottom of slope = distance from tree x (top% - bottom%)

Dominance d = dominant; c = co-dominant; s = subdominant; a = associated

Estimated cover I = isolated (0.2-2%); v = very sparse (2-20%); s = sparse (20-50%); m = mid dense (50-80%); d = dense (80-100%)

Walker & Hopkins height classes: 1-3m = dwarf; 3-6m = low; 6-12m = mid-high; 12-20m = tall; 20-35m = very tall; >35m = extremely tall

W&H Crown cover: <0.2% = isolated trees or clumps; 0.2-20% = open woodland; 20-50% = woodland; 50-80% = open forest; 80-100% = closed forest

50m Transect	10 Points - Foliage Projective Cover			Ground cover tally sheet, 50 points along 50m transect	
Point	Canopy % (photos)	Midstorey %	Exotic %	- every 1m record if plant intersects (hits) point	
5m	10	0	0	Native grass tally - 0	Total (hits/50) 0%
10m	10	↓	↓		
15m	5				
20m	0				
25m	5				
30m	30			Native other (herb, fern, sedge, etc) tally - 0	Total (hits/50) 0%
35m	40				
40m	30				
45m	5				
50m		↓	↓		
Total (sum / 10) =	13.5	0	0	Native shrub tally - 0	Total (hits/50) 0%
Larger 50 x 20m plot					
Length of woody debris >10cm wide & >0.5m long			1.2m		
Proportion of canopy sp. regeneration			0	Exotic tally - 𝍸 𝍸 𝍸 𝍸 𝍸 𝍸 𝍸 𝍸 𝍸 III	Total (hits/50) 96%
Number of trees with hollows >5cm			4		

96%..

JACOBS

Site ID: 209	Survey type: Quadrat 20m x 20m

	Species	Cover	Abund.		Species	Cover	Abund.
1	Eucalyptus molluccana	3	2	41			
2	Pennisetum clandestinum	6	20+	42			
3	Senecio madagascariensis	3	20+	43			
4	Cyperus gracilis	2	20+	44			
5	Cotula	2	20+	45			
6	Paspalum	3	20+	46			
7	Trifolium repens	3	20+	47			
8	chickweed	2	20+	48			
9	Urtica incisa	1	4	49			
10	Sonchus oleraceus	1	2	50			
11	Poa annua	2	20+	51			
12	Malva parviflora	2	20+	52			
13	~~large chickweed~~	~~2~~	~~3~~	~~53~~	just chickweed as below		
14	Plantago lanceolata	1	2	54			
15	Taraxacum officinale	1	1	55			
16	Wire weed	1	1	56			
17				57			
18				58			
19				59			
20				60			
21				61			
22				62			
23				63			
24				64			
25				65			
26				66			
27				67			
28				68			
29				69			
30				70			
31				71			
32				72			
33				73			
34				74			
35				75			
36				76			
37				77			
38				78			
39				79			
40				80			

Sp. Richness	Native	Exotic
Tree		
Shrub	4	
Grass (annual)		
Grass (perennial)		
Other (annual)		
Other (perennial)		

Ground layer % 1x1 plots	Q1	Q2	Q3	Q4	Q5
Native perennial grass					
Native other grass					
Native forb & other					
Native shrub (<1m)					
Exotic grass					
Exotic forb & other					
Leaf & stick litter					
Rocks					
Bare ground					
Cryptogams					
Total	100	100	100	100	100

Cover abundance scale
Modified Braun-blanquet 6 scale

1	<5% - rare
2	<5% - common
3	5 - 25%
4	25 - 50%
5	50 - 75%
6	75 - 100%

Plot Disturbance	Fire damage:
Clearing (inc. logging):	Storm damage:
Cultivation (inc. pasture):	Trampling:
Soil erosion:	Flood damage:
Firewood collection:	Feral herbivores:
Stock grazing:	Other:

HN S28 Mod/wood - Poor

Entered ✓

BioBanking Field Sheet

JACOBS

shale ~~hills~~ Plains - Poor

Survey Site Form - BioBanking				Site ID: S10 Willowdale		Vegetation zone: CPW - Poor	
Date	20/1/2016			Surveyor(s):			
Waypoint ID				Photo numbers	2306		
Coordinates	E -33.904298			Photo direction	N	E	S	W
	N 150.688728						
Mapped Vegetation type: CPW poor				Condition:		Low	Mod-good poor
Slope: Gentle, Mod, Steep		Aspect (degrees or cardinal): Flat		Altitude: ?			
Topography: crest, ridge, upper slope, mid slope, down slope, gully, flat, depression, watercourse, escarpment, terrace							
Geology: basalt, granite, conglomerate, sandstone, siltstone/mudstone, shale, alluvium, limestone, metamorphics, gravel, ?							
Soil type: sand, loam, clay, organic, gravel, skeletal, ?				Soil disturbance: intact, topsoil removed, fill			
Remnant / Old growth (uncleared): Yes / No / Undecided?							
Vegetative Structure (formation) = Open Forest				Ecologically Dominant Layer (EDL) - most biomass = Canopy			

Strata	Height interval	Median	Est. cover	Dominant Species & Dominance
E	-			
T1	20-25m		20%	Eucalyptus tereticornis
T2	-			
T3	-			
S1	1-2m		5%	Lycium ferocissimum
S2	-			
G	0-1m		90%	Kikuyu Solanum prickly type Sida rhombifolia

Tree height (clino) level ground or top of slope = distance from tree x (top% + bottom%)

Tree height (clino) from bottom of slope = distance from tree x (top% - bottom%)

Definitions

Dominance d = dominant; c = co-dominant; s = subdominant; a = associated

Estimated cover i = isolated (0.2-2%); v = very sparse (2-20%); s = sparse (20-50%); m = mid dense (50-80%); d = dense (80-100%)

Walker & Hopkins height classes: 1-3m = dwarf; 3-6m = low; 6-12m = mid-high; 12-20m = tall; 20-35m = very tall; >35m = extremely tall

W&H Crown cover: <0.2% = isolated trees or clumps; 0.2-20% = open woodland; 20-50% = woodland; 50-80% = open forest; 80-100% = closed forest

50m Transect	10 Points - Foliage Projective Cover		
Point	Canopy % (photos)	Midstorey %	Exotic %
5m	30	0	0
10m	0	0	0
15m	0	0	0
20m	0	0	0
25m	10	0	0
30m	20	0	0
35m	10	0	0
40m	5	0	0
45m	20	0	0
50m	10	0	0
Total (sum / 10) =	10.5	0	0

Larger 50 x 20m plot

Length of woody debris >10cm wide & >0.5m long: 8m

Proportion of canopy sp. regeneration: 0

Number of trees with hollows >5cm: 0

Ground cover tally sheet, 50 points along 50m transect

- every 1m record if plant intersects (hits) point

Native grass tally - 11 — Total (hits/50): 4%

Native other (herb, fern, sedge, etc) tally - 𝍸 1 — Total (hits/50): 12% 98!

Native shrub tally - — Total (hits/50): 0%

Exotic tally - 𝍸 𝍸 𝍸 𝍸 𝍸 𝍸 𝍸 1 — Total (hits/50): 82%

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Site ID: 510 Willowdene	Survey type: Quadrat 20m x 20m				
Species	**Cover**	**Abund.**	**Species**	**Cover**	**Abund.**
1 Eucalyptus torticornis	4	5	41		
2 Sida rhombifolia	3	23	42		
3 Kikuyu	6	100+	43		
4 Sporobolus creber	1	1	44		
5 Solanum prickly apple	4	47	45		
6 Atriplex	1	13	46		
7 Cyperus gracilis	1	10	47		
8 Crows foot	2	20+	48		
9 Senecio madagascariensis	1	1	49		
10 Lycium ferocissimum	1	2	50		
11 Trifolium repens	1	1	51		
12 Malva parviflora	1	1	52		
13 Paspalidium	1	2	53		
14 Lepidium africanum	2	10	54		
15 Verbena officinale	1	1	55		
16 Oxalis perrenans	2	20+	56		
17 Gomphrena celosioides	1	1	57		
18 Einadia polygonoides	2	20+	58		
19 Wire weed	1	1	59		
20 Hawkbit	1	2	60		
21 Einadia trigonos	1	10	61		
22 Eragrostis brownii	1	2	62		
23 Conyza bonariensis	1	1	63		
24 Setaria sp.	1	1	64		
25 Cynodon dactylon	4	100+	65		
26 Chloris gayana	1	5	66		
27 Dichondra repens	1	7	67		
28 Cirsium vulgare	1	1	68		
29			69		
30			70		
31			71		
32			72		
33			73		
34			74		
35			75		
36			76		
37			77		
38			78		
39			79		
40			80		

Sp. Richness	Native	Exotic
Tree		
Shrub		
Grass (annual)	11	
Grass (perennial)		
Other (annual)		
Other (perennial)		

Ground layer % 1x1 plots	Q1	Q2	Q3	Q4	Q5
Native perennial grass					
Native other grass					
Native forb & other					
Native shrub (<1m)					
Exotic grass					
Exotic forb & other					
Leaf & stick litter					
Rocks					
Bare ground					
Cryptogams					
Total	100	100	100	100	100

Cover abundance scale
Modified Braun-blanquet 6 scale

1	<5% - rare
2	<5% - common
3	5 - 25%
4	25 - 50%
5	50 - 75%
6	75 - 100%

Plot Disturbance	Fire damage:
Clearing (inc. logging):	Storm damage:
Cultivation (inc. pasture):	Trampling:
Soil erosion:	Flood damage:
Firewood collection:	Feral herbivores:
Stock grazing:	Other:

HN528 Mod/Good - Poor

BioBanking Field Sheet

Entered ✓

JACOBS

Shale Plains - Poor

Survey Site Form - BioBanking		Site ID: 219	Vegetation zone: CPW Hills Plains			
Date		Surveyor(s): Lukas Clews				
Waypoint ID	219	Photo numbers				
Coordinates	E N	Photo direction	N	E	S	W
Mapped Vegetation type: CPW		Condition:		Low	Mod/good	
Slope: Gentle, Mod, Steep	Aspect (degrees or cardinal): SSE	Altitude: 106m				
Topography: crest, ridge, upper slope, mid slope, down slope, gully, flat, depression, watercourse, escarpment, terrace						
Geology: basalt, granite, conglomerate, sandstone, siltstone/mudstone, shale, alluvium, limestone, metamorphics, gravel, ?						
Soil type: sand, loam, clay, organic, gravel, skeletal, ?		Soil disturbance: intact, topsoil removed, fill				
Remnant / Old growth (uncleared): Yes / No / Undecided?		Canopy trees only				
Vegetative Structure (formation) =		Ecologically Dominant Layer (EDL) - most biomass =				

Strata	Height interval	Median	Est. cover	Dominant Species & Dominance
E	X	X	X	X
T1	15-25m		20%	Eucalyptus tereticornis Eucalyptus moluccana
T2	X	X	X	X
T3	X	X	X	X
S1	1m			Lycium ferocissimum
S2	-			
G	-		40%	Pennisetum clandestinum Cirsium vulgare Senecio madagascariensis Dichondra repens

Tree height (clino) level ground or top of slope = distance from tree x (top% + bottom%)

Tree height (clino) from bottom of slope = distance from tree x (top% - bottom%)

Definitions

Dominance d = dominant; c = co-dominant; s = subdominant; a = associated

Estimated cover i = isolated (0.2-2%); v = very sparse (2-20%); s = sparse (20-50%); m = mid dense (50-80%); d = dense (80-100%)

Walker & Hopkins height classes: 1-3m = dwarf; 3-6m = low; 6-12m = mid-high; 12-20m = tall; 20-35m = very tall; >35m = extremely tall

W&H Crown cover: <0.2% = isolated trees or clumps; 0.2-20% = open woodland; 20-50% = woodland; 50-80% = open forest; 80-100% = closed forest

50m Transect	10 Points - Foliage Projective Cover		
Point	Canopy % (photos)	Midstorey %	Exotic %
5m	30	0	0
10m	30	0	0
15m	50	0	0
20m	50	0	0
25m	5	0	0
30m	20	|	0
35m	30	|	10
40m	40	|	5
45m	30	|	10
50m	40	↓	
Total (sum / 10) =	32.5	0	2.5
Larger 50 x 20m plot			
Length of woody debris >10cm wide & >0.5m long			42.2
Proportion of canopy sp. regeneration			0%
Number of trees with hollows >5cm			8

Ground cover tally sheet, 50 points along 50m transect - every 1m record if plant intersects (hits) point

	Total (hits/50)
Native grass tally -	0%
Native other (herb, fern, sedge, etc) tally - |||	6% (86%)
Native shrub tally -	0%
Exotic tally - 𝍸 𝍸 𝍸 𝍸 𝍸 𝍸 𝍸 𝍸	80%