



Additional Ecological Information Report

Huntlee New Town – Stage 2

Prepared for

Huntlee Pty Ltd

Final V4 / June 2024

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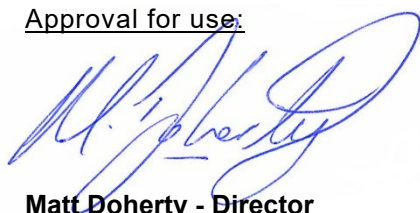
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Matt Doherty - Director

21 June 2024

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GLOSSARY OF TERMS AND ABBREVIATIONS

Term/ Abbreviation	Meaning
BC Act	Biodiversity Conservation Act 2016
BC Savings Regulation	Biodiversity Conservation (Savings and Transitional) Regulation 2017
BOS	Biodiversity Offset Scheme
CCC	Cessnock City Council
Council	Cessnock or Singleton Council
DoEE	Commonwealth Department of the Environment and Energy
DPE	NSW Department of Planning and Environment
EAR	Ecological Assessment Report prepared by RPS (2010)
EP&A Act	NSW Environmental Planning and Assessment Act 1979
EPBC Act	Commonwealth Environment Protection and Biodiversity Conservation Act 1999
LGA	Local Government Area
OEH	NSW Office of Environment and Heritage [former]
SSC	Singleton Shire Council
TSC Act	Threatened Species Conservation Act [former]

1 Introduction

This Additional Ecological Information Report supports an Environmental Impact Statement and State Significant Development Application (SSDA) that seeks consent for the Huntlee New Town Stage 2 development, comprising the concept development for the Stage 2 sites including Villages 2 and 3, land off Old North Road and the Town Centre North area, and the detailed development for the central and southern areas of Village 2, hereafter referred to as the 'site'.

The proposal represents the next phase of an extensive planning, assessment and consultation process completed to date for the development of the Huntlee New Town site.

1.1 Site Context

Huntlee, in its regional context is shown in **Figure 1** below and is located to the south of the town of Branxton in the Hunter Valley of NSW. It is located approximately 20km north of Cessnock, 23km south-east of Singleton, and 55km north-west of Newcastle. The Huntlee site straddles Wine Country Drive, which links Cessnock with the New England Highway and Hunter Expressway. Within the overall Huntlee site, the proposed urban area is bounded to the north and east by the Main North Railway and Hunter Expressway corridor, to the south by the village of North Rothbury and to the west by the Black Creek and floodplain. Other adjoining uses include vineyards, rural residential development and general agriculture.

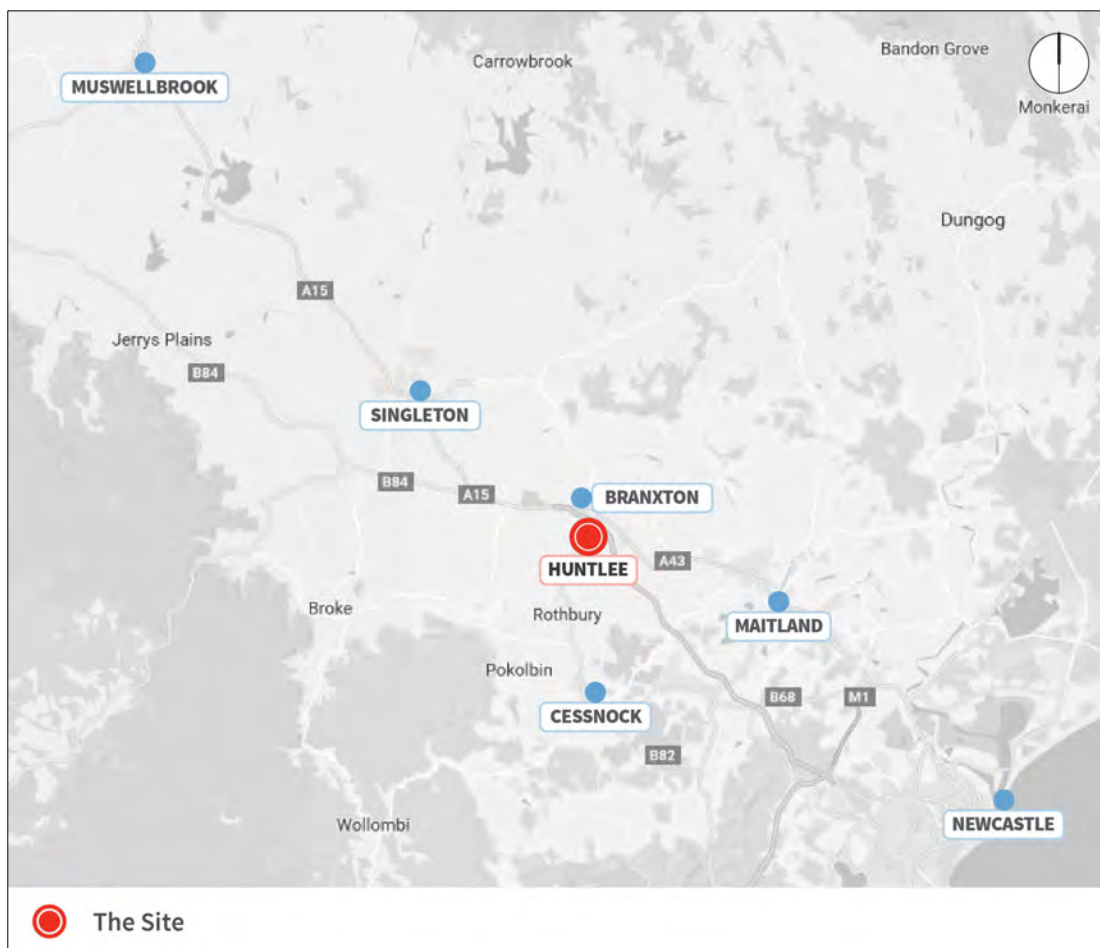
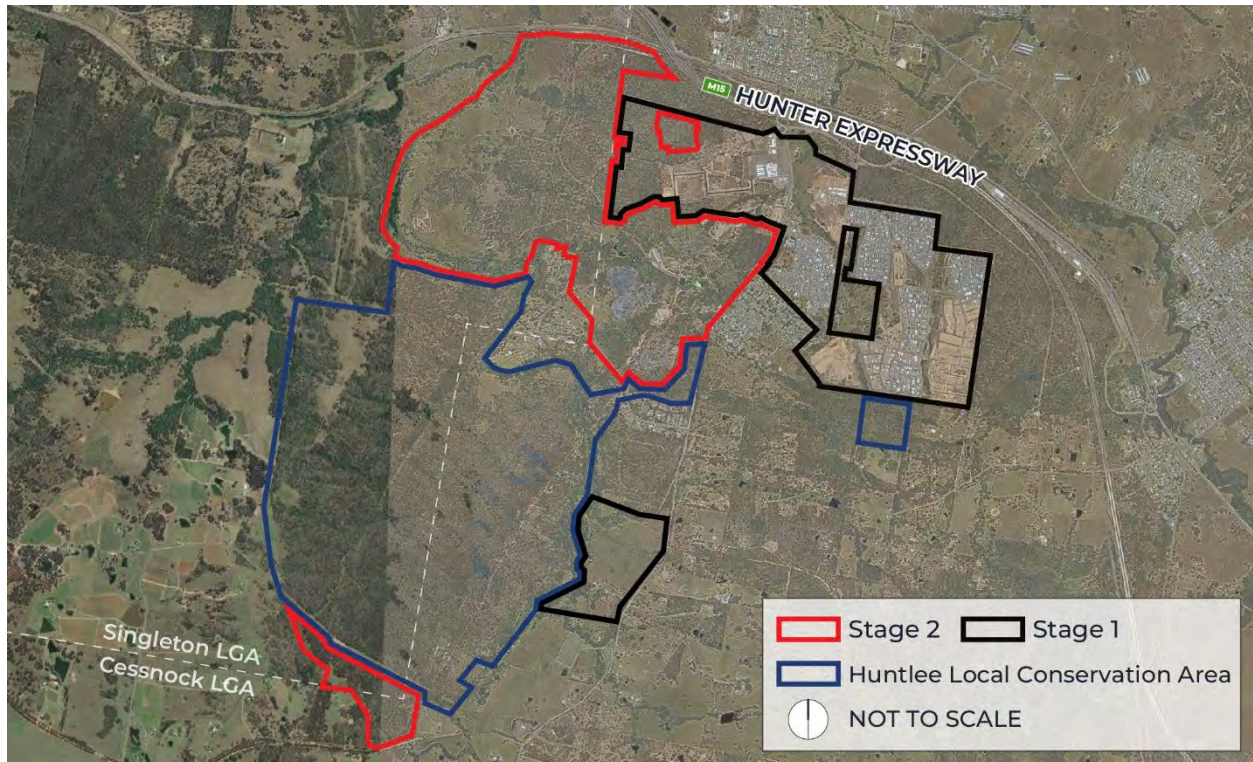


Figure 1 Huntlee Regional Context

The subject site forms a large component of the 1,622 hectare Huntlee New Town, situated to the south of Branxton in the Hunter Valley.

The subject Site comprises a number of allotments located in both Cessnock and Singleton Local Government Areas (LGAs). It has a combined area of approximately 541.71ha, is irregular in shape and is generally extended to the west and south of the approved Huntlee Town Centre. The site is bound to the west by the Black Creek and floodplain. An aerial photo of the site is provided at **Figure 2**.



(Source: Nearmap and Ethos Urban)

Figure 2 Site Aerial

1.2 Description of Proposal

This SSDA proposes the following works for the Huntlee New Town.

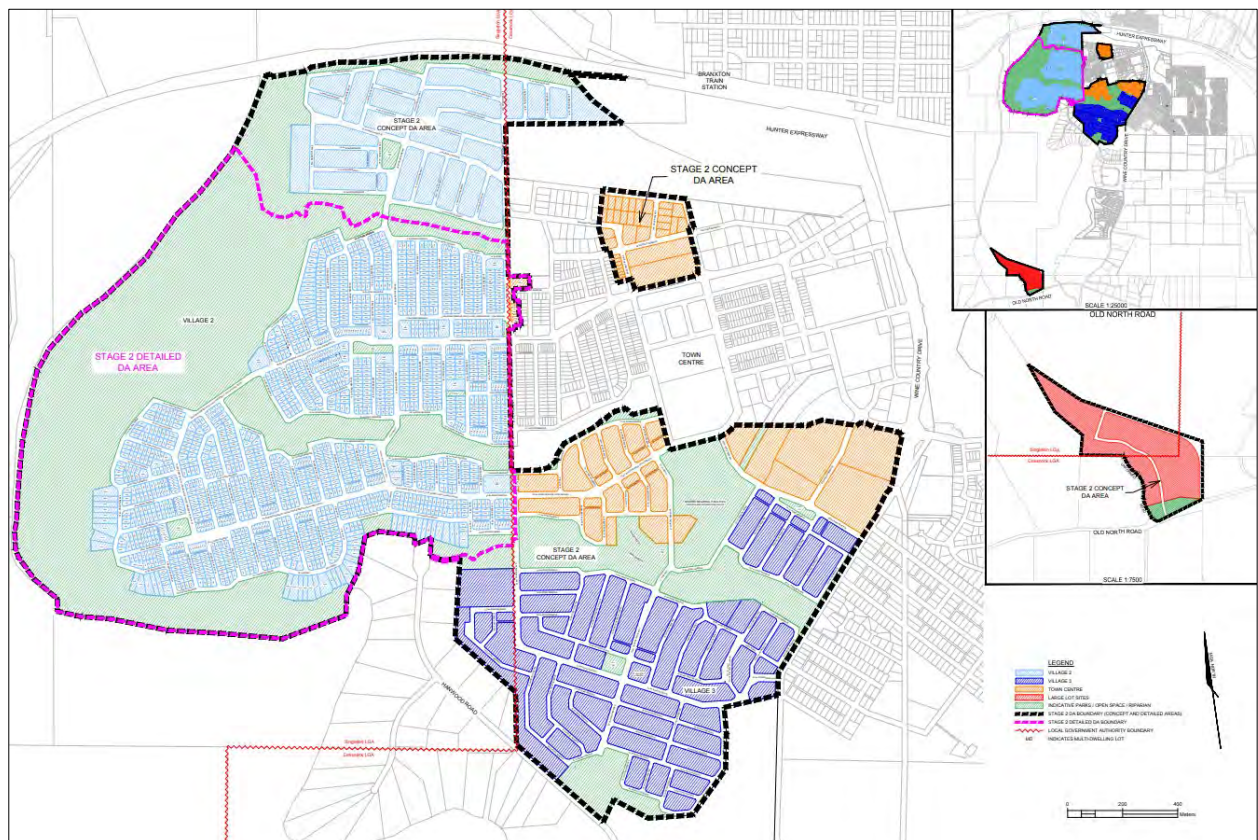
A Concept Master plan for the Stage 2 site, comprising:

- Overall Stage 2 development footprint, including:
 - o The remaining Town Centre North area,
 - o Villages 2 and 3, and
 - o A large lot residential area located to the south of the site on Old North Road;
- Proposed land use and development yield, including the provision for residential subdivision of approximately 5,000 lots;
- Associated new road network and required upgrades to existing network; and
- Site-wide open space and riparian areas;

Detailed development of Village 2 Central and South and eastern connection to the Town Centre, comprising:

- Demolition and clearing of existing built form structures;
- Clearing of existing vegetation within proposed development footprints;
- Open space, recreation, community and riparian areas;
- Construction of road and access infrastructure;
- Bulk earthworks;
- Stormwater and drainage works;
- Utilities and services, including
 - o Sewer and potable water reticulation;
 - o Electricity and communications infrastructure;
- Subdivision to facilitate approximately 1,750 lots across the Village 2 Central and South areas and Town Centre development lots, comprising approximately 1,730 residential lots, eight (8) medium density superlots, two (2) commercial/mixed use lots and open space areas; and
- Select clearing and grading to establish temporary Asset Protection Zones where development interfaces with the Concept Master plan area.

The location of Stage 2 Concept and Detailed areas is shown in **Figure 3**, in the context of the surrounding development. Refer to **Appendix 1** for higher resolution Plans of the Proposal.



(Source: Daly Smith 2023)

Figure 3 Proposed Concept and Detailed Area layout

1.3 Background

The Huntlee New Town development was Gazetted as a State Significant Site (SSS) with an amendment to Schedule 3 of State Environmental Planning Policy (Major Development) 2005 (Major Development SEPP) on 31 December 2010.

The key parameters of the overall Huntlee SSS development framework are:

- Up to 5600 dwellings in residential zones of varying sizes covering up to 612 hectares;
- Employment lands totalling up to 200 hectares, including a mixed use town centre with up to 1,700 residential dwellings;
- Large lot residential development covering up to 93 hectares to achieve 200 lots;
- The provision of associated infrastructure including upgrades to roads, sewerage and water infrastructure and the dedication of land for education, health services, community facilities and utilities;
- Conservation offsets for the entire development including:
 - a. Dedication of 780 hectares of conservation land within Huntlee;
 - b. Dedication of Persoonia Park (17 hectares);
 - c. Dedication of up to 4988 hectares of conservation land elsewhere within the Lower Hunter Region; and
 - d. Conservation funding.

Stage 1 of the planning approval (MP10_0137) for Huntlee was executed by the NSW Government (Minister for Planning and Minister for Climate Change and the Environment) and Huntlee as granted by the Planning and Assessment Commission (PAC) on 24 April 2013.

Huntlee Stage 2 was declared State Significant Development (SSD) by the Minister of Planning on 28 May 2024 (SSD-70748466), under Section 4.34(3) of the EP&A Act.

Development under the Concept Plan is the subject of a certification under clause 34A(4) of the *Biodiversity Conservation (Savings and Transitional) Regulation 2017*, that:

- a. the Huntlee New Town Development is part of a relevant planning arrangement for which the biodiversity impacts of the proposed development have been satisfactorily assessed before 25 August 2017, and
- b. conservation measures to offset the residual impact of the proposed development on biodiversity values after the measures required to be taken to avoid or minimise those impacts have been secured into the future.

Proposed development the subject of a development application is certified by the order if it complies with the provisions of the relevant planning arrangement. For the purposes of the order this was defined as:

1. the Huntlee New Town Development comprises development on land identified on the State Environmental Planning Policy (Major Development) 2005 Huntlee New Town Site Land Application Map.
2. the relevant planning arrangement is Part 27 of Schedule 3 to the State Environmental Planning Policy (State Significant Precincts) 2005 as in force immediately before its repeal by the State Environmental Planning Policy (Major Development) Amendment (Huntlee New Town Site) 2015.

The S34 Certification has the effect that the former section 5A of the EP&A Act and the former *Threatened Species Conservation Act 1995* (TSC Act), instead of the BC Act, apply to the assessment of biodiversity impacts under this application.

Acknowledging the S34 Certification context this application is directly related to the Concept Plan, therefore it is critical to note the existing Ecological Assessment Report (EAR) prepared (RPS 2010) (Refer to **Appendix C**) formed a part of the information prepared and can be relied upon for the Major Project Approval (inclusive of Stage 1 and the current SSDA for Stage 2). As such the Stage 2 application

correctly relies upon the EAR (Refer to **Appendix C**) as assisted by additional contemporary information provided in this report.

2 Changes To Threatened Species Listings

2.1 Review of Threatened Species listed after BC Act Commencement

A review of newly listed threatened species occurring since the commencement of the BC Act has been completed. At the same time a revised BioNet search within a 10km radius of the site was completed. Using the two outputs, a contemporary review of the EAR was completed to derive a species list for survey and assessment.

The review coupled with a revised BioNet search determined the following listed threatened entities occur within 10km and have potential to occur on the site.

Haliaeetus leucogaster – White Bellied Sea Eagle

Persoonia pauciflora – North Rothbury Persoonia (survey and results discussed below)

Pterostylis chaetophora – Tall Rustyhood (survey and results discussed below)

Rhodamnia rubescens – Scrub Turpentine

Rhodomyrtus psidioides – Native Guava

The EAR preliminary methodology involved a comprehensive literature review and collation of previous flora and fauna survey over the preceding decade. Surveys were undertaken recording both threatened species presence and the occurrence of keystone mature trees, and habitat features such as hollows bearing trees.

The North Rothbury Persoonia was considered as part of the EAR, as it was listed as Critically Endangered under the TSC Act and the EPBC Act at the time of preparation of the EAR. As its discovery was and remains relatively recent – first published in 1999 (the same year it was gazetted under the former TSC Act) – the distribution and population size are subject to ongoing updates. The development area was further assessed to confirm that there has been no quantifiable change to the previously assessed impact and understand whether there are new individual plants in the Stage 2 area.

The White-bellied Sea Eagle was considered as part of the EAR due to the pre-existing species listing under the EPBC Act. At the time of field assessment and report production, the species was not detected, and large stick nests associated with the species habit were not observed. Nonetheless surveys were conducted concurrently with contemporary stratified site surveys.

A review of the EAR was completed to determine whether *Rhodamnia rubescens* or *Rhodomyrtus psidioides* were recorded in the development site or conservation lands during the survey period. Of 28 Myrtaceous species recorded in the study, neither was present. Given the nature of the vegetation and landform, it is highly unlikely that these sheltered, wet forest species were present and undetected. Nonetheless surveys were conducted concurrently with comparable growth form flora.

The vulnerable orchid *Pterostylis chaetophora* has records immediately adjacent to the development area generally within the NPWS lands (Huntlee Offsets), and as such targeted stratified survey was undertaken over the development site to understand distribution.

3 Ecological Field Surveys

Surveys undertaken to assess threatened species occurrence or occupation of the development areas consisted of parallel transects of between 5 and 20 metres. A team of 2-8 MJD Environmental ecologists traversed the entire 426 hectare site for each targeted growth form survey.

The surveys targeted all threatened flora species detectable during the survey period with due recognition of individual ecology and seasonality. Surveys were carried out over two periods, in autumn/winter and spring 2023, targeting appropriate growth forms and in suitable periods following flowering of reference populations. Survey effort and transect width were based on *Surveying threatened plants and their habitats NSW survey guide for the Biodiversity Assessment Method* (DPIE 2020).

Flora surveys targeted all areas of native vegetation on the development land, excluding only areas subject to dense suppressing infestation with *Lantana camara* where access was not possible, subject to former intense disturbance (mining / quarrying), or significant earthworks (steep subsoil batter slopes, e.g. associated with the rail alignment). Surveys were generally conducted in fine weather per **Table 1** below.

Table 1 Prevailing Weather Conditions

Date	Min Temp (oC)	Max Temp (oC)	Rain (mm)	Wind (km/h)	Sunrise	Sunset
20/03/2023	16.3	26.7	0	NNE 7 km/h - SSE 26 km/h	6:56 AM	7:08 PM
21/03/2023	18	22.7	0	SSE 9 km/h - ESE 13 km/h	6:56 AM	7:06 PM
22/03/2023	13.9	28.1	0	SE 9 km/h - ESE 11 km/h	6:57 AM	7:05 PM
23/03/2023	16.9	32.4	0.2	ENE 2 km/h - NW 15 km/h	6:58 AM	7:04 PM
24/03/2023	15.9	27.1	35.2	SW 9 km/h - SE 11 km/h	6:59 AM	7:03 PM
29/03/2023	18	27.4	10.6	NNE 6 km/h - NNW 22 km/h	7:02 AM	6:56 PM
30/03/2023	11.1	24.8	1	NNW 15 km/h - SW 19 km/h	7:03 AM	6:55 PM
31/03/2023	12	25	0	NW 15 km/h - WNW 15 km/h	7:04 AM	6:53 PM
3/04/2023	12.7	24.2	0.2	SE 7 km/h - SE 11 km/h	6:06 AM	5:49 PM
4/04/2023	14.5	24.5	6.4	SE 9 km/h - ESE 15 km/h	6:06 AM	5:48 PM
5/04/2023	11.8	25.6	0	SSW 13 km/h - S 13 km/h	6:07	5:47 PM
6/04/2023	11.1	23.7	0.4	N 7 km/h - ESE 13 km/h	6:08 AM	5:46 PM
21/04/2023	11.5	21.9	7.2	S 7 km/h - SE 17 km/h	6:18 AM	5:28PM
26/04/2023	8.5	24.3	0	Calm - ENE 11km/h	6:22 AM	5:22 PM
27/04/2023	11.1	24.5	0	Calm - ENE 11km/h	6:23 AM	5:21 PM
28/04/2023	9.1	27	0	ENE 6 km/h - NW 15 km/h	6:23 AM	5:20 PM
1/05/2023	8.4	19.4	0	NW 13 km/h - WNW 17 km/h	6:25 AM	5:17 PM
2/05/2023	9.8	22.7	0	N 19 km/h - NW 15 km/h	6:26 AM	5:16 PM
3/05/2023	12.1	23.9	0	WNW 26 km/h - WNW 39 km/h	6:27 AM	5:15 PM
4/05/2023	9.3	20.5	0	NNW 11 km/h - SSW 7 km/h	6:28 AM	5:14 PM
5/05/2023	3.9	21.5	0	NNE 6 km/h - ENE 9 km/h	6:28 AM	5:13 PM
15/05/2023	8.1	21	0	Calm - W 6 km/h	6:35 AM	5:05 PM
17/05/2023	5.1	18	1.6	S 13 km/h - SE 19 km/h	6:37 AM	5:04 PM
18/05/2023	8.5	18.5	0	S 9 km/h - SSE 11 km/h	6:38 AM	5:03 PM
19/05/2023	4.4	18.4	0.8	WSW 9 km/h - NW 15 km/h	6:38 AM	5:03 PM
22/05/2023	2.7	19.6	0	NW 11 km/h - N 13 km/h	6:40 AM	5:01 PM
23/05/2023	-0.9	21	0	Calm - E 6 km/h	6:41 AM	5:01 PM
24/05/2023	-0.2	22.1	0	NNW 7 km/h - NNW 13 km/h	6:42 AM	5:00 PM

Date	Min Temp (oC)	Max Temp (oC)	Rain (mm)	Wind (km/h)	Sunrise	Sunset
25/05/2023	0.2	23	0	NW 13 km/h - NNW 15 km/h	6:42 AM	5:00 PM
26/05/2023	7.2	21.1	0	WNW 19 km/h - SSW 13 km/h	6:43 AM	4:59 PM
1/06/2023	13.3	23.3	0	NW 20 km/h - NNW 9 km/h	6:46 AM	4:57 PM
2/06/2023	5.3	21.8	0	Calm - ENE 9 km/h	6:47 AM	4:57 PM
6/10/2023	6.5	23	0	NNW 11 km/h - E 20 km/h	6:24 AM	7:01 PM
6/10/2023	6.5	23	0	NNW 11 km/h - E 20 km/h	6:24 AM	7:01 PM
9/10/2023	3.3	27.1	0	NNE 7 km/h - NNW 17 km/h	6:20 AM	7:03 PM
9/10/2023	3.3	27.1	0	NNE 7 km/h - NNW 17 km/h	6:20 AM	7:03 PM
10/10/2023	7.8	25.4	0	WNW 9 km/h - SE 20 km/h	6:19 AM	7:03 PM
10/10/2023	7.8	25.4	0	WNW 9 km/h - SE 20 km/h	6:19 AM	7:03 PM
12/10/2023	7.3	33.3	0	NE 6 km/h - NNW 26 km/h	6:17 AM	7:05 PM
12/10/2023	7.3	33.3	0	NE 6 km/h - NNW 26 km/h	6:17 AM	7:05 PM
13/10/2023	12.1	26.6	0.2	W 20 km/h - SW 15 km/h	6:15 AM	7:06 PM
16/10/2023	5.7	30.2	0	NNW 17 km/h - WNW 41 km/h	6:12 AM	7:08 PM
16/10/2023	5.7	30.2	0	NNW 17 km/h - WNW 41 km/h	6:12 AM	7:08 PM
17/10/2023	11.2	22	0	SSW 20 km/h - SSE 20 km/h	6:10 AM	7:09 PM
17/10/2023	11.2	22	0	SSW 20 km/h - SSE 20 km/h	6:10 AM	7:09 PM
18/10/2023	8.1	23.6	0	SSE 11 km/h - SE 20 km/h	6:09 AM	7:09 PM
18/10/2023	8.1	23.6	0	SSE 11 km/h - SE 20 km/h	6:09 AM	7:09 PM
19/10/2023	9.8	24.7	0.2	NNE 9 km/h - N 9km/h	6:08 AM	7:10 PM
19/10/2023	9.8	24.7	0.2	NNE 9 km/h - N 9km/h	6:08 AM	7:10 PM
20/10/2023	7.3	30.5	0	NNE 7 km/h - ESE 9 km/h	6:07 AM	7:11 PM
20/10/2023	7.3	30.5	0	NNE 7 km/h - ESE 9 km/h	6:07 AM	7:11 PM
21/10/2023	9.4	33.4	0	NNE 2 km/h - NE 13 km/h	6:06 AM	7:12 PM
23/10/2023	9.8	31.1	0	N 17 km/h - NNW 15 km/h	6:04 AM	7:13 PM
23/10/2023	9.8	31.1	0	N 17 km/h - NNW 15 km/h	6:04 AM	7:13 PM
24/10/2023	6.1	35.1	0	NE 4 km/h - NW 22 km/h	6:02 AM	7:14 PM
24/10/2023	6.1	35.1	0	NE 4 km/h - NW 22 km/h	6:02 AM	7:14 PM
25/10/2023	8.7	29.2	0	Calm - ENE 20 km/h	6:01 AM	7:15 PM
25/10/2023	8.7	29.2	0	Calm - ENE 20 km/h	6:01 AM	7:15 PM
26/10/2023	13.5	14.3	1.6	S 15km/h - SSE 19 km/h	6:00 AM	7:16 PM
26/10/2023	13.5	14.3	1.6	S 15km/h - SSE 19 km/h	6:00 AM	7:16 PM
27/10/2023	11.4	19	15.6	SSW 11 km/h - SSE 20 km/h	5:59 AM	7:17 PM
27/10/2023	11.4	19	15.6	SSW 11 km/h - SSE 20 km/h	5:59 AM	7:17 PM
30/10/2023	6.1	33.1	0	N 15 km/h - NW 28 km/h	5:56 AM	7:19 PM
2/11/2023	8.8	24.9	0	S 13 km/h - E 19 km/h	5:53 AM	7:22 PM
2/11/2023	8.8	24.9	0	S 13 km/h - E 19 km/h	5:53 AM	7:22 PM
3/11/2023	9.7	25.5	0	E 15 km/h - ESE 22 km/h	5:52 AM	7:23 PM
6/11/2023	10.7	22.1	12	S 7 km/h - SE 13 km/h	5:50 AM	7:25 PM

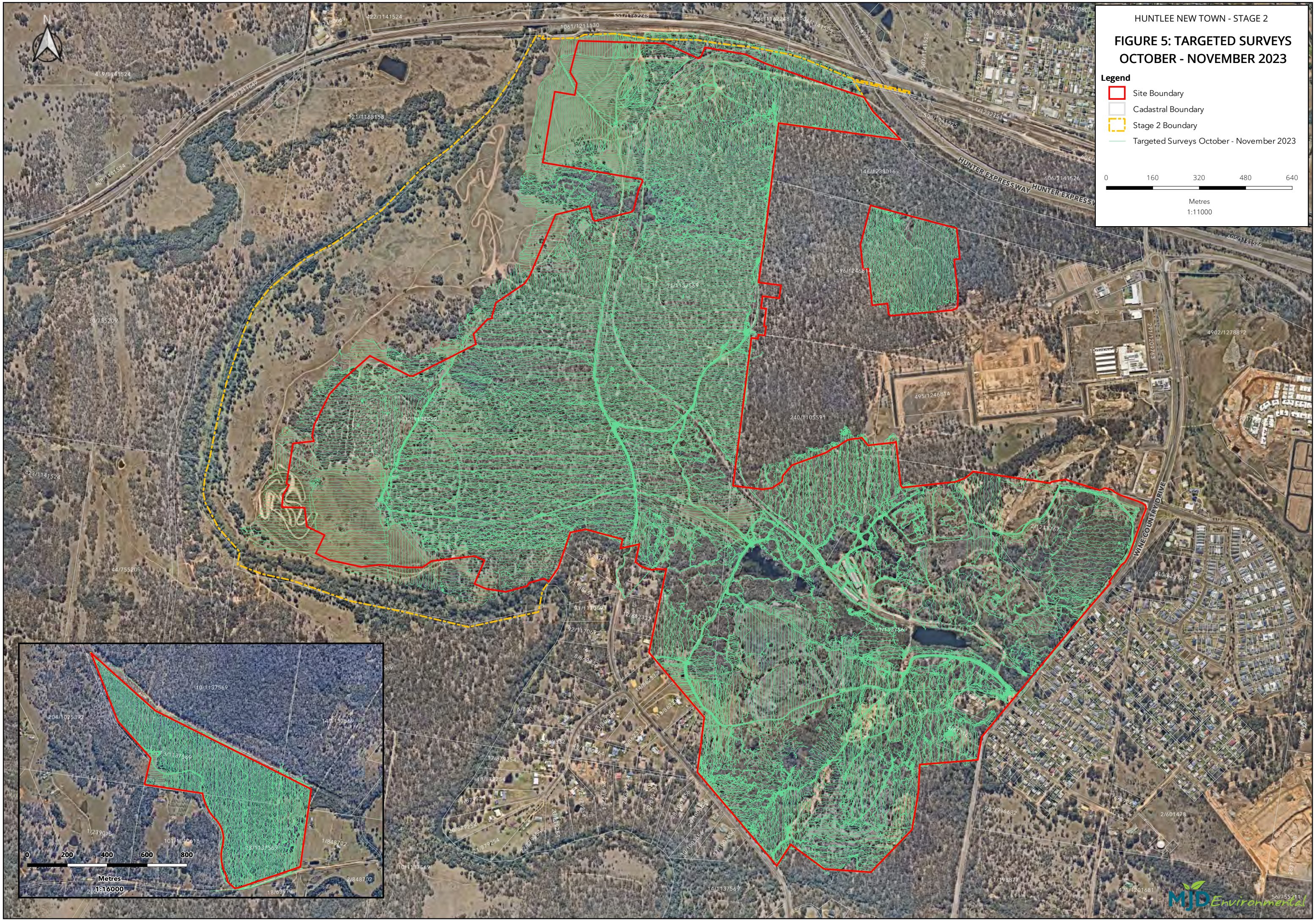
Sources: <http://www.bom.gov.au/climate/dwo/IDCJDW0200.shtml>

<http://www.ga.gov.au/bin/geodesy/run/sunrisenset>

Surveys for tree and shrub growth forms and impermanent fauna habitat such as stick nests were surveyed using 20 m transects between March and June 2023. Site coverage is shown on **Figure 4**.

Surveys for forb growth forms were conducted in October and November 2023, immediately following confirmation from DPE and by MJD Environmental Ecologists of a flowering reference population of *Pterostylis chaetophora*, which had failed to flower in previous years. Note that voucher population was continually checked for duration of surveys. Surveys were carried out using 5-10 m parallel transects, depending on vegetation density. Very open areas with short ground cover were surveyed at 10m, with all other areas using 5m transects. Site coverage is shown on **Figure 5**.

All transects were tracked using handheld GPS, please note that depending on team numbers a single GPS line may represent more than one single individual ecologist traversing the site. Note the development site boundary was buffered by 60m to ensure that all impact areas were surveyed.



HUNTLÉE NEW TOWN - STAGE 2

FIGURE 5: TARGETED SURVEYS
OCTOBER - NOVEMBER 2023

- Legend
- Site Boundary
 - Cadastral Boundary
 - Stage 2 Boundary
 - Targeted Surveys October - November 2023

0 160 320 480 640
Metres
1:11000

0 200 400 600 800
Metres
1:16000

4 Ecological Field Survey Results

The site inspection revealed that the site conditions, vegetation communities and habitat remain generally consistent with those documented in the EAR, although weed infestation, particularly from woody weeds (e.g. Lantana), had increased in some areas. This reinforces the conclusions of the ecological impact assessment undertaken in the EAR.

Surveys did not detect *Rhodamnia rubescens*, *Rhodomyrtus psidioides* or any evidence of occupation by *Haliaeetus leucogaster* in the form of large stick nests. This is consistent with the vegetation class and landform and distance to significant bodies of water. These species therefore are unlikely to occur on or occupy the development lands.

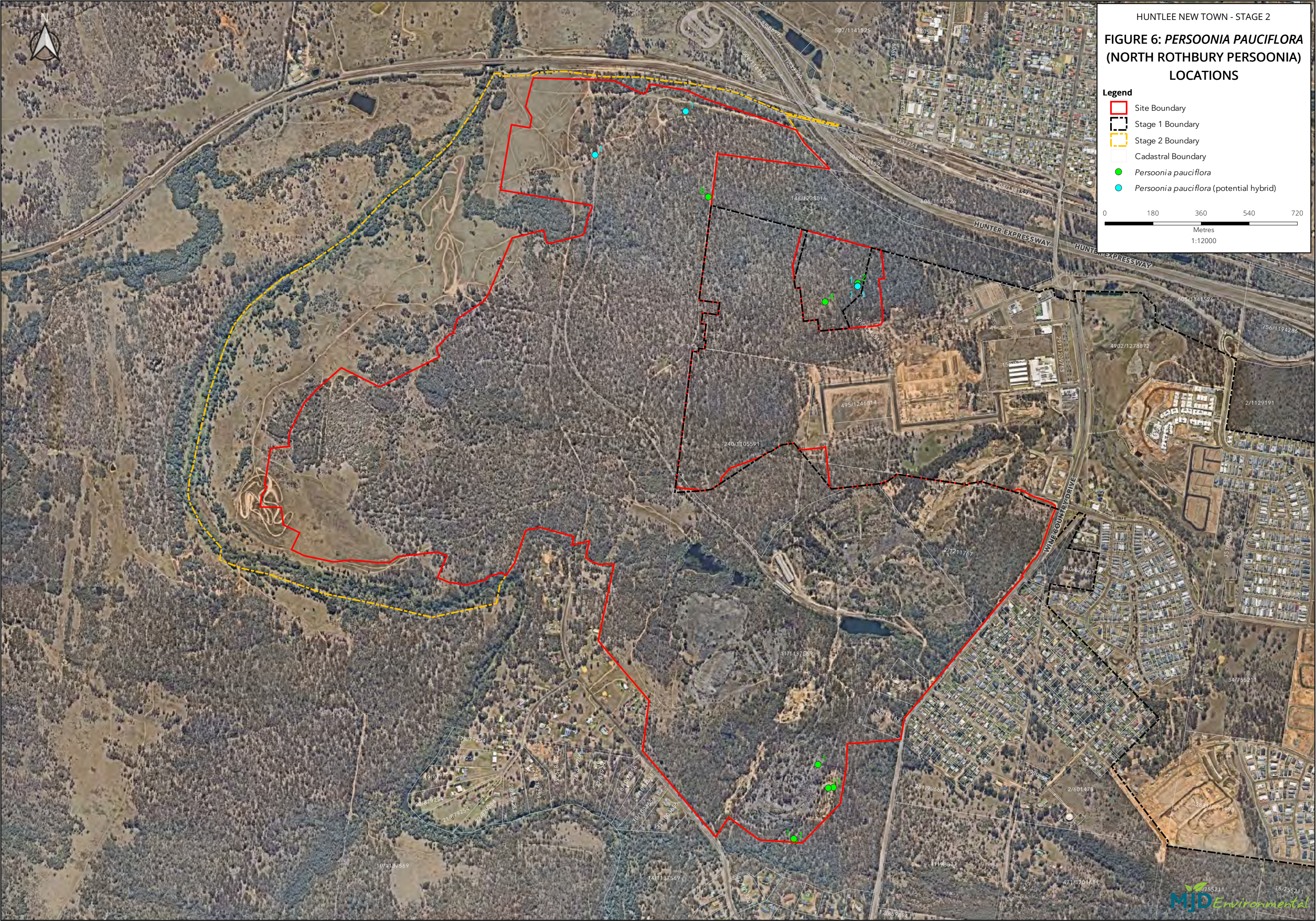
Both *Pterostylis chaetophora* and *Persoonia pauciflora* were recorded within the development lands.

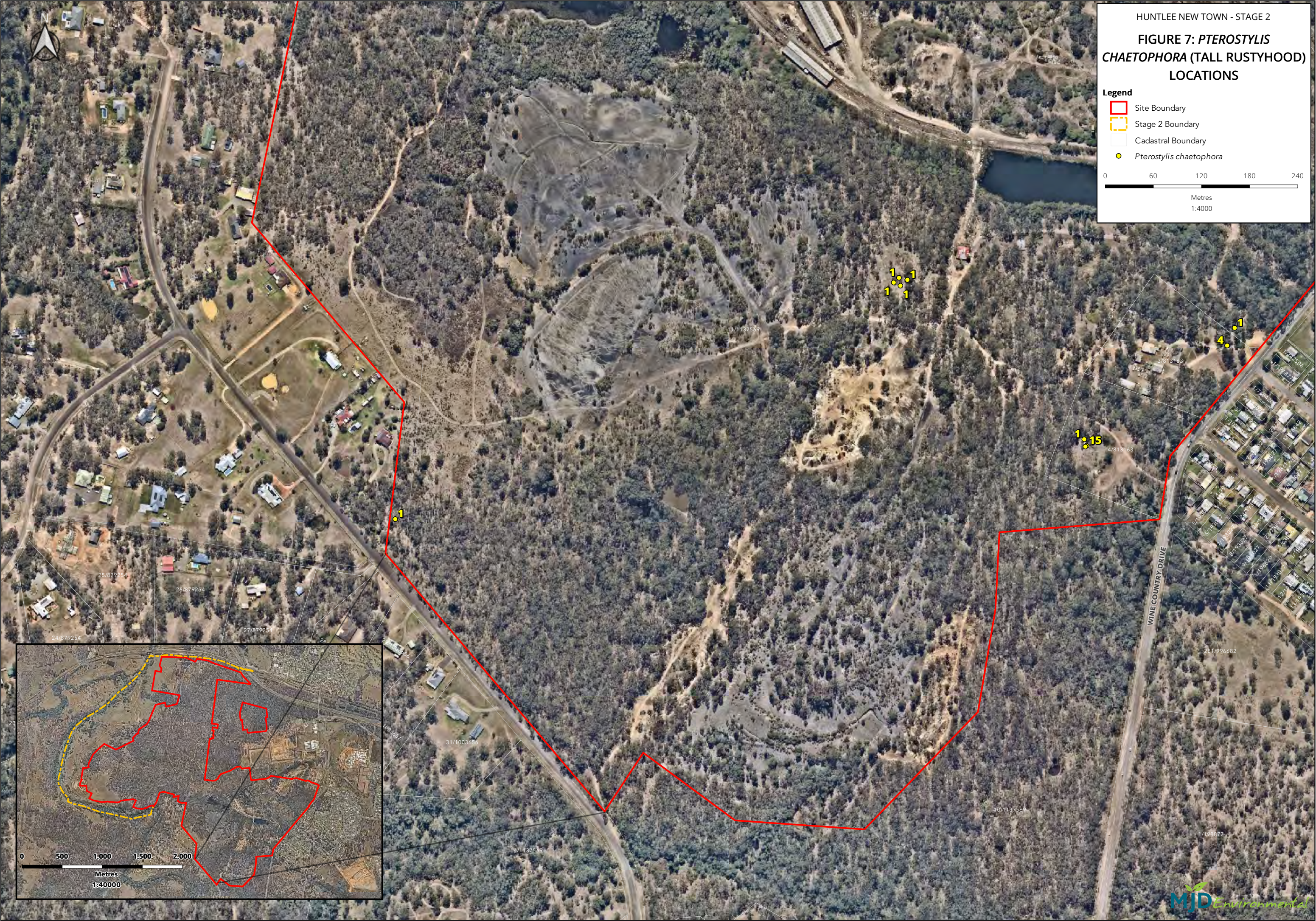
4.1 *Persoonia pauciflora* (North Rothbury Persoonia)

Woody flora surveys identified a total of 28 individual *Persoonia pauciflora* were identified in contemporary surveys of which 5 are considered potential hybrids that require monitoring as they mature. Locations are shown in **Figure 6**. Records were dispersed but generally in the northern and south-eastern quarter of the development land.

4.2 *Pterostylis chaetophora* (Tall Rustyhood)

Orchid surveys identified 27 individuals of *Pterostylis chaetophora* in 11 locations in the development lands as depicted in **Figure 7**. Records were clustered in the south-eastern extreme of the development land, south of the rail line and east of the large coal chitter pad, with all identified individuals separated by no more than 500m. On this basis the 11 locations can be considered a single location in the broader context that species occurrence is generally recorded.





5 Threatened Species Listings

5.1 *Persoonia pauciflora* (North Rothbury Persoonia)

The shrub *Persoonia pauciflora* was listed as a Critically Endangered Species under the former TSC Act on 6 February 1999, and under the EPBC Act on 8 July 2005, in response to the species extremely restricted range and small population size, as well as a 64-77% decline in population over 3 years. Notably the decline was isolated to the illegal clearing of the species on land that was not associated with the Huntlee New Town development. Subsequently, new populations have been discovered and the recovery of the population in decline has occurred from soil-stored seed released from allelopathic suppression following the removal of mature plants.

5.1.1 Summary of Assessment of Significance *Persoonia pauciflora*

The discovery (published in 1999) of this species and its subsequent listing were partly associated with investigations of the development of the North Rothbury area to establish the Huntlee New Town. The ongoing study and identification of new populations and individuals have resulted in a range of instruments to secure the population into the future. This is being achieved either through in-situ conservation in National Park estate and offset instruments securing populations on private land, or through harvest of genetic and propagative material or the translocation of whole plants from isolated occurrences that will ultimately be removed. This process of harvesting cuttings and seed germination trials has occurred, initially based on funding from the Huntlee project and then through continuation of funding via the NSW Save Our Species (SoS) program. Successful planting trials have been established within NPWS Estate (former Huntlee offset lands) and genetic studies have been conducted, spearheaded by the NSW SOS team.

The individuals identified in the development lands will be subject to the opportunity for harvesting propagative material can be carried out over multiple occasions prior to the removal of the vegetation. As such, maintaining consistency with the Huntlee Concept approval outcomes and no increase in the impact as previously assessed is likely to occur based on the contemporary surveys carried out conservatively for this species.

An assessment of significance for *P. pauciflora* is included at **Appendix A**.

5.2 *Pterostylis chaetophora* (Tall Rustyhood)

The orchid *Pterostylis chaetophora* was listed as a Vulnerable species under the former TSC Act on 29 August 2014, on the basis of a highly restricted geographic range and a low total number of mature individuals, as well as a preferred habitat that is susceptible to weed infestation.

5.2.1 Summary of Assessment of Significance *Pterostylis chaetophora*

Pterostylis chaetophora is known in NSW from 18 locations, with 661 current records in NSW Bionet. Of these locations, one occurs adjacent to the development site (Black Creek, west of development site), which includes occurrences in the Tiraki Nature Reserve. This site is one of six (6) Priority Management Sites (PMS) under the NSW SoS strategy. While this management area is adjacent to the development lands, they do not overlap and the PMS site is in the tenure and custodianship of the NSW Government.

The occurrence of this species on the site, near the site extent and adjacent to roads, rail, and former mining operations, represent approximately 1.5% of the recorded occurrences in Bionet. The approximately 25 ha extent of occupancy and low density area of occurrence therein are not significant in the landscape context of this species occurrence in NSW, or the relative abundance and density of individuals in the neighbouring PMS. As such, the clearing of vegetation on the development lands is unlikely to have a significant impact on this species occurrence in the locality or at a population scale. The removal of individuals does provide an opportunity to salvage orchid individuals for scientific research that has been conducted by the NSW SoS team.

An assessment of significance for *P. chaetophora* is included at **Appendix A**.

6 Vegetation Outcome

The following is provided in relation to the overall conservation and development outcomes relating to Endangered Ecological Communities (EEC) mapped as occurring within the Huntlee Stage 2 area based on the vegetation community mapping contained within the EAR (RPS 2010) and presented on Figure 3-2 and Table 5-4 of that report.

Map Unit	EEC	Status (ha)				
		Removed		Retained		
		Stage 1 ⁴	Stage 2 ¹	Huntlee Development Areas		Huntlee Conservation Areas
				Stage 1	Stage 2	
13	Central Hunter Riparian Forest (CHRF)	2.75ha	49.46ha	3.28ha	8.74ha	35.81ha (37.48ha ²)
14	Wollombi Redgum - River Oak Woodland	0ha	0.07ha	3.76ha	11.92ha	10.79ha
18	Central Hunter Ironbark - Spotted Gum - Grey Box Forest (CHISGGBF)	165.71ha	152.96ha	3.9ha	2.76ha	568.06ha (568.36ha ³)

¹ Subject to detailed design

² Huntlee Reserve and Huntlee Development Area (Stage 1 Large Lot – refer to text below)

³ retained in conservation lands per Table 5.4 Huntlee Ecological Assessment Report (2010)

⁴ includes Stage 1 temporary APZ

Central Hunter Riparian Forest (CHRF).

- The outcome described in Table 5-4 of the EAR for CHRF indicates that that 62.30ha of this community occurs in development areas of which 37.48ha will be retained in Huntlee Development Area and Huntlee Reserve (being the Huntlee offset lands). The 37.48ha is comprised of –
 - o 37.45ha is situated in Huntlee Reserve (Huntlee Offset Lands); and
 - o 0.03ha occurs in the existing (approved) large lot site on the central southern boundary (refer green region shown within pink circle on **Figure 8** below).

The remaining areas of CHRF contained within the Huntlee lands (62.30ha) do not form part of the 37.48ha conservation area stated in Table 5-4 of the EAR (2010).

- Section 5.4 including Table 5-3 of the EAR states that, 'impacts could occur to the majority of extant vegetation within the proposed Huntlee development precincts which includes areas of EEC's'. Additionally, Table 5-3 estimates that a 2/3 of this community is likely to be retained with the Huntlee site including within dedicated conservation reserves (37.45ha detailed in the point above). Notwithstanding impacts are to be considered against the numerous beneficial holistic outcomes provided by the Huntlee offsets package.

In the context of the above, CHRF has been retained within the Huntlee Reserve (Huntlee Offset Lands) and large lot development area as reported in the EAR (2010) thereby maintaining consistency with the EAR (2010).

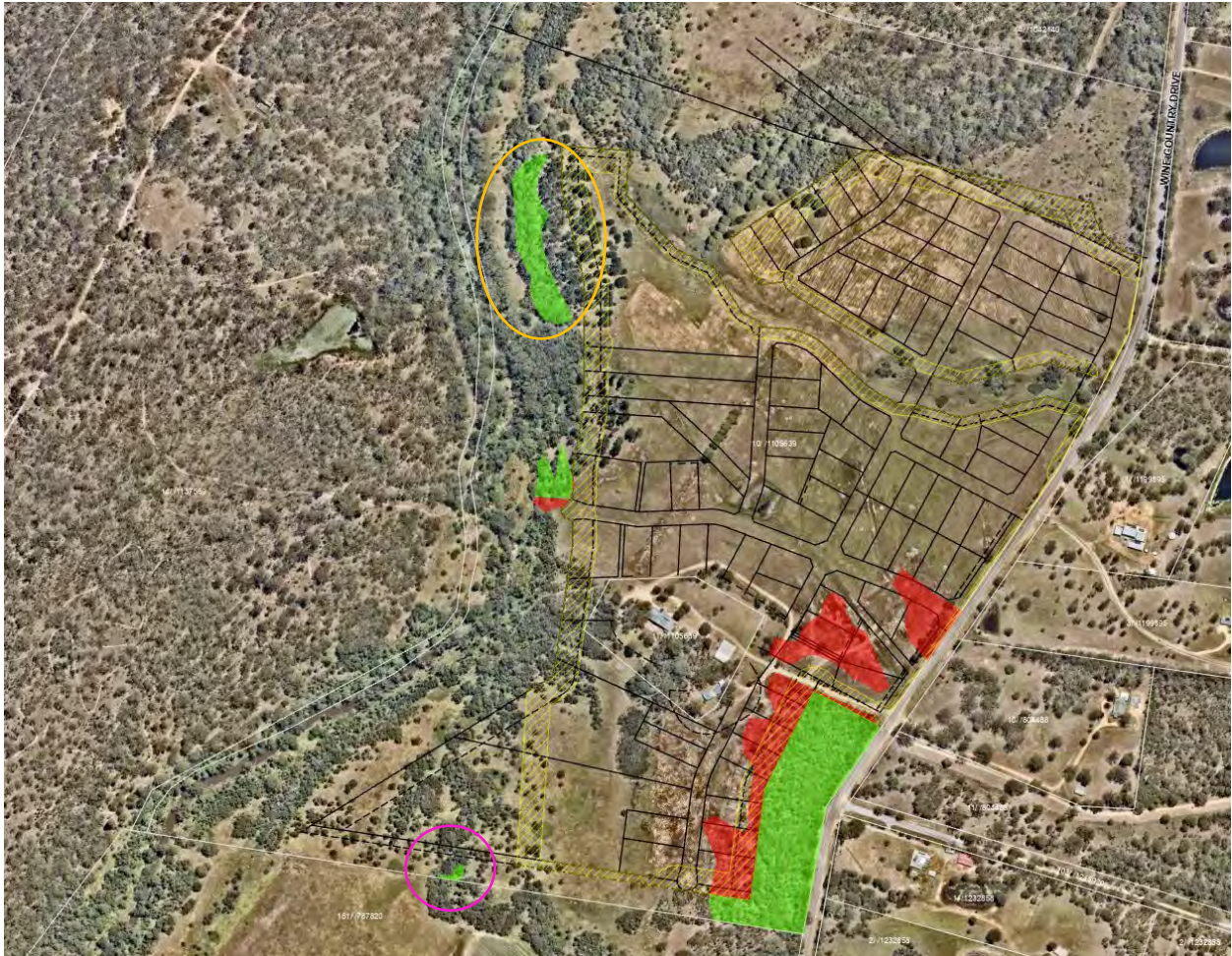


Figure 8 CHRF Areas within Stage 1 Large Lot Approval Area

The Stage 1 and Stage 2 development area will remove a total area of 52.21ha and retain (subject to detailed design) a total area of 12.02ha within Huntlee Development Areas (Refer to **Figure 9**) as follows:

- Stage 1 removal of 2.41ha occurred in the Large Lot living area (**Figure 8**). An area of 3.28ha (excluding the 0.03ha area detailed previously) was retained.
- To the west of the approved Stage 1 large lot development area, a mapped patch of CHRF occurs covering an area of 0.66ha (refer green region shown within orange circle on **Figure 8**) and has been retained. This patch represents an additional retention of CHRF beyond that calculated and reported in the EAR (2010). Note the 0.66ha is included in the 3.28ha reported in the point above.
- An area of 0.34ha is approved for removal to accommodate temporary APZ establishment around Stage 1.
- Stage 2 removal of 49.46ha will occur to in the development area. An area of 8.74ha will be retained within riparian and open space areas.
- A total area of 35.81ha is contained and retained within conservation reserves according to contemporary boundary data.

Wollombi Redgum - River Oak Woodland

- The outcome described in Table 5-4 of the EAR for this community indicates that that 12.46ha of this community occurs in development areas and 14.58ha in conservation areas. Table 5-3 indicates the majority of the community will be kept across all Huntlee areas.
- There was no impact to this community during Stage 1 development works. Stage 2 development will result in the removal of a minor area 0.07ha of this community generally situated south of the development area. Refer to **Figure 9**.

In the context of the above, Wollombi Redgum - River Oak Woodland has been largely retained, thereby maintaining consistency with the EAR (2010).

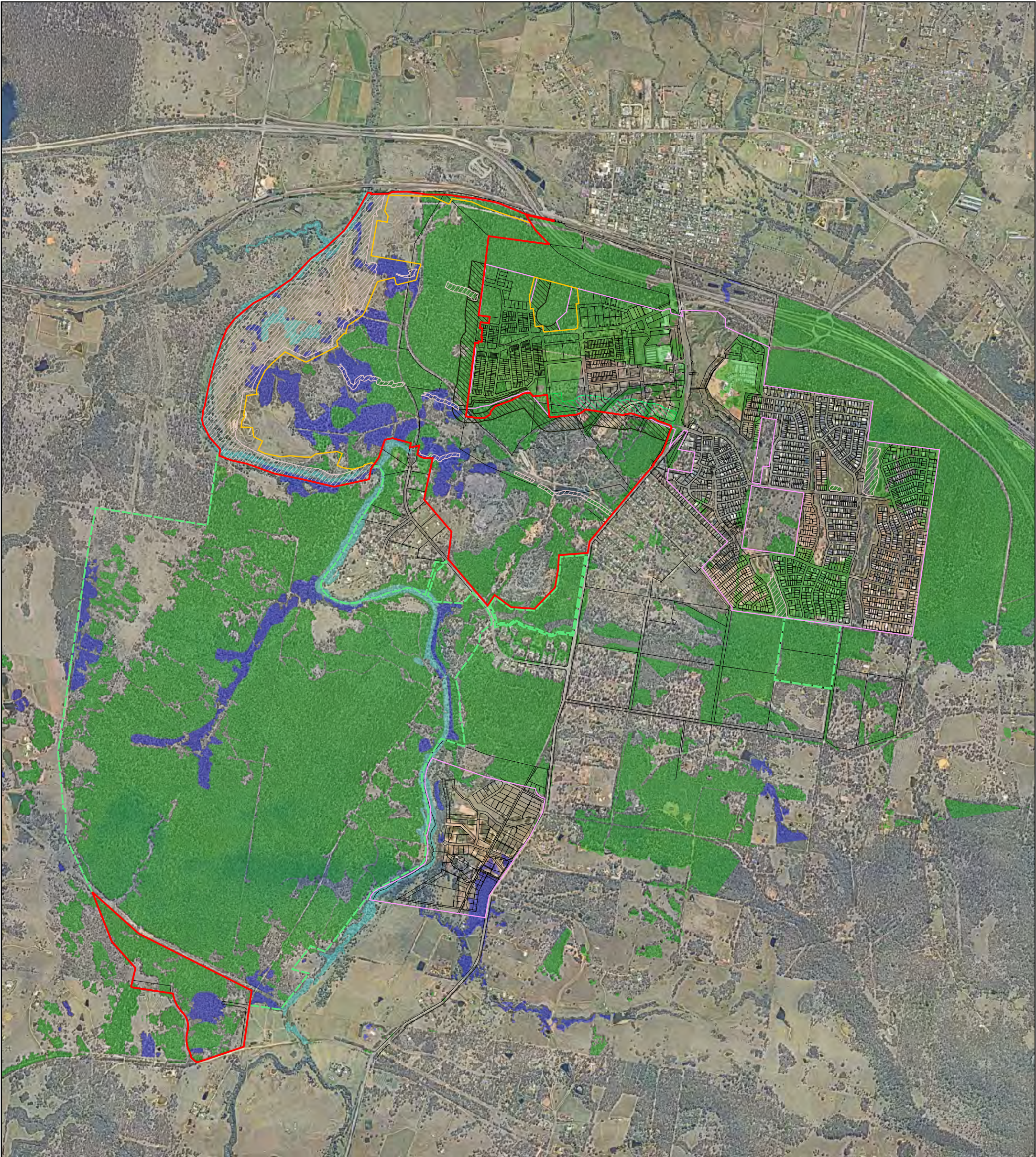
Central Hunter Ironbark - Spotted Gum - Grey Box Forest

- The outcome described in Table 5-4 of the Huntlee Ecological Assessment Report [EAR] (2010) for CHISGGBF indicates that conservation of 568.36ha of this community will occur within the Huntlee Development Area, Huntlee Reserve and Persoonia Reserve. The Huntlee development area will remove 341.24ha of this community.
- Section 5.4 including Table 5-3 of the EAR states that CHISGGBF is the dominant community at Huntlee and 341.24ha of the community occurs outside dedicated conservation areas. Some additional retention within ancillary development area (i.e. open space areas, ephemeral creekline areas) was considered likely. Additionally, Table 5-3 estimates that an overall net loss of this community could occur, however impacts are to be considered against the numerous beneficial holistic outcomes provided by the Huntlee offsets package.

In the context of the above, Stage 1 and Stage 2 development area will remove a total area of 318.67ha and retain (subject to detailed design) a total area of 6.66ha of CHISGGBF within Huntlee Development Areas (Refer to **Figure 9**) as follows:

- Stage 1 removal across developed areas and areas approved for development including temporary APZ establishment around Stage 1 of 165.71ha. An area of 3.9ha is retained.
- Stage 2 removal of 151.96ha will occur to in the development area. An area of 2.76ha will be retained (subject to detailed design) within riparian and open space areas.

In the context of the Huntlee Stage 1 and Stage 2 Development areas, the anticipated cumulative outcome where removal of up to 341.24ha of CHISGGBF would occur has not been exceeded. Additional retention of 6.66ha has been achieved per Table 5-3 of the EAR (2010), thereby maintaining consistency with the intent of the EAR (2010).



HUNTLEE NEW TOWN - STAGE 2

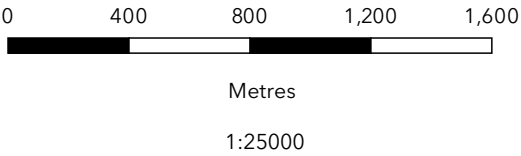
FIGURE 9: VEGETATION OUTCOME

Legend

- Stage 2 Boundary
- Stage 2 Development Area
- Stage 1 Boundary (Approximate)
- Stage 1 Temporary APZ
- Conservation Area
- Retained Vegetation
- Proposed and Existing Layout

Vegetation Community

- Central Hunter Ironbark - Spotted Gum - Grey Box Forest
- Central Hunter Riparian Forest
- Wollombi Redgum - River Oak Woodland



Aerial: Nearmap (2024) | Data: MJD Environmental, Northrop, Daly Smith, ADW Johnson (2024), RPS (2016)
| Datum/Projection: GDA94 / MGA zone 56 | Date: 2024-04-11 | Version: 2 | Z:\16015 - Huntlee, Branxton |
This plan should not be relied upon for critical design dimensions.

7 Additional Mitigation Measures

Huntlee recognises the opportunity and value of threatened flora salvage in development areas ahead of clearing for construction and is happy to collaborate with the NSW Save Our Species representatives to coordinate the salvage of *Pterostylis chaetophora* and *Persoonia pauciflora* propagative material or individuals from plants located within the development lands under the supervision of Huntlee representatives.

8 Conclusion

This Additional Ecological Information Report supports an Environmental Impact Statement SSDA that seeks consent for the Huntlee New Town Stage 2 development. The proposal represents the next phase of an extensive planning, assessment and consultation process completed to date for the development of the Huntlee New Town site.

Acknowledging development under the Huntlee Concept Plan is the subject of a certification under clause 34A(4) of the *Biodiversity Conservation (Savings and Transitional) Regulation 2017*, the application relies upon the Ecological Assessment Report (EAR) prepared (RPS 2010). In order to supplement the EAR (RPS 2010), this report has undertaken a review of newly listed threatened species under the BC Act that have effect under the TSC Act. Where required, contemporary surveys have been undertaken to quantify presence or absence of threatened species and their distribution on the development lands.

In this instance targeted surveys recorded *Persoonia pauciflora* (North Rothbury Persoonia) and *Pterostylis chaetophora* (Tall Rustyhood) within the Stage 2 development area.

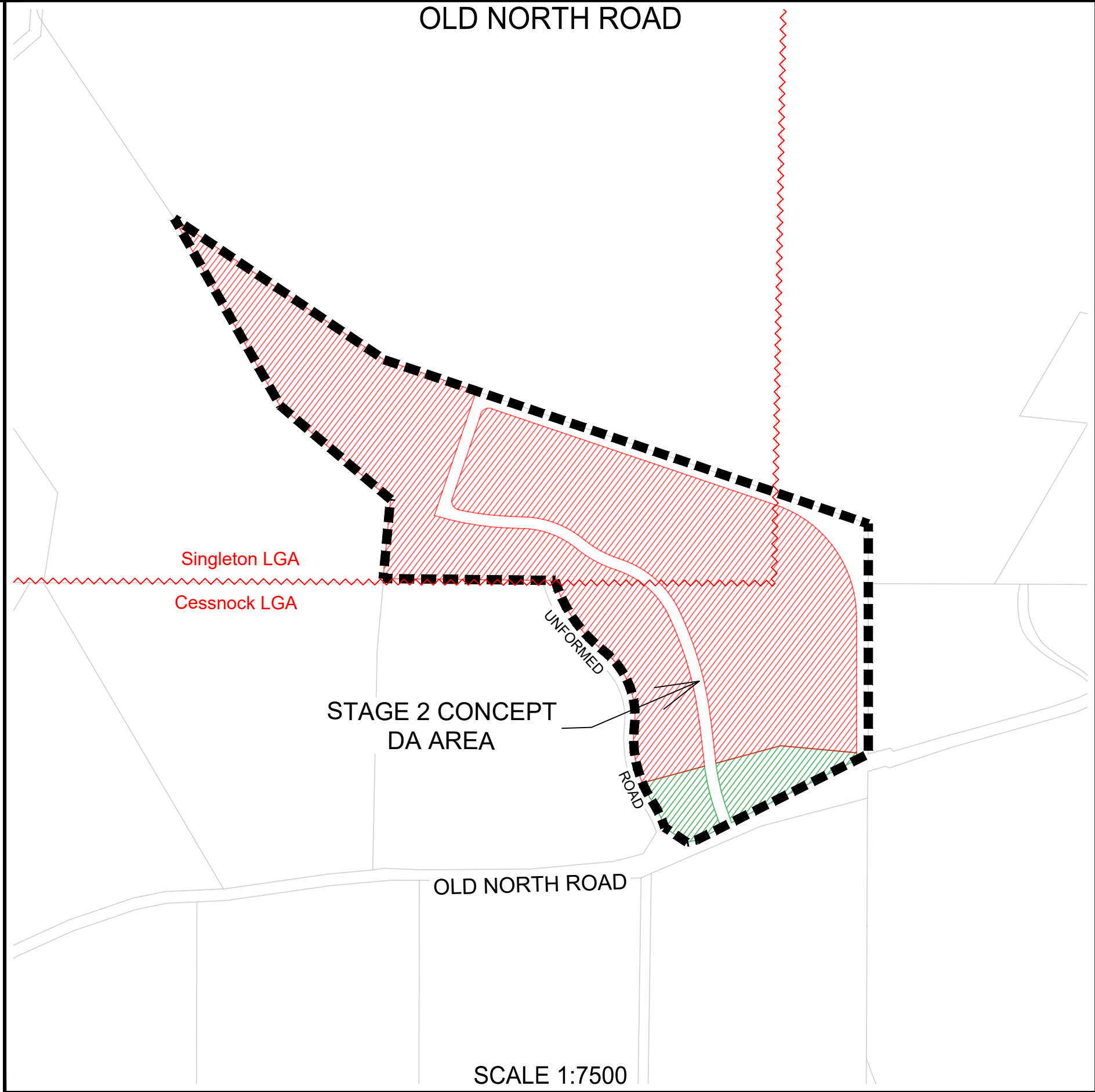
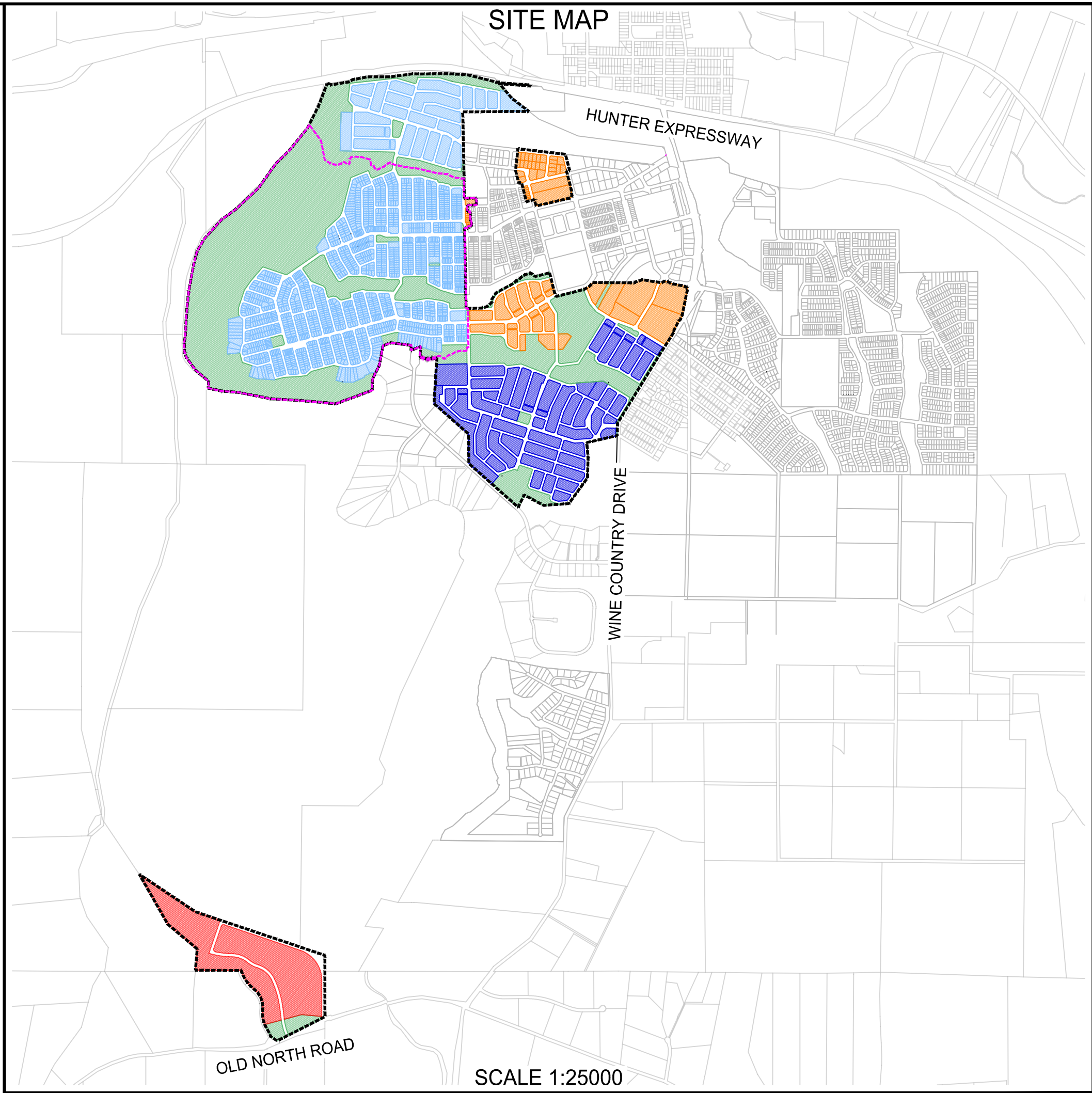
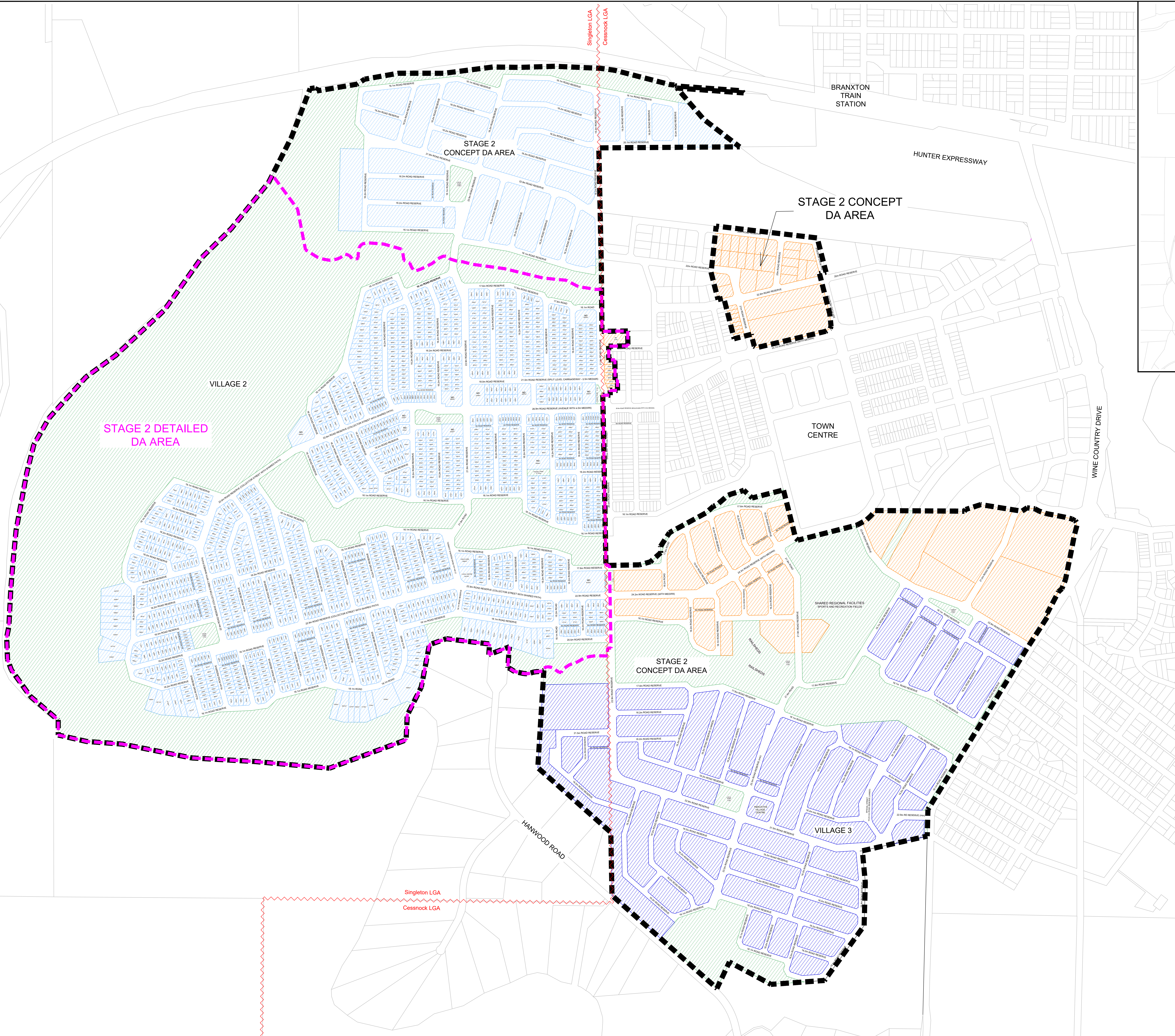
A 7-part test assessment under the former TSC Act has been prepared and benefiting from the approval arrangements pertaining to the Huntlee major project approval, concluded development is not likely to have an adverse effect on the life cycle of the entities such that a viable local population of the species is likely to be placed at risk of extinction.

In the context of the above, Stage 2 generally maintains consistency with the finding of the EAR (2010) and Huntlee Concept Plan approval.

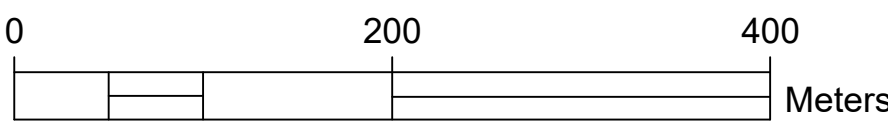
9 References

RPS (2010). *Ecological Assessment Report – Huntlee*. Prepared for Huntlee Pty Ltd. September 2010

Appendix A Plans of Proposal



- LEGEND**
- VILLAGE 2
 - VILLAGE 3
 - TOWN CENTRE
 - LARGE LOT SITES
 - INDICATIVE PARKS / OPEN SPACE / RIPARIAN
 - STAGE 2 DA BOUNDARY (CONCEPT AND DETAILED AREAS)
 - STAGE 2 DETAILED DA BOUNDARY
 - LOCAL GOVERNMENT AUTHORITY BOUNDARY
 - MD INDICATES MULTI-DWELLING LOT



N

ISSUE			ISSUE			ISSUE			ISSUE		
(0) 24/01/2023 PRELIMINARY REVIEW BY CLIENT			(6) 24/07/2023 AMEND LAYOUT TO LATEST STG 1 MOD 21, V2-3 & ONR LARGE LOTS.			(12) 19/09/2023 LOT AMENDMENTS IN CNR.			DRAWING STATUS		
(1) 30/01/2023 AMEND PER GS EMAIL TO ADD OLD NORTH ROAD, DETAILED/CONCEPT DA BDYS.			(7) 25/07/2023 AMEND LAYOUT TO LATEST TC, ADJUST STG 2 DA BDY NEAR HANWOOD ROAD.			(13) 17/10/2023 LOT AMENDMENTS VILLAGES TC, 2, 3.			PRELIMINARY REVIEW		
(2) 31/01/2023 AMEND DA AREA TITLES PER GS EMAIL.			(8) 28/07/2023 REMOVE STG 1, AMEND STG 2 BDY, ADD ROAD WIDTHS, LOT AREAS, DESCRIPTIONS.			(14) 22/11/2023 LOT AMENDMENTS VILLAGE 2.			ALL DRAWING OBJECTS, LEVELS, DIMENSIONS AND AREAS ARE SUBJECT TO SURVEY. THE PARTICULARS ON THIS PLAN AREA SUPPLIED FOR INFORMATION ONLY AND SHOULD NOT BE TAKEN AS A REPRESENTATION IN ANY RESPECT ON THE PART OF THE VENDOR OR ITS AGENT.		
(3) 01/02/2023 ADD OVERALL STAGE 2 DA BOUNDARY.			(9) 31/07/2023 AMEND PER GS MARKUPS 28/07/2023.						COPYRIGHT © Daly.Smith PTY LTD ABN 63 063 228 880		
(4) 07/02/2023 AMEND PER GS EMAIL ADD OLD NORTH ROAD DIAGRAM.			(10) 01/08/2023 AMEND TO INCREASE STG 2 TC PUBLIC OPEN SPACE INCLUSION CLARITY.						CLIENT		
(5) 07/06/2023 AMEND TO LATEST MOD 21 STAGE 1 BDYS, AMEND STAGE 2 DA BDY EXTENTS.			(11) 05/09/2023 LOT AMENDMENTS IN TOWN CENTRE, VILLAGES 2-3.						Huntlee		
									LWP		
									HUNTLEE STAGE 2 DA		
									PROJECT		
									HUNTLEE STAGE 2 - DEVELOPMENT AREA		
									WINE COUNTRY DRIVE, HUNTLEE		
									CLIENT		
									HUNTLEE PTY.LTD.		
									SCALE		
									1:4000		
									SHEET SIZE		
									A0		
									DRAWN BY		
									RB		
									CHECKED BY		
									ADM		
									DRAWING TITLE		
									HUNTLEE STAGE 2 DA		
									PROJECT		
									HUNTLEE STAGE 2 - DEVELOPMENT AREA		
									WINE COUNTRY DRIVE, HUNTLEE		
									CLIENT		
									HUNTLEE PTY.LTD.		
									LEGEND		
									VILLAGE 2		
									VILLAGE 3		
									TOWN CENTRE		
									LARGE LOT SITES		
									INDICATIVE PARKS / OPEN SPACE / RIPARIAN		
									STAGE 2 DA BOUNDARY (CONCEPT AND DETAILED AREAS)		
									STAGE 2 DETAILED DA BOUNDARY		
									LOCAL GOVERNMENT AUTHORITY BOUNDARY		
									MD INDICATES MULTI-DWELLING LOT		
									Daly.Smith		
									EXPERIENCE YOU CAN TRUST		
									A: 6 Doyallon Street, Morisset NSW 2264		
									A: 4/9 Lambton Road, Broadmeadow NSW 2292		
									T: (02) 4973 2745 F: (02) 4970 5366		
									E: mail@dailysmith.com.au		
									DALYSMITH.COM.AU		
									DAILY SMITH JOB NO:		
									20406		
									SHEET NO:		
									1 OF 1		

Appendix B Assessment of Significance (7-part test)

Acknowledging the savings provisions of clause 34A of the BC Savings Regulation, Section 5A of the EP&A Act lists seven factors that must be taken into account in the determination of the significance of potential impacts of proposed activities on 'threatened species, populations or ecological communities or their habitats' (threatened biota) listed under the TSC Act. The '7-part test' is used to determine whether there is likely to be a significant effect on threatened species, populations or ecological communities, or their habitats and thus whether a Species Impact Statement is required to be produced.

- *Haliaeetus leucogaster* – White-bellied Sea Eagle
- *Persoonia pauciflora* – North Rothbury Persoonia
- *Pterostylis chaetophora* – Tall Rustyhood
- *Rhodamnia rubescens* – Scrub Turpentine
- *Rhodomyrtus psidioides* – Native Guava

1. PART 1

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

1.1. *Haliaeetus leucogaster* – White-bellied Sea Eagle

Habitat for this species has been subject to targeted searches. The species was not detected, and large stick nests associated with the species habit were not observed.

On the basis of the species current known home range generally along the east coast of NSW and along major inland waterways, coupled with a lack of records for individual sightings or stick nests indicating site occupation, it is considered that the proposed development is not likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.

1.2. *Rhodamnia rubescens* – Scrub Turpentine

Parallel transect surveys over the entirety of the native vegetation of the development lands did not detect this species. The vegetation formation and landform are not well suited to this species, which prefers a moist and sheltered microclimate.

The species is unlikely to occupy the site. Therefore, the proposed development is not likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.

1.3. *Rhodomyrtus psidioides* – Native Guava

Parallel transect surveys over the entirety of the native vegetation of the development lands did not detect this species. The vegetation formation and landform are not well suited to this species, which prefers a moist and sheltered microclimate. Further, no records identifying this species occur within a 10km Bionet search.

The species is unlikely to occupy the site. Therefore, the proposed development is not likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.

1.4. *Persoonia pauciflora* – North Rothbury *Persoonia*

This species was subject to assessment and offset under the Concept Approval, and approval granted under Part 3A of the EP&A Act, on the basis that the conservation efforts and contributions for this species were sufficient to protect the species from any increased risk of extinction as a result of the development concept.

The species is subject to ongoing study, recovery of genetic and propagative material in association with the proposed action. The installation of propagated and translocated individuals in National Park estate is ongoing, and the majority of extant mature individuals are captured in secure holdings or retained within the development site. The identified individuals from contemporary surveys are available to be harvested and further population security stocks installed within adjacent conservation reserves.

Therefore, the species is unlikely to be adversely affected by the proposed action such that the local population is placed at increased risk of extinction.

1.5. *Pterostylis chaetophora* – Tall Rustyhood

The removal of 27 individuals of this species identified on the site represent a small proportion of the local population which is better represented at the adjacent Priority Management Site (PMS - Black Creek). The PMS is located in conservation zoned land in the tenure and custodianship of the NSW Government. Therefore, the proposed action is unlikely to have an adverse effect on the lifecycle of this species such that the local population is placed at increased risk of extinction.

2. PART 2

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

No endangered populations are known to occur on site or are assessed under this test of significance.

3. PART 3

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

- i. is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or***
- ii. is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction.***

No new EECs have been determined to occur on the site and therefore EEC(s) are not further assessed under this test of significance.

4. PART 4

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

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

The proposal involves clearing encompassing Huntlee Stage 2 development areas contained within the Cessnock and Singleton LGAs.

ii. whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and

Notwithstanding the regional connectivity to be maintained in perpetuity via the conservation of lands in association with the concept approval, the proposal seeks to remove vegetated areas within the development land. The development is sited in the landscape such that fragmentation is limited, as the site boundaries are adjacent to existing hostile connections including highway and rail corridors, and cleared land. While substantial development is proposed over a large site, the action is not likely to result in a significant increase in the existing degree of habitat fragmentation in the landscape, nor isolate areas of habitat.

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

For the following species:

- *Haliaeetus leucogaster* – White-bellied Sea Eagle
- *Pterostylis chaetophora* – Tall Rustyhood
- *Rhodamnia rubescens* – Scrub Turpentine
- *Rhodomyrtus psidioides* – Native Guava

Due the presence of large amounts of suitable habitat found outside the Development Site within the conservation lands, notwithstanding the removal of potential habitat within the Development Site, the removal is not considered to be important for the long-term survival of the species in the locality.

For *Persoonia pauciflora* – North Rothbury Persoonia:

The broad study area associated with the concept approval under which this stage of development is assessed represents the entire known extent of occupancy of this species. Its discovery in association with survey works for this concept development has resulted in the systematic preservation, propagation and conservation of this species and contributed substantially to the increased knowledge of this species ecology. While any land in the study area would contribute to potential habitat for this species, its long term survival has been secured by the development of this area through the removal of grazing pressure, inappropriate fire regimes, and uncontrolled development. The land set aside and the recovery of genetic and propagative material for installation in National Parks estate has effectively increased the habitat available to this species, where the land can be best managed to cater to the specific ecology of this species. The development also contributed significant funding for ongoing study and harvesting of this species.

Therefore, the land to be removed does not represent land that is important to the long-term survival of this species.

PART 5

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

No declared areas of critical habitat occur within, or in close proximity to, the Site.

PART 6

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

***Haliaeetus leucogaster* – White-bellied Sea Eagle**

The NSW Government has assigned *Haliaeetus leucogaster* (White-bellied Sea Eagle) to the 'Landscape Species' management stream, under the 'Saving our Species' program, that aims to ensure the species is secure in the wild in NSW and that its NSW geographic range is extended or maintained and maintain its conservation status under the BC Act. Currently no management sites have been identified for this species.

The proposal includes the clearing of land, which could theoretically provide habitat for the species. However, no evidence has been found of the species using the site. The dedication of conservation land to the NSW Government is consistent with the management actions arising for the species.

***Rhodamnia rubescens* – Scrub Turpentine**

The NSW Government has assigned *Rhodamnia rubescens* (Scrub Turpentine) to the 'Landscape Species' management stream, under the 'Saving our Species' program, that aims to ensure the species is secure in the wild in NSW and that its NSW geographic range is extended or maintained and maintain its conservation status under the BC Act. A total of 13% of the species distribution occurs on NPWS reserve. Currently no individual management sites have been identified for this species, moreover a statewide SoS management site has been established for the species management.

No individuals of the species are recorded on the development land. Therefore, no actions under the *R. rubescens* SoS strategy are contradicted by the proposal.

***Rhodomyrtus psidioides* – Native Guava**

The NSW Government has assigned *Rhodomyrtus psidioides* (Native Guava) to the 'Landscape Species' management stream, under the 'Saving our Species' program, that aims to ensure the species is secure in the wild in NSW and that its NSW geographic range is extended or maintained and maintain its conservation status under the BC Act. A SoS management site has been established for the species management covering an area generally spanning the coastal fringe from Ku-ring-gai Chase National Park to the QLD boarder.

No individuals of the species are recorded on the development land. Therefore, this proposal is not inconsistent with the management actions arising for the species.

***Pterostylis chaetophora* – Tall Rustyhood**

The NSW Government has assigned *Pterostylis chaetophora* (Tall Rustyhood) to the 'Site-managed Species' management stream under the 'Saving our Species' (SoS) program, on the basis that this species requires site-based management in order to secure it from extinction in NSW for 100 years.

Development is not listed as a Threat to this species.

Under the Black Creek Priority Management Site (PMS), Action specifically relating to Huntlee Pty Ltd are enforced, being the installation of suitable wildlife-friendly fencing to protect the PMS.

***Persoonia pauciflora* – North Rothbury Persoonia**

The NSW Government has assigned *Persoonia pauciflora* (North Rothbury Persoonia) to the 'Site-managed Species' management stream under the 'Saving our Species' (SoS) program, on the basis that this species requires site-based management in order to secure it from extinction in NSW for 100 years.

Two PMS are managed for this species – both in the vicinity of the development. The North Rothbury PMS (National Parks estate) and the *Persoonia pauciflora* Translocation PMS. The establishment and ongoing monitoring of this species at both sites is directly associated with the offsets and the resources provided by this development.

This proposal is not inconsistent with the management actions arising for the species.

PART 7

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

A Key Threatening Process (**KTP**) is listed under Schedule 3 of the TSC Act. KTPs considered relevant to the proposal were considered in the EAR. This assessment concluded that the Proposal was unlikely to trigger KTPs currently not operating on the Site and/or not significantly contribute to or increase the activity of a KTP operating on the Site.

Since the time of the EAR production, the KTP *Introduction and establishment of Exotic Rust Fungi of the order Pucciniales pathogenic on plants of the family Myrtaceae* is considered to apply. This KTP is the primary driver of the threatened species listing for *Rhodamnia rubescens* and *Rhodomyrtus psidioides* (Native Guava). No individuals of either species were recorded during surveys on the development lands.

Appendix C

Ecological Assessment Report (RPS 2010)



Ecological Assessment Report

Huntlee

Prepared by:

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Report No: PR105216

Version/Date: Final/ September 2010

Document Status

<i>Version</i>	<i>Purpose of Document</i>	<i>Orig</i>	<i>Review</i>	<i>Review Date</i>	<i>Format Review</i>	<i>Approval</i>	<i>Issue Date</i>
<i>Final</i>	<i>For Public Exhibition</i>	<i>CA</i>	<i>MD</i>	<i>28-09-10</i>	<i>JH 28-9-10</i>	<i>MD</i>	<i>28-09-10</i>

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Executive Summary

Introduction

RPS has been commissioned by Huntlee Pty Ltd to update an existing Ecological Constraints Master Plan (ECMP) report over the area proposed to accommodate Huntlee, and to prepare the Ecological Assessment Report (EAR) herewith. The EAR covers all relevant terrestrial and aquatic ecology matters.

On the 26th July 2010, the Minister for Planning agreed to consider Huntlee as a potential State Significant Site (SSS) for listing under Schedule 3 of *State Environmental Planning Policy (Major Projects) 2005* (Major Projects SEPP), and listed requirements for a SSS study. The report herewith forms part of the package that has been generated to meet these SSS requirements.

The EAR is based on ecological investigations undertaken from 2005 - 2010 over approximately 3,750ha of lands formerly known as 'Sweetwater', surrounding the township of North Rothbury, in the Cessnock and Singleton LGA's. Within this study area detailed ecological investigations were undertaken over 1558ha then under ownership or control of Huntlee (Study Area A – incorporating the vast majority of the Huntlee site) and more broadscale investigations were also undertaken across the remaining 2,150 ha of lands, most of which occurred in private land tenures (Wider Study Area).

The ECMP for Huntlee, as summarised and incorporated herein within the EAR, provides a detailed level of baseline ecological data from which planning, conservation and development sequencing decisions can be made.

The ECMP approach involves intensive and systematic ecological ground survey and mapping, leading to the creation of an ecological GIS (Geographic Information System) database. Such detailed ecological information in a GIS format facilitates accurate and transparent land use management planning and decision making processes. Conservation offsets for Huntlee have been proposed by both onsite reservation of key areas, and by supplementation via dedication of other offsite key conservation lands parcels. Most notably, the lands south of Black Creek are largely proposed to be dedicated to National Park.

The ECMP approach is that utilised on the state significant Hunter Economic Zone (HEZ) and has been the recipient of numerous industry awards for excellence including the Asia-Pacific Spatial Information Excellence Awards, NSW Urban Taskforce Awards, NSW Survey Institute Awards and Lower Hunter Business Excellence Awards.

Methods

The development of the ECMP and hence EAR for Huntlee comprised of the following elements:

- **Collation of existing flora and fauna datasets and survey reports** – The results of the numerous flora and fauna investigations that have been undertaken within and adjoining the study area to date, in particular threatened species records, have been incorporated into the

EAR. Important information sources utilised include Bell (2005), Bell & Discoll (2005), Conacher Travers (2003a; 2003b; 2004), Ecotone (2003), Patrick, G (1998-2001), NPWS Atlas of NSW Wildlife (2010), and EPBC On-line Atlas Data (2010).

- **Vegetation survey & mapping over the entire study area** – Vegetation survey and mapping reports were undertaken by Stephen Bell (Eastcoast Flora Survey) on behalf of RPS. This was undertaken to replace the broad-scale vegetation map of the area previously produced for the Lower Hunter Central Coast Regional Environmental Management Strategy (LHCCREMS) by NPWS (2000) and House (2003) and for the Hunter – Central Rivers Catchment Management Authority by Peake (2005). Detailed vegetation survey and mapping was undertaken over Study Area A, whilst the Wider Study Area was subject to more broadscale investigations.
- **Detailed threatened species surveys and habitat investigations** – Detailed ecological investigations, using high accuracy GPS ('Trimble' Global Positioning Systems), were undertaken in 2005 & 2010 to obtain a comprehensive overview of the habitat features / attributes throughout Study Area A and to document the distribution and abundance of threatened flora and fauna species. Key aspects of the 2005 work have been revisited and reaffirmed by fieldwork in 2007, and recent inspections in 2010 in association with the 2010 grid survey work.

The combined survey effort of the above mentioned studies satisfies the requirements of Cessnock City Council's Development Control Plan No. 56 "Flora and Fauna Survey Guidelines Lower Hunter Central Coast Region 2002" (DCP No. 56) for Study Area A. Surveys and reporting, including this report have also been developed with regard to DECCW's 'Guidelines for Threatened Species Assessment (2005)'.

Flora

A total of over 325 plant taxa and six (6) vegetation communities have been recorded with the Huntlee Study Area to date, including four (4) threatened plant species and four (4) endangered ecological communities (EEC's).

Threatened species include:

- ***Acacia bynoeana*** – this species is listed as Endangered under the TSC Act and Vulnerable under the EPBC Act. It was recorded at one location off Littlewood Road and this population is considered to be significant as it extends the known distribution of this species a further 15km to the north of the previous known limit at Kurri Kurri and it occurs in a completely new habitat type not previously recognised as supporting the species. This area is well outside the development areas depicted within the Huntlee Study Area;
- ***Eucalyptus glaucina*** – this species is listed as Vulnerable under both the TSC Act and EPBC Act. Many individual redgum trees across the study area show characteristics of the vulnerable *Eucalyptus glaucina*. During studies undertaken at the Hunter Economic Zone near Cessnock, this species was considered by Ken Hill (National Herbarium of NSW) to occur within hybrid swarms with *Eucalyptus tereticornis*. This trend is also apparent within the study area, with considerable hybridisation occurring. Conservation of this species will be best achieved through a landscape approach of conserving larger stands of redgum Eucalypts. The proposed conservation area creation south of Black Creek, and retentions within Black Creek and other select major watercourses within the site will achieve suitable conservation outcomes. This

species is also represented within other proposed conservation lands at Elderslie, and red gum stands potentially containing *E. glaucina* genes at Mt Popong / Pickle Bottle Creek and Cedar Creek;

- ***Eucalyptus parramattensis* subsp. *decadens*** – this species is listed as Vulnerable under both the TSC Act and EPBC Act. A single, healthy individual of *Eucalyptus parramattensis* subsp. *decadens* was discovered in the southern part of Study Area A, in a small drainage line associated with sandstone bedrock material and surrounded by Central Hunter Ironbark – Spotted Gum – Grey Box Forest. The specimen occurs well north (at least 10km) of the currently accepted distributional range of this taxon and is also present in currently undocumented habitat for the species. The single specimen may represent a vestige of what may have occurred prior to European settlement, which may have been a small disjunct population at the northern limit of the main population. This specimen, its habitat, and appropriate buffers have been retained within the proposed conservation area south of Black Creek;
- ***Persoonia pauciflora*** – this species is listed as Critically Endangered under the TSC Act and under the EPBC Act. The entire known distribution of this species is contained within the Study Area. The most significant population(s) of this species at the time of the 2005 surveys occurred in the vicinity of Hanwood Estate and along Tuckers Lane. The proposed creation and dedication of 'Persoonia Park' and protection of other plants within the Huntlee Development areas will assist in the efforts to preserve and propagate this species into the future. As a part of this effort, the proponent has commissioned updated *Persoonia pauciflora* status reports for all of its holdings and immediate surrounds. This document is appended to this EAR report as part of the SSS study;

In addition, four rare (ROTAP) species (*Acacia bulgaensis*, *Eucalyptus fergusonii* subsp. *dorsiventralis*, *Grevillea montana*, *Macrozamia flexuosa*), two undescribed species (*Diuris* sp. aff. *dendroboides* (Hunter Valley) and *Eucalyptus* sp. aff. *agglomerata*) and several other species considered of some conservation significance are present within the study area. As per the work of Bell (2005a & 2005b), the majority of these species occurrences are within the proposed conservation area south of Black Creek. A number of plant species occur which are more typical of western inland locations and which occur as disjunct populations in the Huntlee locality. Such species and their communities are well represented in the proposed conservation area south of Black Creek, and are also represented to varying degrees within the proposed off-site conservation lands.

Six native vegetation communities have been delineated and described within the REMS framework for the Huntlee study area, including five classifiable as EECs:

- **Hunter Valley Dry Rainforest** (listed as an EEC under the TSC Act – equivalent to **Lowland Rainforest**): restricted to a small area of Black Creek. This community will be retained in entirety in the proposed conservation area, south of Black Creek. Weed removal and rehabilitation could significantly improve the condition of this community;
- **Central Hunter Riparian Forest** (listed as an EEC under the TSC Act – equivalent to **River-Flat Eucalypt Forest on Coastal Floodplains**): riparian and floodplain community dominated by invasive stands of *Casuarina glaucina*. Approx ⅔ of the occurrence is likely to be retained within the Huntlee site. This community is also likely to be enhanced in extent via proposed revegetation works in key areas around Black Creek, associated tributaries and floodplain area;

- **Wollombi Redgum – River Oak Woodland** (listed as an EEC under the TSC Act – equivalent to **River-Flat Eucalypt Forest on Coastal Floodplains**): restricted to riparian areas of Black Creek and its major tributaries. The entire occurrence of this community at Huntlee is likely to be retained within the proposal. This community is also likely to be enhanced in extent via proposed revegetation works in key areas around Black Creek, associated tributaries and floodplain area. Also occurs within the offset reserve at Elderslie.
- **Central Hunter Ironbark – Spotted Gum – Grey Box Forest** (listed as an EEC under the TSC Act): dominant vegetation community over the majority of the study area, with a number of variants noted. Conservation of >60% of the Huntlee area occurrence of this community will occur, including the most intact areas of this community within proposed National Park. Large occurrences also proposed to be dedicated at Elderslie.
- **Hunter Lowland Redgum Forest** (listed as an EEC under the TSC Act): restricted to several drainage lines. Only a small amount of this vegetation community will be removed by development at Huntlee. This community is also likely to be enhanced in extent via proposed revegetation works in key areas around Black Creek, associated tributaries and floodplain area; and
- **Phragmites Rushland**: contained within a small number of man-made dams and water bodies. Excellent potential for habitat retention, enhancement and creation (eg. waterbodies, dams, lakes) as part of the development.

Fauna

A total of 206 vertebrate fauna taxa have been recorded within the Huntlee Study Area to date, including twenty-seven (27) threatened species. Threatened fauna species that have been recorded within the study area include:

Species	Legislative Status		Occurrence on Site
	TSC Act	EPBC Act	
Grey-crowned Babbler	Vulnerable		Relatively common and widespread species across the entire study area, except where <i>Bursaria spinosa</i> constitutes thick understorey. Well represented within the proposed Conservation Area south of Black Creek.
Brown Treecreeper	Vulnerable		Only recorded from a small area in the centre of south western portion of Study Area A within the proposed Conservation Area south of Black Creek.
Black-chinned Honeyeater	Vulnerable		Only recorded on a single occasion and likely to be seasonal resident / nomadic visitor to larger forested remnants. Proposed Conservation Area would provide adequate seasonal foraging habitat for this species.
Speckled Warbler	Vulnerable		Widespread records across Study Area A where well-developed shrub layers exist, particularly south of Black Creek in the proposed National Park.
Varied Sitella	Vulnerable		Recorded within the site. Proposed Conservation Area south of Black Creek would provide suitable habitat for any birds residing in, or moving through the area.
Scarlet Robin	Vulnerable		Recorded within the site. Proposed Conservation Area south of Black Creek would provide suitable habitat for any birds residing in, or moving through the area.
Glossy Black-	Vulnerable		Favoured foraging trees exist (<i>Allocasuarina spp.</i>),

Species	Legislative Status		Occurrence on Site
	TSC Act	EPBC Act	
Cockatoo			predominately in the proposed Conservation Area south of Black Creek, where the existing records of GBC's occur. Likely to use the site on irregular basis.
Painted Honeyeater	Vulnerable		Historical record from 1977 in North Rothbury township. Probable aberrant record. Proposed Conservation Area south of Black Creek would provide suitable habitat for any birds moving through the area.
Regent Honeyeater	Endangered	Endangered	Historical record from 1977 in North Rothbury. Possible vagrant. Proposed Conservation Area south of Black Creek would provide suitable habitat for any birds moving through the area.
Swift Parrot	Endangered	Endangered	Seasonal migrant, especially during the winter flowering of Spotted Gums in the wider Hunter Valley. In winter 2005, flocks representing approximately 3% of the total national population were recorded using areas south of Black Creek for foraging and roosting. Very small number recorded within proposed Conservation Area and Persoonia Park sites in winter 2007.
Little Lorikeet	Vulnerable		Recorded within the site in response to Eucalypt flowering events. Proposed Conservation Area would provide adequate seasonal foraging habitat for this species.
Turquoise Parrot	Vulnerable		Recorded on several occasions within the proposed Conservation Area south of Black Creek.
Powerful Owl	Vulnerable		Historical record from 1977 in North Rothbury. Areas of site may represent part of larger territory. Proposed Conservation Area south of Black Creek would provide suitable habitat for any birds residing in the area.
Barking Owl	Vulnerable		Historical record from 1977 in North Rothbury. Portions of site may represent part of larger territory. Proposed Conservation Area south of Black Creek would provide suitable habitat for any birds residing in the area.
Little Eagle	Vulnerable		Recorded within the site. Wider area would provide habitat for this wide-ranging species. Proposed Conservation Area south of Black Creek would provide suitable habitat for any birds residing in, or moving through the area.
Spotted Harrier	Vulnerable		Recorded within the site. Wider area would provide habitat for this wide-ranging species. Proposed Conservation Area south of Black Creek would provide suitable habitat for any birds residing in, or moving through the area.
Square-tailed Kite	Vulnerable		Atlas of NSW Wildlife record from 2006 at the western edge of North Rothbury township. Areas of the site may represent part of a larger territory. Proposed Conservation Area south of Black Creek would provide suitable habitat for any birds residing in, or moving through the area.
Squirrel Glider	Vulnerable		Recorded consistently during surveys where hollows exist, but not in high numbers. Records all outside the proposed development area. Most records from within the proposed Conservation Area south of Black Creek.
Koala	Vulnerable		Record from 2004 in Hanwood Estate. Potential habitat occurs throughout the site.
Grey-headed Flying-fox	Vulnerable	Vulnerable	Nomadic forager for Eucalypt blossom and likely to visit the site when such resources are available. No communal camps known from the locality. Proposed

Species	Legislative Status		Occurrence on Site
	TSC Act	EPBC Act	
			Conservation Area south of Black Creek would provide suitable seasonal foraging habitat for this species.
Yellow-bellied Sheathtail-bat	Vulnerable		Known and potential roosting and foraging habitat throughout. One record, being within the proposed Conservation Area south of Black Creek.
Little Bentwing-bat	Vulnerable		Known and potential foraging habitat throughout, but no preferred roosting habitat (eg. caves) found within the study area. One record, being within the proposed Conservation Area south of Black Creek.
Eastern Bentwing-bat	Vulnerable		Known and potential foraging habitat throughout, but no preferred roosting habitat (eg. caves) found within the study area. Several records in the locality, but none within the proposed development area. Records noted within the proposed Conservation Area south of Black Creek.
Eastern Freetail Bat	Vulnerable		Known and potential roosting and foraging habitat throughout. Some records in the locality, but none within the proposed development area. Record noted within the proposed Conservation Area south of Black Creek.
Greater Broad-nosed Bat	Vulnerable		Known and potential roosting and foraging habitat throughout. Only one record, within the southern end of the site, in land adjacent to the proposed Conservation Area south of Black Creek, which will provide suitable protected habitat.
Large-footed Myotis	Vulnerable		Prefers to reside and forage in close proximity to water, including creeklines. Potential habitat over large areas of the site. One record, being within the proposed Conservation Area south of Black Creek.
Eastern Cave Bat	Vulnerable		Known and potential foraging habitat throughout, but no preferred roosting habitat (eg. caves). One Atlas of NSW Wildlife record from 2006 in the north-eastern edge of the wider study area.

This assemblage of threatened fauna (excluding historical records) provides a typical portrayal of the species known from the larger forest remnants within this part of the Hunter Valley (eg. such as Belford & Werakata National Parks) and of the dry woodland and open forest habitats characteristic of the study area. Distinct faunal influences typical of more western environs were also noted.

Habitat Assessment

The vegetation of the study area has been subject to an ongoing degradation regime from present and past land uses such as rural / residential development, cattle grazing, mining activities, weed invasion, partial clearing, motocross bike riding and other illegal / unauthorised activities. The majority of the study area occurs in private tenure and rural –residential development / occupation forms the predominant land use.

Despite the disturbance factors and large areas of the site occurring as cleared pasture, the areas of remnant vegetation on the site and in the wider locality provide some viable habitat resources for flora and fauna. Some areas contain a higher density of mature and hollow bearing trees and an intact understorey. Native regeneration was noted in 2010 in several parts of the site previously

subject to active management (slashing). Such factors have been considered in the conservation / development outcomes proposed for the site.

As noted below, approximately 1,754ha (47%) of the Wider Study Area is cleared of native vegetation, whilst 1,660ha (44%) is listed as an Endangered Ecological Community.

Land Class	Area within Wider Study Area	Comment
Endangered Ecological Communities (EEC's)	1,660ha	Comprised mostly of Central Hunter Ironbark – Spotted Gum – Grey Box Forest, with 'Hunter Lowland Redgum Forest', 'River-Flat Eucalypt Forest' and 'Lowland Rainforest' predominately occurring as linear areas along Black Creek and associated creeklines and in patches in associated areas of suitable topography / soils.
Cleared Areas	1,754ha	Approximately 47% of the Study Area is devoid of any significant intact native vegetation.
Other	345ha	Majority of remnant vegetation within the Study Area consists of disturbed areas with only canopy species remaining or as young regrowth, which do not readily conform to a described ecological community. Water and Phragmites Rushland comprise the remainder of this land class.

To the north of the site lies rail, New England Highway, Branxton and extensive areas of cleared farmland. Rail and the Highway also occur to the east along with Greta and cleared agricultural areas leading down to the Hunter River. Connections to the southeast along Molly Morgan Range are discontinuous and disjunct and linkages to the south are broken by agricultural and vineyard areas. Lands west of Huntlee support some linear connections along creeklines through cleared agricultural lands. There are currently no strong direct vegetated linkages to Belford National Park to the west of the site, however the conservation area south of Black Creek in Huntlee will assist in protecting those areas that currently offer the most prominent linkages to that National Park. The importance of the conservation area south of Black Creek within Huntlee as a habitat corridor is recognised in the regional corridor mapping (NPWS 2003).

Conservation and Development Outcomes

The initial ECMP document (2005) outlined key factors that were suggested to be taken into consideration in determining an appropriate development / conservation framework for the study area. These factors were:

- Retention of adequate threatened species population(s) and endangered ecological communities;
- Appropriate siting of land use units to be compatible with retained open space and green corridor areas (eg. urban, rural-residential, commercial and industrial);
- Implementing principles of habitat conservation, wildlife corridors and habitat linkages (e.g. minimizing edge and fragmentation effects) by appropriate marriage of urban design and ecological theory;
- Maximising development densities in the extensive cleared and degraded areas; and
- Rehabilitation, revegetation and management of adopted key conservation areas post development.

It is considered that the Huntlee Plan, when viewed holistically with the proposed conservation measures, both on and off site of Huntlee (as detailed below), adequately addresses the above factors. Such conservation measures include:

On-site

- Dedication of an conservation area south of Black Creek to the State Government for conservation;
- Creation of 'Persoonia Park', being a dedicated conservation reserve (17ha) targeting the recovery of this endangered species;
- Riparian buffers will be established as part of future detailed Project Applications for each stage of the development in consultation with the NSW Office of Water as underpinned by the *Water Management Act* and guidelines;
- Retention of all *Persoonia pauciflora* individuals with a 30m buffer for so long as such plants persist in situ; and
- Commitment by the proponent to a range of other ongoing environmental protection, enhancement and management measures.

Off-site

- Dedication of 2,287.45ha of conservation lands at Mt Popong & Pickle Bottle Creek;
- Dedication of 429.15ha of conservation lands at Howes Valley;
- Dedication of 228.05ha of conservation lands as in-holdings within Yengo National Park;
- Dedication of 101.21ha of conservation lands at Mount Warrawalong;
- Dedication of 440.08ha of conservation lands at Corabare Forest;
- Dedication of 1002.84ha of conservation lands at Cedar Creek; and
- Dedication of 499.63ha of conservation lands at Elderslie.

The vast majority of the offset areas contain intact native forest communities. Combining this feature with their strategic locations, particularly those on the ranges that exist within significantly large expanses of virtually unbroken habitat stretching over 100's of kilometres, suggests that these areas form part of critically important regional biodiversity gene pools. These areas collectively infill, consolidate and bolster the extant reserve system, and in doing so contribute to the increased long term vigour and sustainability of such. Forest communities contained therein provide significant diversity, ranging from dry ridgetop forests to subtropical rainforest and wet sclerophyll forest. This diversity provides known and predicted habitat opportunities for an array of native fauna species, including numerous species listed as threatened.

In essence, the conservation offset lands provide an enduring green legacy both in regards to ecological biodiversity, and also wider environmental outcomes relating to the maintenance of air and water quality within the Hunter Region.

Irrespective of the overall holistic ecological benefits of such large dedications, the information presented above and in more detail within this report clearly shows that the conservation offsets package provides robust ecological outcomes for threatened species and endangered ecological communities. It is noted that there is some overall shortfall on some specific ecological communities; however, this shortfall needs to be considered against the increased level of formal protection that will result for these communities by the creation of the new conservation area south of Black Creek, and by the significant conservation excess provided by numerous other vegetation communities associated with the conservation offsets outcomes proposed.

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Appendix

APPENDIX 1

Threatened Species Habitat Profiles

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Vegetation Survey and Mapping Reports

APPENDIX 3

Fauna Species Lists

APPENDIX 4

Persoonia pauciflora Report

APPENDIX 5

RPS Key Staff Qualifications

TERMS AND ABBREVIATIONS

Abbreviation	Meaning
CCC	Cessnock City Council
DBH	Diameter (centimetres) at Breast Height
DCP	Development Control Plan
DECCW	NSW Department of Environment, Climate Change & Water (formerly NSW National Parks and Wildlife Service, NSW Department of Environment and Conservation)
DEWHA	Department of the Environment, Water, Heritage & the Arts (formerly Environment Australia)
DGPS	Differential Global Positioning System
DNR	Department of Natural Resources (formerly Department of Land and Water Conservation, Department of Infrastructure, Planning and Natural Resources)
EAR	Ecological Assessment Report
ECMP	Ecological Constraints Master Plan
EP&A Act	NSW Environmental Planning & Assessment Act 1979
EPBC Act	Commonwealth Environment Protection and Biodiversity Conservation Act 1999
GPS	Global Positioning System
ha	hectare
HBOC	Hunter Bird Observers Club
HCCREMS	Hunter and Central Coast Regional Environmental Management Strategy
HEZ	Hunter Economic Zone (formerly Hunter Employment Zone)
LEP	Local Environment Plan
LGA	Local Government Area
LHCCREMS	Lower Hunter and Central Coast Regional Environmental Management Strategy
LHRCP	Lower Hunter Regional Conservation Plan
LHRS	Lower Hunter Regional Strategy
NoW	NSW Office Of Water
NP	National Park
NPWS	NSW National Parks and Wildlife Service
NV Act	NSW Native Vegetation Act 2003
RF Act	NSW Rural Fires Act 1997
ROTAP	Rare or Threatened Australian Plants
SF	State Forest
SSC	Singleton Shire Council
SSS	State Significant Site
ssp. / subsp.	sub-species
TSC Act	NSW Threatened Species Conservation Act 1995
WM Act	NSW Water Management Act 2000

I Introduction

This chapter provides the necessary background information and rationale that led to the development of firstly the Ecological Constraints Master Plan (ECMP) for Huntlee, and hence this complete Ecological Assessment Report (EAR).

RPS has been commissioned by Huntlee Pty Ltd to update an existing Ecological Constraints Master Plan (ECMP) report over the area proposed to accommodate Huntlee, and to prepare the Ecological Assessment Report (EAR) herewith. The EAR covers all relevant terrestrial and aquatic ecology matters.

On the 26th July 2010, the Minister for Planning agreed to consider Huntlee as a potential State Significant Site (SSS) for listing under Schedule 3 of *State Environmental Planning Policy (Major Projects) 2005* (Major Projects SEPP), and listed requirements for a SSS study. The report herewith forms part of the package that has been generated to meet these SSS requirements, namely:

- describe the suitability of the site for any proposed land use taking into consideration the environment and principles of ESD;
- provide a flora and fauna assessment in accordance with DECCW's Guideline for Threatened Species Assessment (2005) with particular regard to *Persoonia pauciflora*;
- discuss the development of ecological corridors to link flora and fauna corridors both on and adjoining the site; and
- identify the ecological attributes of the lands proposed for dedication and how proposed environmental land offsets will mitigate the impacts of the development.

The ECMP upgrade builds on ecological investigations undertaken in 2005 over approximately 3,750ha of lands, surrounding the township of North Rothbury, in the Cessnock and Singleton LGA's. Within this study area detailed ecological investigations were undertaken over 1558ha then under ownership or control (Study Area A – incorporating the vast majority of the Huntlee site) and more broadscale investigations were also undertaken across the remaining 2,150 ha of lands, most of which occurred in private land tenures (Wider Study Area).

The Ecological Constraints Master Plan (ECMP) for Huntlee, as summarised herein, provides a detailed level of baseline ecological data from which planning, conservation and development sequencing decisions can be made.

The ECMP approach involves intensive and systematic ecological ground survey and mapping, leading to the creation of an ecological GIS (Geographic Information System) database. Such detailed ecological information in a GIS format facilitates accurate and transparent land use management planning and decision making processes. Conservation offsets for Huntlee are made by both onsite reservation of key areas, and by supplementation via dedication of other offsite key conservation lands parcels. Most notably, the lands south of Black Creek are largely proposed to be zoned for conservation.

The ECMP approach is that utilised on the state significant Hunter Economic Zone (HEZ) and has been the recipient of numerous industry awards for excellence including the Asia-Pacific Spatial Information Excellence Awards, NSW Urban Taskforce Awards, NSW Survey Institute Awards and Lower Hunter Business Excellence Awards.

This report also identifies and discusses the aquatic habitats occurring over the wider Huntlee site, and discusses general impacts and mitigation measures as relevant to future development.

Development of Huntlee, as discussed above, is intrinsically linked to dedication of several areas of conservation offset lands. These lands, like the current subject site, contain numerous watercourses and other aquatic features (including dams and wetlands) of varying sizes, magnitude order, condition, and habitat variability. Whilst this report does not involve specific assessment of these conservation offset lands aquatic features, the dedication of these features is taken into account when assessing the impact context of the Huntlee development.

1.1 Description of the Proposal

In accordance with the outcomes of the Lower Hunter Regional Strategy (LHRS), development is proposed to take place at the Huntlee site to accommodate a new township, comprising a balanced mix of residential, commercial / employment, industrial, open space and conservation lands.

The Huntlee Plan showing development & conservation lands are presented in Figure 1-2.

A full description of the proposal, including all proposed mitigation measures, is contained within the Environmental Assessment prepared for the SSS application.

1.2 Study Areas

'Huntlee' is located within the lower Hunter Valley of New South Wales in the Cessnock and Singleton Local Government Areas. The original ECMP study area occupies an area of approximately 3,750 hectares. The refined 2010 study focus area, which incorporates those areas within the proposed development and conservation lands, covers an area of approximately 1,722ha. The actual area proposed for development is 925ha.

The site is located to the south of the township of Branxton and surrounds the village of North Rothbury (refer to Figure 1-1 and Figure 1-2).

Large areas of the site remain covered in native vegetation, although most of the study area has been impacted upon by a number of anthropogenic land uses, including rural / residential development, grazing, viticulture, cultivation, timber-getting (pit props) and mining. The disused Ayerfield No.3 Colliery and the Hanwood Estate rural / residential

subdivision are also included as part of the wider study area to ensure a holistic overview is achieved of the locality.

The wider district comprises a mixture of urban, agricultural, mining and viticultural land uses, although cleared grazing lands comprise the major activity. Conservation zoned lands are restricted to Belford National Park, approximately 2km to the north-west and Werakata National Park 8km to the south-east.

A more detailed description of environmental setting (ie. climate, landform, geology, soils) of the Huntlee study area is provided in Appendix 2 (Bell & Driscoll 2005).

There are approximately 70 watercourses defined on the 1:25,000 topographic map that covers the Huntlee study area. Within the extent of the Huntlee site study area (see Figure 1-3), Black Creek is the only named and perennial watercourse, with others shown as intermittent watercourses. The catchment areas of the majority of these intermittent watercourses exist within the site with only two extending more than 1km from the site boundary.

The site drains into 3 distinct catchments (being Black Creek, Anvil Creek and Sweetwater Creek Catchments), each of which form part of the larger Black Creek Catchment and also the greater Hunter River Catchment. The vast majority of watercourses on the site drain into Black and Anvil Creek with a smaller number draining to Sweetwater Creek to the west of the site.

1.3 Scope of this Study

There are two main goals of this EAR. These can be succinctly stated as:

- Provide a detailed level of ecological data that can be used in consideration of Huntlee as a potential State Significant Site (SSS);
- Satisfy the SSS Guidelines; and
- Provide a detailed level of ecological information to facilitate the ecologically sustainable development of Huntlee in a regional context.

The ECMP was originally structured to take into account a number of relevant environmental planning instruments including Cessnock City Council's Development Control Plan (DCP) No. 56 "Flora and Fauna Survey Guidelines Lower Hunter Central Coast Region 2002". Additional refinement has occurred in producing this EAR to provide information necessary to meet SSS study requirements including the DECCW Guidelines.

Information provided and contained within the ECMP provides a substantial baseline ecological database that can be used to inform all forthwith project or development application processes.

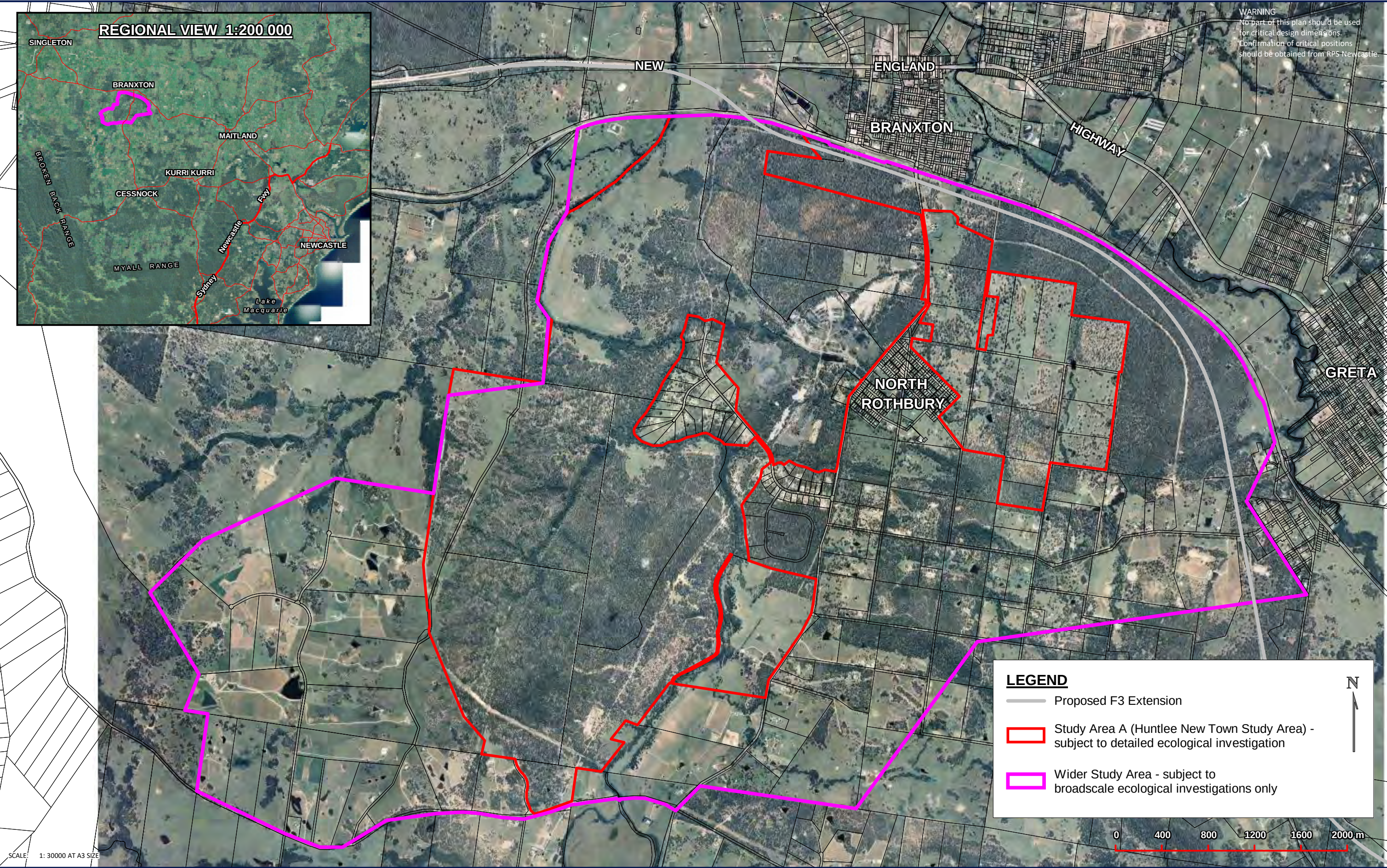
The report also addresses the standard relevant legislation pertaining to the assessment and management of aquatic species and their habitats.

The *Fisheries Management Act 1994* (FMA Act), as amended by the *Fisheries Management Amendment Act 1997* (FMAA), includes provisions to declare and list threatened species of fish and marine vegetation, endangered populations and ecological communities and key threatening processes. These provisions are similar to those in the *Threatened Species Conservation Act 1995* (TSC Act), and must be considered when assessing a proposal under Section 5A of the *Environmental Planning and Assessment Act 1979* (EPA Act). The FMAA Act has the following objectives in terms of the protection of threatened species and their habitats:

- a) to conserve biological diversity of fish and marine vegetation and promote ecologically sustainable development;
- b) to prevent the extinction and promote the recovery of threatened species, populations and ecological communities of fish and marine vegetation;
- c) to protect the critical habitat of those threatened species, populations and ecological communities that are endangered;
- d) to eliminate or manage certain processes that threaten the survival or evolutionary development of threatened species, populations and ecological communities of fish and marine vegetation;
- e) to ensure that the impact of any action affecting threatened species, populations and ecological communities of fish and marine vegetation is properly assessed; and
- f) to encourage the conservation of threatened species, populations and ecological communities of fish and marine vegetation by the adoption of measures involving co-operative management.

Other Federal and State Acts and Policies that are relevant to the study area with regard to aquatic flora and fauna are listed below.

- *Environment Protection and Biodiversity Conservation Act 1999* (Commonwealth) (EPBC Act)
- *Water Management Act 2000* (WM Act).



TITLE: FIGURE 1-1 THE HUNTLEE NEW TOWN STUDY AREA

LOCATION: ECMP - HUNTLEE NEW TOWN

DATUM: DATUM
PROJECTION: MGA ZONE 56 (GDA 94)

DATE: 11/8/2010
PURPOSE: REPORT FIGURE

LAYOUT REF: J:\JOBS\105K\105216 North Rothbury (Huntlee)\10- Drafting\ECMP
VERSION (PLAN BY): PH (C-A3)

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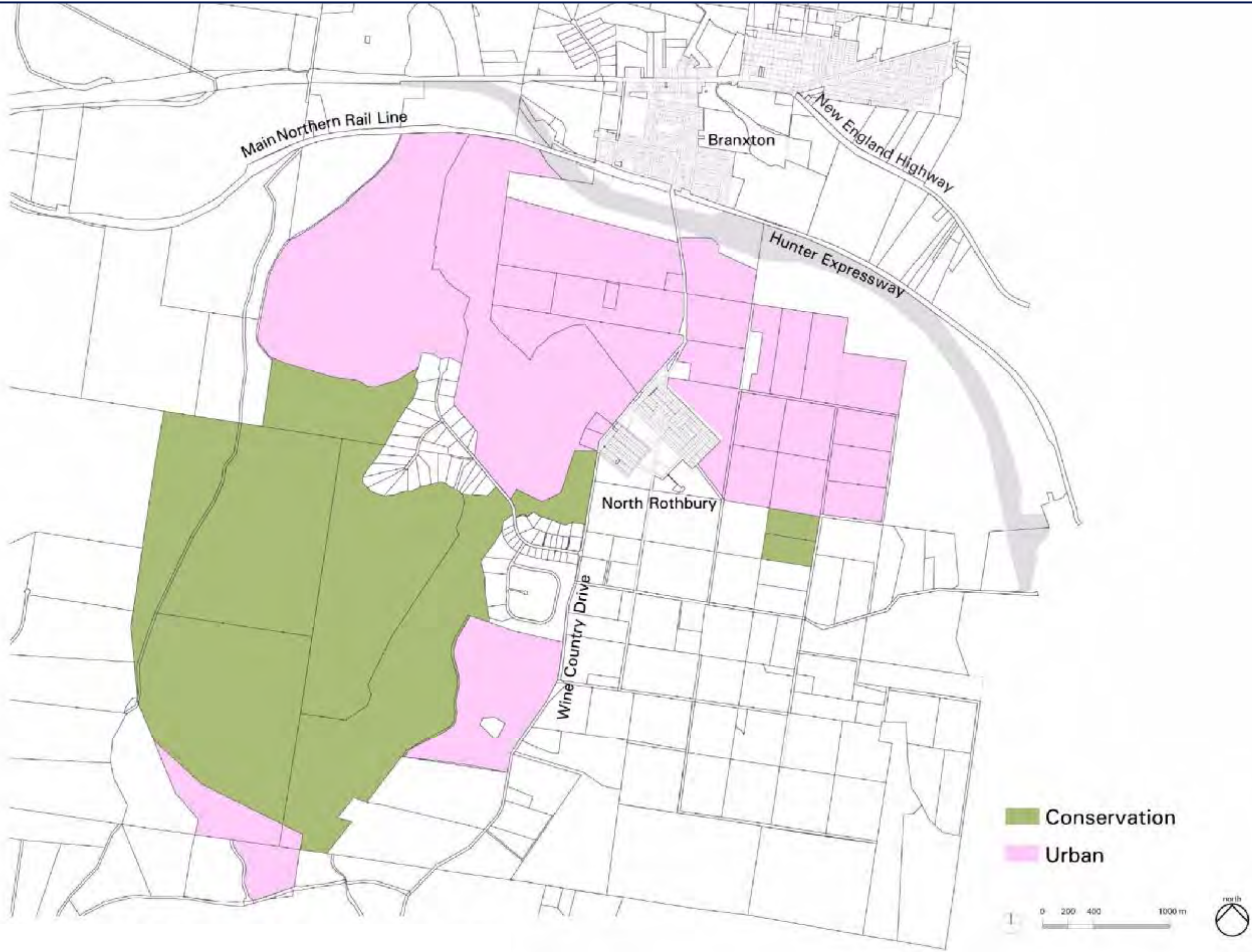
CLIENT: HUNTLEE PTY LTD
JOB REF: 105216

RPS AUSTRALIA EAST PTY LTD (ABN 44 140 292 762)
241 DENISON STREET BROADMEADOW PO BOX 428 HAMILTON NSW 2303
T: 02 4940 4200 F: 02 4961 6794 www.rpsgroup.com.au

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WARNING
No part of this plan should be used
for critical design dimensions.
Confirmation of critical positions
should be obtained from RPS Newcastle.



TITLE: FIGURE 1-2 THE HUNTLEE
NEW TOWN PLAN

LOCATION: ECMP - HUNTLEE NEW TOWN

DATUM: DATUM
PROJECTION: MGA ZONE 56 (GDA 94)

DATE: 9/8/2010
PURPOSE: REPORT FIGURE

LAYOUT REF: J:\JOBS\105K\105216 North Rothbury (Huntlee)\10- Drafting\ECMP
VERSION (PLAN BY): PH (A-A3)

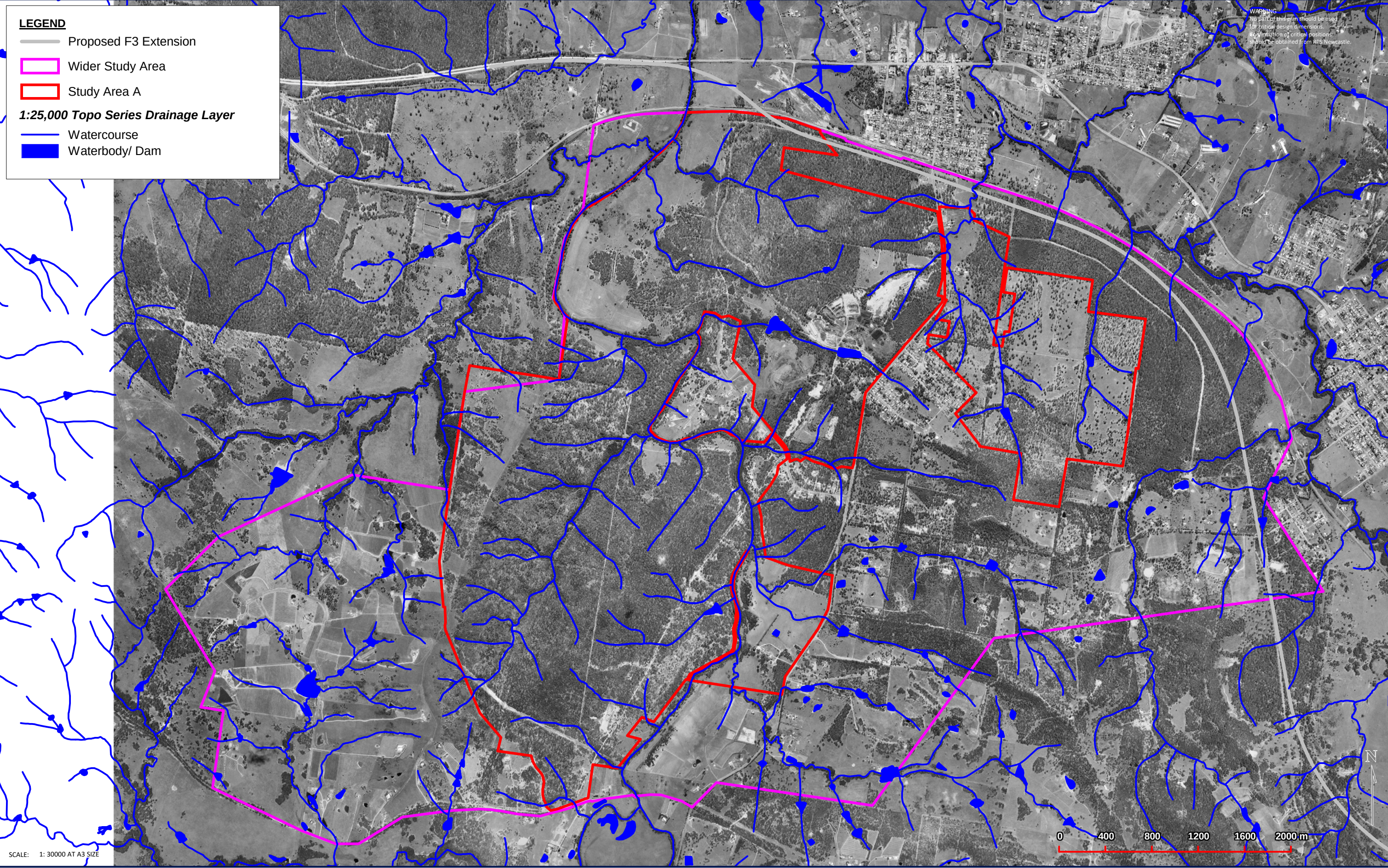
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- LEGEND**
- Proposed F3 Extension
 - Wider Study Area
 - Study Area A
 - 1:25,000 Topo Series Drainage Layer**
 - Watercourse
 - Waterbody/ Dam

WARNING
No part of this plan should be used for critical design dimensions. Confirmation of critical positions should be obtained from RPS Newcastle.

SCALE: 1: 30000 AT A3 SIZE

TITLE: FIGURE 1-3 HUNTLEE DRAINAGE	LOCATION: ECMP - HUNTLEE NEW TOWN	DATUM: DATUM PROJECTION: MGA ZONE 56 (GDA 94)	DATE: 28/9/2010 PURPOSE: REPORT FIGURE	LAYOUT REF: J:\JOBS\105k\105216 North Rothbury (Huntlee)\10- Drafting\ECMP VERSION (PLAN BY): MD (A-A3)	Copyright "This document and the information shown shall remain the property of RPS Australia East Pty Ltd. The document may only be used for the purpose for which it was supplied and in accordance with the terms of engagement for the commission. Unauthorised use of this document in any way is prohibited."
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1.4 Report Qualification

1.4.1 Ecological Staff

The Ecological Constraints Master Plan (ECMP) was primarily undertaken by ecologists from RPS including:

2005: Lucas Grenadier (B App Sc (EAM) Hons), Allan Richardson (B Env Sc (Hons)), Paul Hillier (B Env Sc), Jason Brown (B Env Sc), Craig Anderson (B App Sc (EAM)).

2007: Allan Richardson (B Env Sc (Hons)), Craig Anderson (B App Sc (EAM)), Matt Doherty (BLMC), Deb Landenberger (B Sc (Hons.)), Sam Bishop (BEnvSc), Rod Gray (B Env Sc).

2008: Allan Richardson (B Env Sc (Hons)), Craig Anderson (B App Sc (EAM)), Matt Doherty (BLMC), Deb Landenberger (B Sc (Hons.)), Sam Bishop (BEnvSc).

2009: Allan Richardson (B Env Sc (Hons)), Craig Anderson (B App Sc (EAM)), Matt Doherty (BLMC), Deb Landenberger (B Sc (Hons.)), Steve Roderick.

2010: Craig Anderson (B App Sc (EAM)), Matt Doherty (BLMC), Paul Hillier (BEnvSc), Shaun Corry (B Sc (Biol)), Anna McConville (B Env Sc).

The academic qualifications and professional experience of the key managing RPS ecologists involved with the project are documented in Appendix 5.

A number of sub-consultants were also employed for the production of the report, as detailed below in 'Certification'.

1.4.2 Licensing

Research was conducted under the following licences:

- NSW National Parks and Wildlife Service Scientific Investigation Licence S10300 (Valid 30 November 2010);
- Animal Research Authority (Trim File No: 01/1142) issued by NSW Agriculture (Valid 12 March 2011);
- Animal Care and Ethics Committee Certificate of Approval (Trim File No: 01/1142) issued by NSW Agriculture (Valid 12 March 2013); and
- Certificate of Accreditation of a Corporation as an Animal Research Establishment (Trim File No: 01/1522 & Ref No: AW2001/014) issued by NSW Agriculture (Valid 22 May 2011).

1.4.3 Certification

The following persons and organizations have assisted or been utilised for the production of data included within the EAR:

Vegetation Survey and Mapping: Stephen Bell
Eastcoast Flora Survey
PO BOX 216 Kotara Fair NSW 2289
Tel/ Fax: 02 4956 2952

Plant Species Identification: Royal Botanic Gardens
National Herbarium of NSW
The Domain
Mrs. Macquaries Road
Sydney NSW 2000
Tel. (02) 92318111
Fax. (02) 9251 7231

***Persoonia pauciflora* information:** Gordon Patrick
(then at) SKM
710 Hunter Street
Newcastle West, NSW 2302
Tel: (02) 4979 2600
Fax: (02) 4979 266

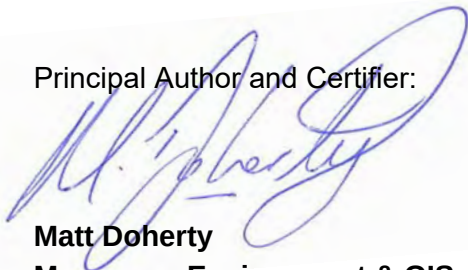
Anabat Bat Call analysis: Glenn Hoyer
Fly By Night Bat Surveys Pty Ltd
PO Box 271
Belmont NSW 2280
Tel. (02) 49477794
Fax. (02) 49477537

Hair and Scat Analysis: Barbara Triggs
"Dead Finish"
Genoa VIC 3981

As the principal author, I, Matt Doherty, make the following certification:

- The results presented in the report are, in the opinion of the principal author and certifier, a true and accurate account of the species recorded, or considered likely to occur within the site; and
- Commonwealth, state and local government policies and guidelines formed the basis of this Proposal's surveying methodology. Where the survey work has been undertaken with specified departures from industry standard guidelines, this is discussed and justified in the report.

Principal Author and Certifier:



Matt Doherty

Manager – Environment & GIS

RPS

September 2010

2 Methods

This chapter provides an overview of the methods that were utilised for the development of the Ecological Constraints Master Plan (ECMP) in 2005, and updating and supplementation in 2007 and 2010, culminating in this EAR.

2.1 Terrestrial

2.1.1 Summary of Methods

The development of the ECMP for Huntlee comprised of the following aspects:

- **Collation of existing flora and fauna datasets and survey reports** – The results of the numerous flora and fauna investigations that have been undertaken within and adjoining the study area to date, in particular threatened species records, have been incorporated into the ECMP. Important information sources utilised include Bell (2005), Bell & Driscoll (2005), Conacher Travers (2003a; 2003b; 2004), Ecotone (2003), Patrick, G (1998-2001), NPWS Atlas of NSW Wildlife (2005, 2007 & 2010) and EPBC Atlas Data (2005, 2007 & 2010).
- **Vegetation survey & mapping over the entire study area** – Vegetation survey and mapping reports were undertaken by Eastcoast Flora Survey on behalf of RPS (then HSO). This was undertaken to replace the broad-scale vegetation map of the area previously produced for the Lower Hunter Central Coast Regional Environmental Management Strategy (LHCCREMS) by NPWS (2000) and House (2003) and more recently for the Hunter – Central Rivers Catchment Management Authority by Peake (2005). Detailed vegetation survey and mapping was undertaken over Study Area A, whilst the Wider Study Area was subject to more broadscale investigations. These reports are provided in full in Appendix 2.
- **Detailed threatened species surveys and habitat investigations** – Detailed ecological investigations, using high accuracy GPS ('Trimble' Global Positioning Systems), were undertaken to obtain a comprehensive overview of the habitat features / attributes throughout Study Area A and to document the distribution and abundance of threatened flora and fauna species. Updating of existing information regarding threatened species which have been recorded in the area, particularly such significant species as *Persoonia pauciflora* and Swift Parrot, has been carried out in 2007 to monitor the status of such species. A *Persoonia pauciflora* survey, which checked the status of previously recorded individuals, as well as a search for new specimens, has been undertaken in August 2010. Ongoing targeted survey works over time will assist in further understanding these species and seasonal variations in their population status in the locality.

The combined survey effort of the above mentioned studies satisfies the requirements of Cessnock City Council's Development Control Plan No. 56 "Flora and Fauna Survey Guidelines Lower Hunter Central Coast Region 2002" (DCP No. 56) for Study Area A. It is considered that the generated field survey effort for the original ECMP, combined with additional targeted works undertaken more recently, provides an adequate body of data

for environmental assessment and determination to meet the requirements of a SSS study, including reference to the DECCW's 'Guidelines for Threatened Species Assessment (2005)'.

2.1.2 Pre-Existing Data Collation

A number of flora and fauna investigations have been undertaken within the Huntlee area. The results of these reports, in particular vegetation mapping and threatened species records, have been incorporated into the ECMP. These include:

- Bell, S. A. J. & Driscoll, C. (2005) *Vegetation survey of "Sweetwater", North Rothbury, mid Hunter Valley, New South Wales*. Prepared for Harper Somers O'Sullivan by Eastcoast Flora Survey. Final Report. 3 October 2005;
- Bell, S. A. J (2005) *Vegetation survey of "Sweetwater", North Rothbury, mid Hunter Valley, New South Wales. Supplementary Report of Expanded Study Area*. Prepared for Harper Somers O'Sullivan by Eastcoast Flora Survey. Draft Report. 30 September 2005;
- Conacher Travers (2004) *Flora and Fauna Survey &Assessment Report for Proposed Rural Residential Subdivision Rezoning for Lot 300 DP 1029733 Old North Road Pokolbin*. Report prepared by Conacher Travers Environmental Consultants, March 2004;
- Conacher Travers (2003a) *Flora and Fauna Survey &Assessment Report for Proposed Tourist Accommodation Lot 102, DP 1040618 Old North Road Pokolbin*. Report prepared on behalf of CoePlan Pty Ltd by Conacher Travers Environmental Consultants, February 2003.
- Conacher Travers (2003b) *Flora and Fauna Survey &Assessment Report for Proposed Rural Residential Subdivision Rezoning for Lot 33 DP 1029733 Old North Road Pokolbin*. Report prepared by Conacher Travers Environmental Consultants, April 2003.
- Conacher Travers (2003c) *Addendum to Flora and Fauna Survey &Assessment (April 2003) Report for Proposed Rural Residential Subdivision Rezoning for Lot 33 DP 1029733 Old North Road Pokolbin*. Report prepared by Conacher Travers Environmental Consultants, May 2003.
- Conacher Travers (2003d) *Addendum to Flora and Fauna Survey &Assessment Report (April 2003) for Proposed Rural Residential Subdivision Rezoning for Lot 33 DP 1029733 Old North Road Pokolbin*. Report prepared by Conacher Travers Environmental Consultants, November 2003.
- Conacher Travers (2001) *Flora and Fauna Survey &Assessment Report for proposed Holiday Lodges Old North Road Rothbury*. Conacher Travers Environmental Consultants, 2001.
- Ecotone Ecological Consultants (2003) *Preliminary Flora and Fauna Constraints Assessment for the "Hunter Valley Project", North Rothbury, Hunter Valley*. Report prepared for Toland Williams Pty Ltd & Hunter Development Brokerage. July 2003;
- RPS Harper Somers O'Sullivan (2007a) *Swift Parrot Surveys of Huntlee Lands, North Rothbury. Winter 2007*. Report prepared for Huntlee Holdings Pty. Ltd.

- RPS Harper Somers O'Sullivan (2007b) *Individual Profiles of Persoonia pauciflora (North Rothbury Persoonia) occurring within Huntlee. Updated August 2007.* Report prepared for Huntlee Holdings Pty. Ltd.
- RPS Harper Somers O'Sullivan (2008) *Swift Parrot Surveys – Winter 2008 For North Rothbury.* Report prepared for Huntlee Holdings Pty. Ltd.
- RPS Harper Somers O'Sullivan (2009) *Swift Parrot Surveys – Winter 2009 For North Rothbury.* Report prepared for Huntlee Holdings Pty. Ltd.
- RPS Harper Somers O'Sullivan (2009b) *Persoonia Pauciflora Survey Updates – August 2009.* Report prepared for Huntlee Holdings Pty. Ltd.
- RPS (2010) *Persoonia Pauciflora Survey Updates – August 2010.* Report prepared for Huntlee Pty. Ltd.

Table 2-1 summarises the survey methods / effort undertaken as part of each of the above-mentioned studies.

Several other important data sources were utilised for the ECMP, including:

- Atlas of NSW Wildlife (NSW National Parks & Wildlife Service);
- EPBC On-line Atlas Data (DEWHA);
- Hunter Bird Observers Club (HBOC) records; and
- Birddata (web version of Birds Australia's New Atlas of Australian Birds).

Table 2-1: Combined Survey Effort of Previous and Current Flora and Fauna Investigations within the Study Area

	Ecotone (2003)	Conacher Travers (2001)	Conacher Travers (2003a)	Conacher Travers (2003b)	Conacher Travers (2004)	Bell & Driscoll (2005)	Harper Somers O'Sullivan (2005)	Harper Somers O'Sullivan (2007)	RPS HSO (2008)	RPS HSO (2009)	RPS (2010)	Combined Total	Minimum Cessnock DCP 56 Requirements
Season	Winter (June-July)	Autumn Winter (April – June)	Summer (February)	Autumn (April)	Autumn (March 2004)	September 2004 – March 2005	Spring – Summer (September, November, & December) Autumn – winter (April – August).	Winter	Winter	Winter	Winter	Autumn, Winter, Spring, Summer	
Location		Lot 1 DP 658074 and Lot 301 DP 1029733	Lot 102 DP 1040618	Lot 300 DP 1029733	Lot 300 DP 1029733	Refer to Appendix 2	Lot 1 DP 1042140, Lot 1 DP 707207, Lot 32 DP 1003656, Lot 200 DP 828486, Lot 123 DP 1012402 & Lot 2 DP 1042140	All Huntlee Lands	All Huntlee Lands	All Huntlee Lands	All Huntlee Lands		
Flora Survey Work	Vehicle Based and Walking Transects	(8) linear transects (100m), (8) DBH quadrats (20 x 20m), (8) forb and herb quadrats (20 x 20m).	(6) linear transects (100m), (6) DBH quadrats (20 x 20m) (6) forb and herb quadrats (20 x 20m).	-	(8) linear transects (100m), (8) DBH quadrats (20 x 20m), (8) forb and herb quadrats (20 x 20m).	62 floristic plots & 380 kms of dedicated searches and random meander	2000ha DBH quadrats (500 x 200m x 200m).	Updated survey of known <i>Persoonia pauciflora</i> Plants and random meander opportunistic searches.	Updated survey of known <i>Persoonia pauciflora</i> plants and random meander opportunistic searches.	Updated survey of known <i>Persoonia pauciflora</i> plants and random meander opportunistic searches.	Updated survey of known <i>Persoonia pauciflora</i> plants and random meander opportunistic searches.	Delineation of vegetation community boundaries noting vegetation and significant species	> 50 ha 7 – 10 walking transects + 2 quadrats per community + 1 quadrat per community > 10 ha.
Diurnal Bird Survey	General observation and call identification	Census, Opportunistic observation	Census, Opportunistic observation	-	-	-	Opportunistic observation	Targeted Swift Parrot surveys and opportunistic surveys for other threatened bird species.	-	Targeted Swift Parrot surveys and opportunistic surveys for other threatened bird species.	Opportunistic surveys for threatened bird species.	Census, and surveys Persoonia pauciflora).	General targeted (eg. Formal Census Summer - Winter
Effort	Undertaken during each site visit	10 hours	9 hours	-	-	-	Undertaken during each site visit	Undertaken during each site visit	-	Undertaken during each site visit	Undertaken during each site visit	Unspecified, (est. >700 hours) targeted and incidental observations	1ha sample per 20 mins / habitat.
Nocturnal Bird Survey	Spotlighting and call identification	Owl playback call & Spotlighting	Owl playback calls & Spotlighting.	Owl playback call & Spotlighting	-	-	Owl playback call & Spotlighting	Targeted searches of potential roosting habitats.	-	Targeted searches of potential roosting habitats.	-	Call playback and spotlighting	Formal Census Summer - Winter
Effort	Unknown	5 hours	1 hours	1 hour	-	-	1 hour (4 points)	Undertaken within appropriate habitat during each site visit	-	Undertaken within appropriate habitat during each site visit	-	8+ hours of spotlighting and playback. Various locations.	One point census per 1km ²
Herpetofauna Survey	General observation	Habitat search, call detection and spotlighting.	Habitat search, call detection and spotlighting	Call detection and spotlighting	-	-	Opportunistic observation	Opportunistic searches.	Opportunistic searches.	Opportunistic searches.	Opportunistic searches.	Diurnal-hand searches in suitable habitat for frogs and reptiles. Nocturnal– spotlighting and frog call playback	REPTILES: Diurnal, nocturnal and habitat searches. September to March. AMPHIBIANS: Diurnal, nocturnal and habitat searches. Playback of recorded calls September to March.
Effort	Unknown	14 hours	2 hours	1 hour	-	-	Undertaken during each site visit	Undertaken during each site visit	Undertaken during each site visit	Undertaken during each site visit	Undertaken during each site visit	Combined Diurnal and nocturnal searches > 700 hours	REPTILES: Diurnal: 1 ha searches for 1 person hr on 2 separate days per habitat. Nocturnal: Walking rate of 1.0 km per hr per person on 2 separate nights Habitats searches One-person hr per ha. Both Diurnal and Nocturnal. AMPHIBIANS: Diurnal: 1 ha searches for one-person hour per habitat. Nocturnal: Spotlighting - 30 mins on 2 separate nights

	Ecotone (2003)	Conacher Travers (2001)	Conacher Travers (2003a)	Conacher Travers (2003b)	Conacher Travers (2004)	Bell & Driscoll (2005)	Harper Somers O'Sullivan (2005)	Harper Somers O'Sullivan (2007)	RPS HSO (2008)	RPS HSO (2009)	RPS (2010)	Combined Total	Minimum Cessnock DCP 56 Requirements
													Playback - Once on each of 2 separate nights Habitat: 2 hrs per 200 metre of water body edge
Bat Survey	None	Anabat II	Anabat II / spotlight	Anabat II / spotlight	-	-	Anabat II	-	-	-	-	Anabat II Surveys and spotlighting	Harp traps and Echolocation call. Spotlighting and listening.
Effort	-	5 hours	1 hour	1 hour	-	-	4 hours	-	-	-	-	7 hours of mobile overnight sessions & 4 hours of stationary sessions.	Harp: 2 harp trap nights per broad habitat. Echolocation call: 45 minute continuous recording plus call activated all night Spotlighting: Walking rate of 1.0 km hr per person.
Terrestrial Mammal Survey	General observation	Type A & B Elliot Traps, Cage Traps, Hair Tubes and spotlighting.	Type A & B Elliot Traps and spotlighting.	Spotlighting	-	-	Type A Elliot Traps and spotlighting.	-	-	-	-	Elliott Type A, Elliott Type B, cage traps and Hair Tubes	Elliott Type A, Elliott Type B and / or cage traps.
Effort	Undertaken during each site visit	144 trap nights, 30 tubes for 10 nights and 6 hours spotlighting.	15 trap nights and 1 hour spotlighting.	1 hour	-	-	48 trap nights and 3.5 hours spotlighting.	-	-	-	-	231 Elliott Type A, Elliott Type B trap nights and cage trap nights, 320 Hair Tube nights and 11.5 hours spotlighting.	10 trap nights over 3-4 consecutive nights per habitat type
Arboreal Mammal Survey	General observation	Type A & B Elliot Traps, Hair Tubes and spotlighting.	Type A & B Elliot Traps, Hair Tubes and spotlighting.	Spotlighting	-	-	Type B Elliot Traps, hair traps and Spotlighting	-	-	-	-	Elliott Type A and Elliott Type B trapping, Hair Tubes and Spotlighting	Elliott Type B, Spotlighting and Faecal pellet counts.
Effort	Undertaken during each site visit	160 trap nights, 30 tubes for 10 nights and 10 hours spotlighting.	30 trap nights, 50 tube nights and 1 hour spotlighting.	1 hour	-	-	120 trap nights, 153 hair tube nights and 3.5 hours spotlighting	-	-	-	-	310 Elliott Type A and 354 Elliott Type B trap nights, 523 hair tube and 14.5+ hours spotlighting	Elliott Type B: Trapping grid of 1.0 ha sampling each major habitat, with 10 traps per grid opened for 3-4 consecutive nights. Spotlighting: Walking rate of 1.0 km hr per person Faecal pellet: Minimum of one plot per 1,000 m2
Koala Survey	General observation	Targeted observations around feed trees and targeted spotlighting.	Targeted observations around feed trees and targeted spotlighting.	-	-	-	Targeted observations around feed trees and spotlighting.	Targeted observations around feed trees for secondary indications.	-	Targeted observations around feed trees for secondary indications.	-	Searches for scratch marks & scats, spotlighting and SEPP 44 assessment	The 'spot assessment technique'
Effort	Undertaken during each site visit	Undertaken during each site visit.	Undertaken during each site visit.	-	-	-	Opportunistic observation	Undertaken during each site visit.	-	Undertaken during each site visit.	-	Unspecified, but considerable.	Sampling a minimum of 20 trees within a circle radiating from a central point. Searches for Koala scats or faecal pellets are conducted at the base of each tree for a maximum of two to three person mins. Minimum sampling density is one plot per 1,000 m2 of potential development areas that contain native trees
Secondary indications and incidental observations	-	Feed trees identified, presence of scratch claw marks, scats	Feed trees identified, presence of scratch claw marks, scats.	-	-	Incidental observations of threatened fauna species	Feed trees identified, presence of scratch claw marks, scats	Incidental observations of threatened fauna species	Incidental observations of threatened fauna species	Incidental observations of threatened fauna species	Incidental observations of threatened fauna species	Searches for scratches, scats, diggings, whitewash, nests, burrows, bones, feathers	
Effort	-	Unknown hours (8) quadrats.	Unknown hours	-	-	-	Opportunistic observation	Opportunistic observation	Opportunistic observation	Opportunistic observation	Opportunistic observation	Unspecified	

2.1.3 Vegetation Survey and Mapping

A detailed vegetation survey and mapping report was undertaken by Eastcoast Flora Survey on behalf of RPS (then HSO) for Study Area A (Bell & Driscoll 2005). A more broad-scale assessment was also undertaken for the remaining lands within the Wider Study Area (Bell 2005).

Study Area A - The survey involved aerial photograph interpretation and a detailed ground truthing program (including vegetation survey plots and transects) to produce a vegetation map of the study area, showing the distribution of vegetation communities and their variants, following the terminology of the Lower Hunter and Central Coast Regional Environmental Management Strategy. This was undertaken to replace the broad-scale vegetation maps of the Huntlee area previously produced by House (2003) – LHCCREMS.

The Bell & Driscoll (2005) report is included in Appendix 2.

Study Area B - The survey involved one day driving around public access roads within the extended study area, viewing the remnant vegetation and making notes on a hard copy air photo of the area. Where possible, foot traverses were also made to better assess the larger patches of vegetation. Significant plant species observed were way pointed with a GPS unit. No full floristic surveys were undertaken and not all remnants were accessible due to private land tenures. From this survey a preliminary vegetation map was prepared.

The Bell (2005) report is included in Appendix 2.

***Persoonia pauciflora* Monitoring** – Update surveys of all *Persoonia pauciflora* plants known to occur within Huntlee lands was conducted by RPS in 2007, 2008, 2009 and 2010. Each plant was evaluated for any changes in status or dimensions and surrounding habitat was searched for potential new plants, which may be the progeny of existing plants. The results of the inventories have been included with the results from the 2005 *P. pauciflora* report and are contained within the accompanying *Persoonia pauciflora* report for Huntlee lands (See Appendix 4).

During these surveys (and other site fauna surveys), watch was kept for any other occurrences of threatened plants to that previously documented within Bell reports (2005).

2.1.4 Detailed Survey & Habitat Investigations in Study Area A

In order to obtain an overview of a broad range of ecological and environmental variables, detailed investigations were conducted by RPS throughout Study Area A. These surveys involved intensive field based surveys from November – December 2004, April – September 2005, June – August 2007, and September 2010, which totalled over 800 person hours. These surveys collected both qualitative and semi-quantitative data, ranging from individual species distributions, to specific habitat features for threatened species and disturbance and degradation regimes.

The key features detailed as part of these detailed ecological investigations included:

- Keystone Mature Tree Species;
- Hollow-bearing Trees;
- 'Grid Pattern' Habitat Investigations; and
- Threatened Species Surveys.

These surveys were undertaken using sub-metre accurate Trimble GPS systems (Geo XT / Pro XRS / Recon). Currently, the ECMP dataset contains over 25,000 points and regions of ecological information, forming a large and detailed ecological database.

The above-mentioned ecological variables collected were based on the survey requirements of CCC DCP No. 56, scientifically recognised principles of habitat definition / quality and that previously undertaken and endorsed for the Hunter Economic Zone by HSO (2004).

Keystone Mature Tree Species

'Keystone Mature Tree Species' refers to those species of tree identified as representing potentially important habitat resources (shelter / foraging) for threatened fauna species. Individual trees qualify for this status when possessing a DBH (diameter at breast height) of greater than 50cm.

Species

A number of tree species occurring were identified to be 'Keystone Mature Tree Species', including:

- *Allocasuarina littoralis* (Black She-oak);
- *Allocasuarina torulosa* (Forest Oak);
- *Angophora floribunda* (Rough-barked Apple);
- *Corymbia maculata* (Spotted Gum);
- *Eucalyptus albens* (White Box);
- *Eucalyptus amplifolia* (Cabbage Gum);
- *Eucalyptus crebra* (Narrow-leaved Ironbark);
- *Eucalyptus fibrosa* (Broad-leaved Ironbark);
- *Eucalyptus glaucina* (Slaty Red Gum);
- *Eucalyptus microcarpa* (Inland Grey Gum);
- *Eucalyptus moluccana* (Grey Box);
- *Eucalyptus punctata* (Grey Gum);
- *Eucalyptus punctata* X *canaliculata* (Grey Gum); and

- *Eucalyptus tereticornis* (Forest Red Gum).

The occurrence of each Keystone Mature Tree Species was mapped as an individual point by GPS.

Size Classes

Each mature tree species collected was afforded a size class: Diameter at Breast Height (DBH) 50-60cm; DBH 60-80cm; DBH 80-100cm; DBH >100cm.

Hollow Bearing Trees

Every tree hollow within Study Area A was detailed. Ten (10) of the twenty-seven (27) threatened fauna species recorded in the study area utilise tree hollows, therefore the collection of this data was considered important to provide an accurate overview of the distribution of these important habitat features. The attributes collected for each hollow bearing tree were based on a review of Gibbons and Lindenmayer (2002). The data collected includes:

- Tree Species: (*List Species)
- Entrance Diameter: 2-10cm; 11-20cm; and > 20cm
- Number of Hollows: 2-10cm (*Count); 11-20cm (*Count); and > 20cm (*Count)
- Type of Hollow: Main stem; Crown branch; Fire scar; Fissure

Grid Pattern Habitat Investigations

To obtain an overview of a broad range of ecological and environmental variables, Study Area A was split into 500 individual grid squares of area 4 ha each (200m x 200m), within which information on a number of ecological attributes was collected. The location of the grid cells is shown in Figure 2-1 and the ecological / environmental attributes collected within each grid are shown in Table 2-2.

The data was collected by systematic random meander surveys within each particular grid (mainly determined by navigation to mature and hollow bearing trees and threatened flora occurrences), comprising a minimum survey effort of one (1) person hour per grid. 'Complex' grids containing large number of trees and/or threatened species were noted as taking up to 3 hours to detail.

Figure 2-1: 200m x 200m Survey Grid Locations

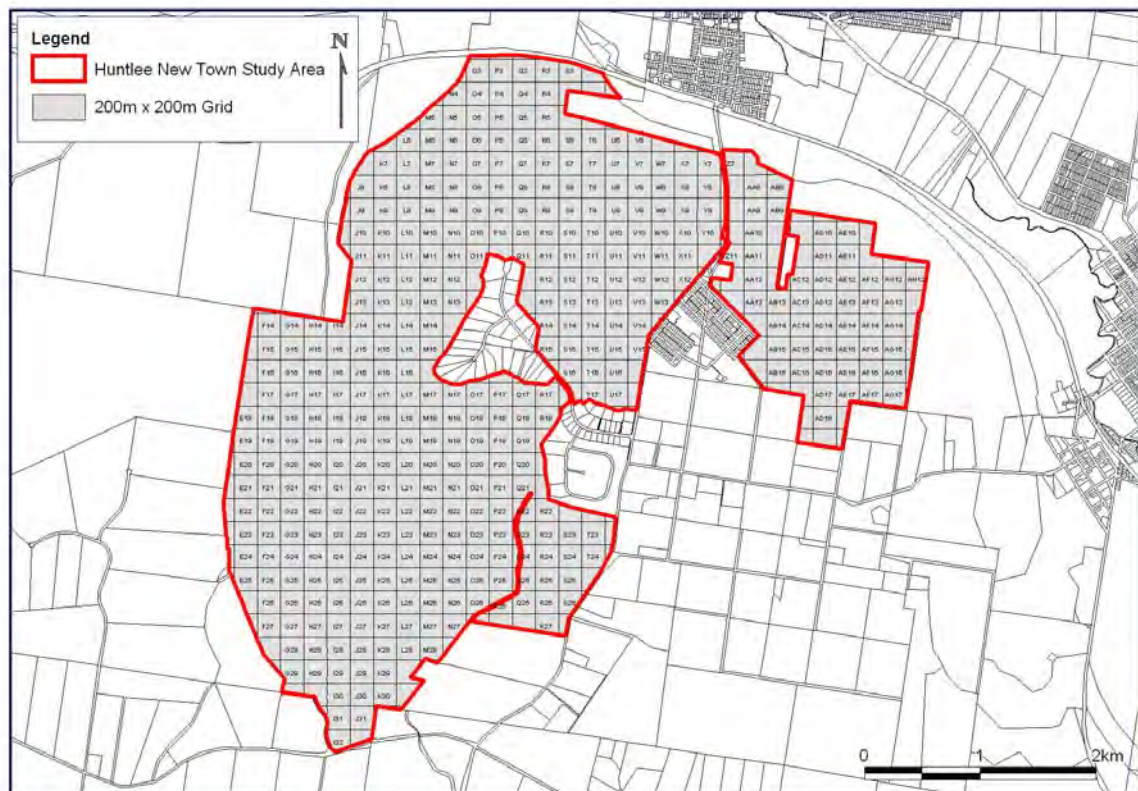


Table 2-2: Ecological / Environmental Attributes collected within 200m x 200m Grids

Feature / Attribute	Variables	Value	Threatened Species Targeted
<i>Grevillea montana</i>	Presence / Absence index	Determine the broad distribution of this ROTAP species across Huntlee.	-
<i>Macrozamia flexuosa</i>	Presence / Absence index	Determine the broad distribution of this ROTAP species across Huntlee.	-
<i>Allocasuarina</i> sp.	- Low Density - Moderate Density - High Density	Determine the density and distribution of this habitat resource across the Huntlee study area.	Glossy Black-cockatoo, Grey-crowned Babbler
Mistletoe	- Low Density - Moderate Density - High Density	Determine the density and distribution of this habitat resource across the Huntlee study area.	Regent Honeyeater Painted Honeyeater
Fallen Timber	- Low (few or none) - Moderate (scattered) - High (intact)	Determine the density and distribution of this habitat resource across the Huntlee study area.	Brown Treecreeper Grey-crowned Babbler Speckled Warbler Brush-tailed Phascogale
Structural Diversity	- Low (1 layer) - Moderate (2 layers) - High (3+ layers)	A measure of habitat quality across the Huntlee study area.	Brown Treecreeper Turquoise Parrot Speckled Warbler Grey-crowned Babbler Brush-tailed Phascogale

Weeds	▪ Low Density ▪ Moderate Density ▪ High Density	A measure of the density and distribution of weeds across the Huntlee study area.	-
Level of Disturbance	▪ No evidence ▪ Light ▪ Moderate ▪ Severe	Measure of habitat quality / habitat disturbance.	-

Threatened Species Surveys

The undertaking of extensive diurnal surveys represented a significant amount of time on the ground and this enabled a considerable number of observations to be made of a number of threatened flora and fauna species. Nocturnal surveys were conducted throughout the survey period and included, targeted frog surveys, spotlighting, owl call broadcast to illicit response, Anabat II surveys and arboreal and terrestrial mammal trapping. During the course of these detailed surveys, all threatened species encountered in the field were recorded.

Details collected for **threatened flora** in the field included – Species; Number Observed; Date Observed; and Field Notes.

Details collected for **threatened fauna** in the field included – Species; Number Observed; Observation Type; Date Observed; and Field Notes.

Given the level of survey effort undertaken by RPS it is considered that a very accurate depiction of the extent and distribution was obtained for some threatened species (eg. *Persoonia pauciflora*, Grey-crowned Babbler and Speckled Warbler). It is noted that in the time since the majority of surveys were undertaken, additional fauna species have been listed as threatened under the TSC Act (e.g. Varied Sitella, Little Lorikeet, Scarlet Robin and Little Eagle). Where there is a paucity of specific records and details for these species within Study Area A, a conservative approach has been taken and consideration is given to the habitat attributes important to each species. In many cases such attributes overlap with other threatened species previously assessed and recorded in more detail.

Winter 2007, 2008 and 2009 – Further threatened fauna surveys were conducted during June - July 2007, June - September 2008 and May - September 2009 to coincide with the southeast Australian dispersal of Swift Parrots (*Lathamus discolor*) during the winter months. These additional survey efforts are part of ongoing annual Swift Parrot surveys, which have been initiated by the Huntlee landholders, to better understand the movements within and use of Huntlee lands by this species. Swift Parrot surveys were conducted over a number of dates to encompass possible variations in the availability of lerps and *Eucalyptus* spp. blossoming cycles.

During these survey periods, notes were also made of any other fauna species or their secondary indications encountered in the field, to contribute to the ECMP database and to provide an updated overview of fauna occurrence and distribution patterns.

General Fauna Surveys

In addition to the fauna species surveys previously conducted within parts of the Huntlee Study Area, including Conacher Travers (2003a; 2003b) and Ecotone (2003), further targeted fauna surveys within Study Area A were undertaken by RPS HSO to provide for an adequate fauna inventory (see Appendix 3).

Methods employed by RPS HSO included:

- Hair Tubes;
- Bat Call Detection (Anabat II Detector and CF ZCAIM);
- Avifauna Survey (Diurnal and Nocturnal Surveys);
- Targeted seasonal Threatened Avifauna Surveys;
- Herpetofauna Surveys;
- Spotlighting; and
- Secondary Indications and Incidental Observations.

The above-mentioned survey methods were based on the guidelines and requirements of DCP No.56 and the survey effort undertaken for each of these methods is detailed in Table 2-1.

Any other incidental observations of fauna were recorded during all phases of fieldwork. Records of species gathered via personal communication with local residents were also noted.

2.2 Aquatic

2.2.1 Literature and Database Review

Database searches were conducted in August 2007 & August 2010. Records of threatened fish species were obtained from Department of Primary Industries (DPI) Fisheries Record Viewer (<http://www.dpi.nsw.gov.au/fisheries/species-protection/records/viewer>) for the Hunter-Central Rivers system. Records for threatened species, populations and communities listed under the EPBC Act were obtained from the Department of Environment and Water Resources (DEWR) EPBC Online Database in August 2010. In addition DPI Fish files for the Hunter-Central River were checked for potential species of significance documented or occurring within the study area.

Consideration was also given to the potential occurrence of Groundwater Dependant Ecosystems (GDEs) within the site.

2.2.2 Field Habitat Assessment

Field inspections and documenting of aquatic habitats and features within the Huntlee study area were undertaken in July 2007, and an additional site inspection was undertaken in August 2010. The 2007 inspections were undertaken approximately four weeks after a period of extremely high rainfall within the Hunter Catchment. Watercourses showed signs of previous flooding events (such as instream and bank vegetation flattened, debris on banks and in trees above the normal water level, some recent creek bank scouring etc). The 2010 inspection was in a much drier period, which provided a good indication of natural variability within the site.

The field investigations focused on identification, assessment and documentation of the range of representative aquatic habitats within the study area, including:

- Perennial Watercourses (Black Creek);
- Large Intermittent Watercourses;
- Small Intermittent Watercourses; and
- Dams / Artificial Wetlands.

Aquatic habitats were surveyed by traversing all major watercourses, and representative sections of lesser intermittent watercourses. An assessment of the waterway and riparian condition and habitat was undertaken following a modified AUSRIVAS protocol. Photographic records, relevant habitat notes and incidental observations were logged. Aquatic habitats were also classified according to the DPI (Fisheries) Fish Habitat Scheme, which assesses waterways / waterbodies on their potential to provide fish habitat. The habitat classes are defined as:

- *Class 1 - Major Fish Habitat:* Large named permanently flowing stream, creek or river. Threatened species habitat or area of declared "critical habitat" under the threatened species provisions of the *FM Act*. Aquatic vegetation is present. Known fish habitat and / or fish observed inhabiting the area;
- *Class 2 - Moderate Fish Habitat:* Smaller named permanent or intermittent stream, creek or watercourse. Clearly defined drainage channels with semi permanent to permanent waters in pools or connected wetland areas. Marine or freshwater aquatic vegetation present. Known fish habitat and / or fish observed inhabiting the area;
- *Class 3 - Minimal Fish Habitat:* Named or unnamed watercourse with intermittent flow, with potential refuge, breeding or feeding areas for some aquatic fauna (e.g. some fish, yabbies). No to minimal defined drainage channel. Semi-permanent pools, ponds, farm dams or wetlands nearby, or form in the watercourse after a rain event. Watercourse interconnects wetlands or stream habitat; and
- *Class 4 - Unlikely Fish Habitat:* Named or unnamed watercourse with intermittent flow during rain events only, little or no defined drainage channel, little or no free standing water or pools after rain (e.g. dry gully, shallow floodplain depression with no permanent wetland aquatic flora present). No aquatic or wetland vegetation present.

The waterways classification is used to determine matters relevant to development and management, such as the appropriate type of bridge / crossing required and whether inclusion of a fishway is required within a development (NSW Fisheries 1999).

2.3 Limitations

A number of limitations / deficiencies were experienced during the course of these investigations and / or are inherent in the results data. These should be noted and considered in regards to the Huntlee assessment process, and include:

- The results of threatened species surveys are somewhat biased to those threatened species which are easily detected such as diurnal / sedentary birds, perennial plants and some mammals. This has been taken into account in the habitat assessment phase, and has also attempted to be catered for by sheer number of person hours spent surveying the site over a number of years and seasons;
- The collated threatened species records within the study area vary in accuracy and reliability. For example, RPS GPS records are generally accurate to within 1 metre, whilst data obtained from the Atlas of NSW Wildlife may only be accurate to within one kilometre;
- Ecosystems / species distributions are dynamic in nature and are likely to change over time, therefore the data presented should only be viewed as a 'snapshot in time'. The more recent 2007, 2008, 2009 and 2010 surveys have somewhat lessened the effect of this limitation by feeding updated data into the ECMP dataset for those species targeted. To compensate for this limitation it is a recommendation of this report that prior to any development within the study area, that the ECMP data in the immediate vicinity of a proposed development be verified by an ecologist in the field;
- The majority of diurnal fauna surveys were undertaken during the winter months of 2005 & 2007, although some additional targeted surveys were conducted later in spring and summer 2005/06, and in Spring 2010, to compensate for this disparity in seasonal survey effort. As such there was less survey work accomplished during times when migratory bird or bat species might be present on the site and when reptile and amphibian species might exhibit greater activity. This has been taken into account in the habitat assessment phase; and
- The flowering and fruiting plant species that attract some nomadic or migratory threatened species, such as Regent Honeyeaters, Painted Honeyeaters and Grey-headed Flying-foxes, often fruit or flower in cycles spanning a number of years. Furthermore these resources might only be accessed in some areas during years when resources more accessible to threatened species fail. As a consequence threatened species may be absent from some areas where potential habitat exists for extended periods and this might be the case for the above-mentioned species, which have not been observed during the survey efforts to date. Again, this has been taken into account in the habitat assessment phase, although ongoing annual surveys, conducted during the winter months, are designed to elucidate any potential significance the Huntlee lands might represent for seasonal avian species, such as Swift Parrots & Regent Honeyeaters.

Where possible, these above mentioned limitations have been taken into consideration with regards to results interpretations, threatened species assessments and conclusions.

3 Results

This chapter details the results from RPS detailed Ecological Constraints Master Plan surveys as well as information collated from the other flora and fauna surveys conducted within the Huntlee Study Area to date.

3.1 Terrestrial

3.1.1 Flora

Information for the following Section 3.3.1 has been extracted from Bell and Driscoll (2005) & Bell (2005) in studies commissioned by RPS to fulfil flora survey and vegetation mapping requirements for Huntlee (both reports provided in full in Appendix 2). A summary of these reports is provided below.

A total of over 325 plant taxa and six (6) vegetation communities have been recorded with the wider Huntlee Study Area to date, including four (4) threatened plant species and three (3) endangered ecological communities (EEC's) (N.B, includes EEC listed subsequent to the Bell report).

Threatened Flora

Threatened flora species recorded in the wider Huntlee study area includes:

- ***Acacia bynoeana*** – this species is listed as Endangered under the TSC Act and Vulnerable under the EPBC Act. It was recorded at one location off Littlewood Road, extending the known distribution of this species a further 15km to the north of the previous known limit at Kurri Kurri. It occurs in a completely new habitat type not previously recognised as supporting the species;
- ***Eucalyptus glaucina*** – this species is listed as Vulnerable under both the TSC Act and EPBC Act. Many individual redgum trees across the study area show characteristics of the vulnerable *Eucalyptus glaucina*. During studies undertaken at the Hunter Economic Zone near Cessnock, this species was considered by Ken Hill (National Herbarium of NSW) to occur within hybrid swarms with *Eucalyptus tereticornis*. This trend is also apparent within the study area, with considerable hybridisation occurring. Conservation of this species is probably best achieved through a landscape approach of conserving larger stands of redgum eucalypts;
- ***Eucalyptus parramattensis* subsp. *decadens*** – this species is listed as Vulnerable under both the TSC Act and EPBC Act. A single healthy individual of *Eucalyptus parramattensis* subsp. *decadens* was discovered in the southern part of Study Area A, in a small drainage line associated with sandstone bedrock material and surrounded by Central Hunter Ironbark – Spotted Gum – Grey Box Forest. The specimen occurs well north (at least 10km) of the currently accepted distributional range of this taxon and is also present in previously undocumented habitat for the species. The single specimen may represent a vestige of what may have occurred prior to European settlement, which may have been a small disjunct population at the northern limit of the main population.

- ***Persoonia pauciflora*** – this species is listed as Critically Endangered under the TSC Act and under the EPBC Act. The entire known distribution of this species is contained within the wider Study Area. The most significant population(s) of this species occur(s) in the vicinity of Hanwood Estate and along Tuckers Lane. Estimates of the total population number was in the order of 550 plants in 2005 (Patrick 2006), but subsequent surveys of other North Rothbury holdings by RPS realised greater numbers than previously realised, such that Patrick (2006) reported a total of 631 plants as of March 2006. This number was reduced significantly to 354 plants by June 2006, as a result of actions of an unrelated third party. The estimated total number of mature individuals in 2003 was between 80 - 125 mature individuals. The main populations are located at 3 locations 450 m to 750 m apart with each subpopulation containing no more than 50 mature individuals (G. Patrick 2004, pers. comm.).

Further information on the above-mentioned threatened flora species is provided in Appendix 2 and known records are presented graphically in Figure 3-3. Specific detailed information regarding individual *Persoonia pauciflora* plants occurring within or closely adjacent to Huntlee lands is contained within the accompanying *Persoonia pauciflora* Report.

In addition, four rare (ROTAP) species (*Acacia bulgaensis*, *Eucalyptus fergusonii* subsp. *dorsiventralis*, *Grevillea montana*, *Macrozamia flexuosa*), two undescribed species (*Diuris* sp. aff. *dendrobioides* (Hunter Valley) and *Eucalyptus* sp. aff. *agglomerata*) and several other species of floristic note are present within the study area. A number of plant species which are more typical of western inland locations occur as disjunct populations in the Huntlee locality.

Vegetation Communities

Six (6) native vegetation communities have been delineated and described within the REMS framework for the Huntlee study area, including four (4) EECs which comprise approximately 61% of the Huntlee study area:

- **Hunter Valley Dry Rainforest** (listed as an EEC under the TSC Act – equivalent to Lowland Rainforest in NSW North Coast and Sydney Basin Bioregion) restricted to a small area adjacent to Black Creek;
- **Central Hunter Riparian Forest** (listed as an EEC under the TSC Act – equivalent to **River-Flat Eucalypt Forest on Coastal Floodplains**): riparian and floodplain community dominated by invasive stands of *Casuarina glaucina*;
- **Wollombi Redgum – River Oak Woodland** (listed as an EEC under the TSC Act – equivalent to **River-Flat Eucalypt Forest on Coastal Floodplains**): restricted to riparian areas such as Black Creek and its major tributaries;
- **Central Hunter Ironbark – Spotted Gum – Grey Box Forest** (listed as an EEC under the TSC Act – equivalent to **Central Hunter Ironbark – Spotted Gum – Grey Box Forest in the NSW North Coast and Sydney Basin Bioregions**): dominant vegetation community over the majority of the study area, with a number of variants noted;

- **Hunter Lowland Redgum Forest** (listed as an EEC under the TSC Act): restricted to several drainage lines; and
- **Phragmites Rushland**: contained within a small number of man-made dams and water bodies.

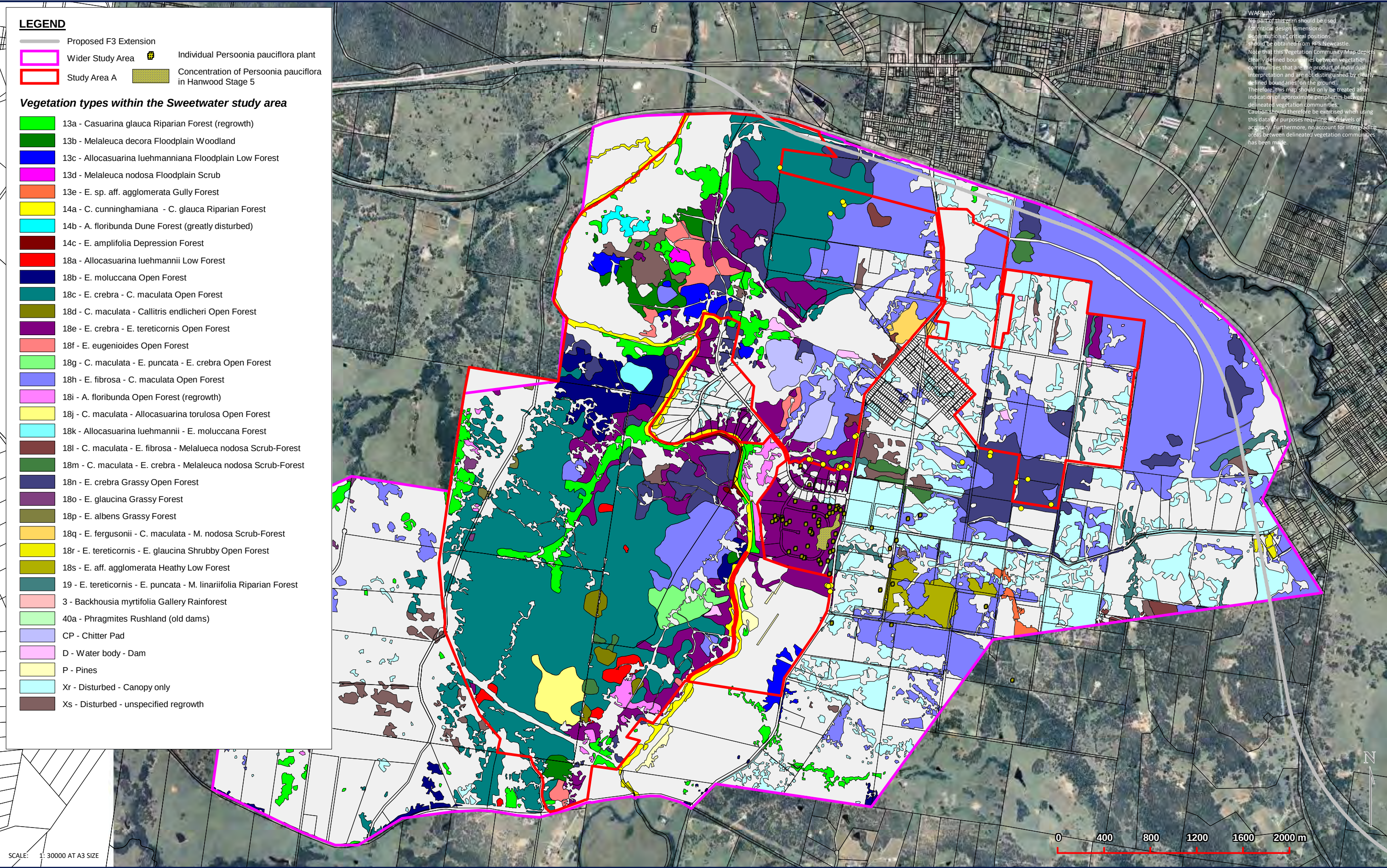
The vegetation associations delineated as part of the Huntlee studies are shown in Figure 3-1. A map of the currently listed EEC's is shown in Figure 3-2.

Of interest is that large sections of the site have been incorrectly mapped by LHCCREMS as being Lower Hunter Spotted Gum – Ironbark Forest (LHSGIF). The vegetation survey conducted by Eastcoast Flora Survey (Bell & Driscoll 2005) clearly shows that the Spotted Gum Forests of the site comprise of a number of sub-variants of Central Hunter Ironbark - Spotted Gum - Grey Box Forest (CHISGGBF).

Table 3-1: Vegetation Associations delineated within Huntlee (Bell 2005)

REMS Unit	REMS Community	Huntlee Association
3	Hunter Valley Dry Rainforest	3 <i>Backhousia myrtifolia</i> Gallery Rainforest
13	Central Hunter Riparian Forest	13a <i>Casuarina glaucina</i> Riparian Forest (regrowth)
		13b <i>Melaleuca decora</i> Floodplain Woodland
		13c <i>Allocasuarina luehmannii</i> Floodplain Low Forest
		13d <i>Melaleuca nodosa</i> Floodplain Scrub
	Wider Study Area only	13e <i>E. sp. aff. agglomerata</i> Gully Forest
14	Wollombi Redgum - River Oak Woodland	14a <i>C. cunninghamiana</i> – <i>C. glaucina</i> Riparian Forest
		14b <i>A. floribunda</i> Dune Forest (greatly disturbed)
		14c <i>E. amplifolia</i> Depression Forest
18	Central Hunter Ironbark – Spotted Gum – Grey Box Forest	18a <i>Allocasuarina luehmannii</i> Low Forest
		18b <i>E. molucanna</i> Open Forest
		18c <i>E. crebra</i> – <i>C. maculata</i> Open Forest
		18d <i>C. maculata</i> – <i>Callitris endlicheri</i> Open Forest
		18e <i>E. crebra</i> – <i>E. tereticornis</i> Open Forest
		18f <i>E. eugenioides</i> Open Forest
		18g <i>C. maculata</i> – <i>E. punctata</i> – <i>E. crebra</i> Open Forest
		18h <i>E. fibrosa</i> – <i>C. maculata</i> Open Forest
		18i <i>Angophora floribunda</i> Open Forest (regrowth)
		18j <i>C. maculata</i> – <i>Allocasuarina torulosa</i> Open Forest
		18k <i>Allocasuarina luehmannii</i> – <i>E. moluccana</i> Forest
		18l <i>C. maculata</i> – <i>E. fibrosa</i> - <i>Melaleuca nodosa</i> Scrub-Forest
		18m <i>C. maculata</i> – <i>E. crebra</i> – <i>Melaleuca nodosa</i> Scrub-Forest
		18n <i>E. crebra</i> Grassy Open Forest
		18o <i>E. glaucina</i> Grassy Forest
		18p <i>E. albens</i> Grassy Forest
	Wider Study Area only	18q <i>E. fergusonii</i> – <i>C. maculata</i> – <i>M. nodosa</i> Scrub-Forest
	Wider Study Area only	18r <i>E. tereticornis</i> – <i>E. glaucina</i> Shrubby Open Forest

	Wider Study Area only	18s	<i>E. aff. agglomerata</i> Healthy Low Forest
19	Hunter Lowland Redgum Forest	19	<i>E. tereticornis</i> – <i>E. punctata</i> – <i>M. linariifolia</i> Riparian Forest
40a	Phragmites Rushland	40a	Phragmites Rushland (old dams)



TITLE: FIGURE 3-1 THE HUNTLEE NEW TOWN VEGETATION MAP (BELL 2005)

LOCATION: ECMP - HUNTLEE NEW TOWN

DATUM: DATUM
PROJECTION: MGA ZONE 56 (GDA 94)

DATE: 9/8/2010
PURPOSE: REPORT FIGURE

LAYOUT REF: J:\JOBS\105K\105216 North Rothbury (Huntlee)\10- Drafting\ECMP
VERSION (PLAN BY): PH (B-A3)

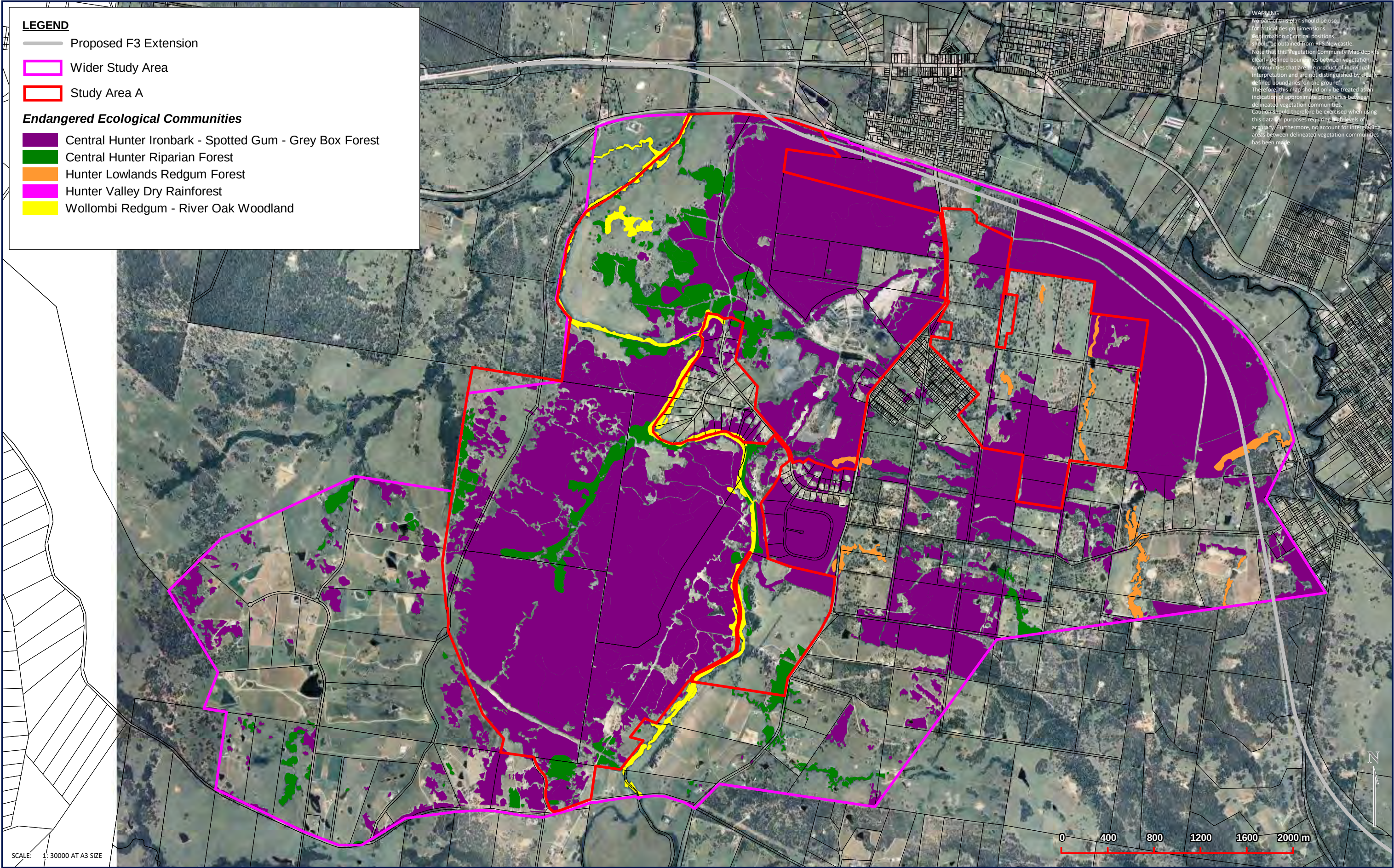
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TITLE: FIGURE 3-2 THE HUNTEE NEW TOWN
ENDANGERED ECOLOGICAL COMMUNITIES

LOCATION: ECMP - HUNTEE NEW TOWN

DATUM: DATUM
PROJECTION: MGA ZONE 56 (GDA 94)

DATE: 11/8/2010
PURPOSE: REPORT FIGURE

LAYOUT REF: J:\JOBS\105K\105216 North Rothbury (Huntlee)\10- Drafting\ECMP
VERSION (PLAN BY): PH (B-A3)

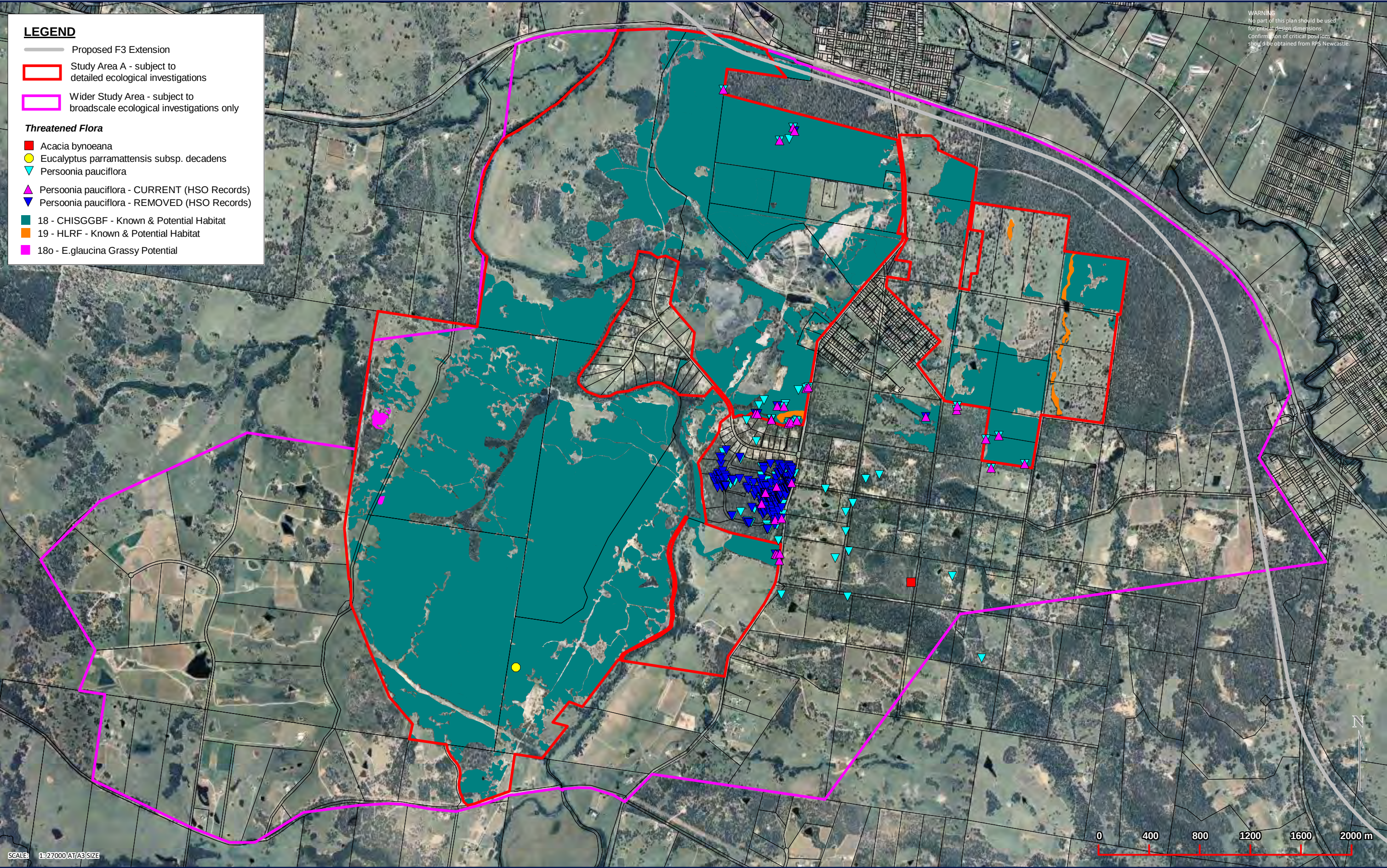
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TITLE: FIGURE 3-3 THREATENED FLORA SPECIES RECORDS

LOCATION: ECMP - HUNTLÉE NEW TOWN

DATUM: DATUM
PROJECTION: MGA ZONE 56 (GDA 94)

DATE: 9/8/2010
PURPOSE: REPORT FIGURE

LAYOUT REF: J:\JOBS\105K\105216 North Rothbury (Huntlee)\10- Drafting\ECMP
VERSION (PLAN BY): PH (C-A3)

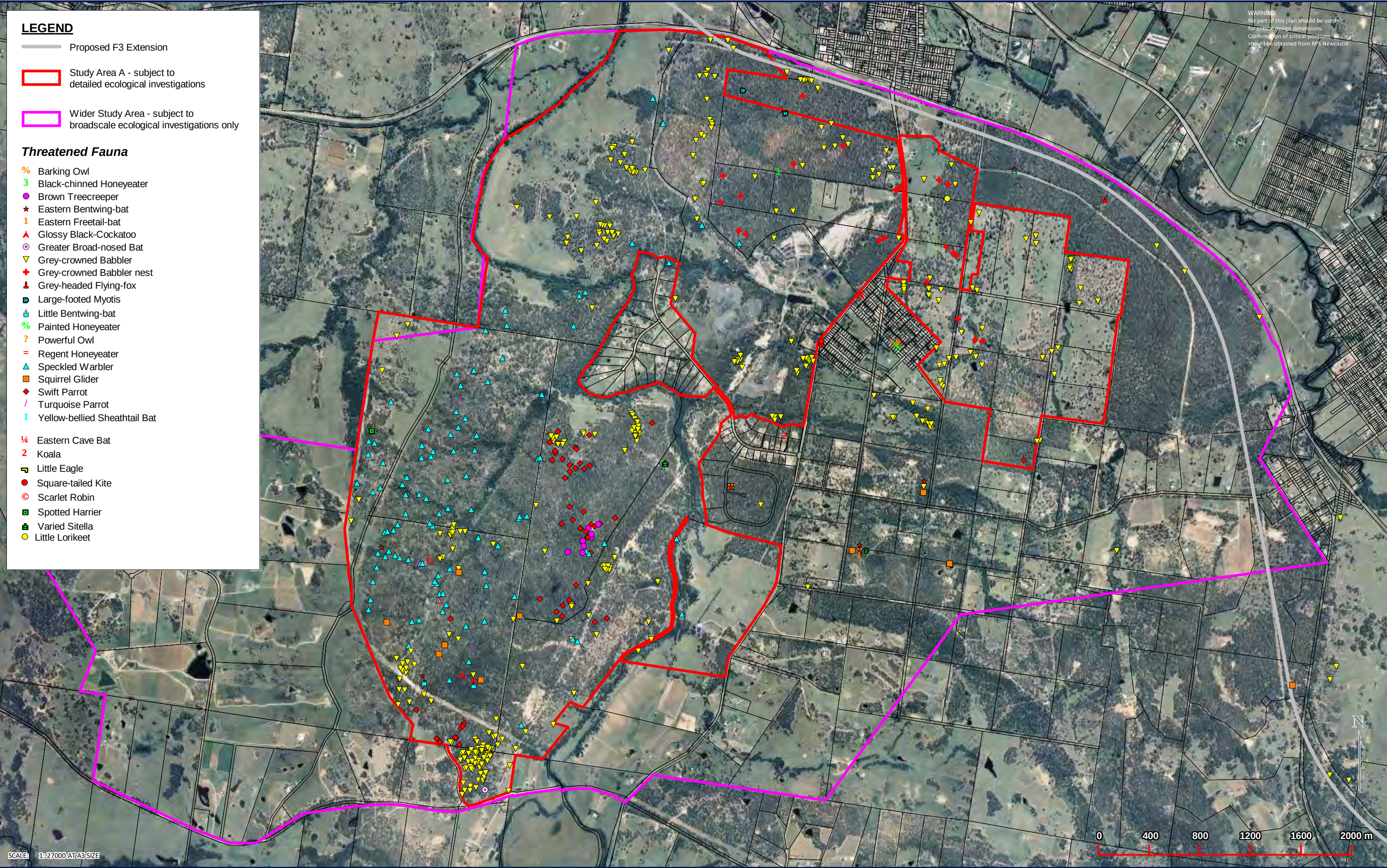
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TITLE: FIGURE 3-4 THREATENED FAUNA SPECIES RECORDS

LOCATION: ECMP - HUNTLÉE NEW TOWN

DATUM: DATUM
PROJECTION: MGA ZONE 56 (GDA 94)

DATE: 21/9/2010
PURPOSE: REPORT FIGURE

LAYOUT REF: J:\JOBS\105K\105216 North Rothbury (Huntlee)\10- Drafting\ECMP
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3.1.2 Fauna

A total of 207 vertebrate fauna taxa have been recorded within the Huntlee Study Area to date, including twenty-seven (27) threatened species and a number of other regionally noteworthy species. The number of bird, frog, reptile and mammal taxa is shown in Table 3-2, whereas a complete list of fauna species recorded is provided in Appendix 3.

The faunal diversity is largely representative of the habitats within and surrounding the Huntlee study area. Considerable expanses of land on the Hunter Valley floor surrounding the area are cleared for agricultural purposes, and as such the site represents a habitat vestige for the locality. Diversity has been reduced by historical and ongoing degradation regimes, such that its ability to support a more complete faunal assemblage has been reduced. Consequently a number of species, including threatened fauna, are only present in small numbers, localised in distribution or not present on a continuous basis. The relatively isolated nature of habitats within the study area and in a regional context is another factor contributing to the reduced status of some fauna.

The study area's position in the central Hunter Valley shows distinct faunal influences from both the western slopes of the Great Dividing Range and more eastern in the lower Hunter, suggesting that like the flora the area represents a confluence between these two regions. More westerly occurring fauna such as *Neophema pulchella* (Turquoise Parrot), *Chthonicola sagittata* (Speckled Warbler), *Climacteris picumnus* (Brown Treecreeper), *Gerygone fusca* (Western Gerygone), *Smicronis brevirostris* (Weebill) and *Antechinus flavipes* (Yellow-footed Antechinus) are present on the site with coastal species including *Ptilonorhynchus violaceus* (Satin Bowerbird), *Petroica rosea* (Rose Robin), *Lopholaimus antarcticus* (Topknot Pigeon) and *Antechinus stuartii* (Brown Antechinus).

Table 3-2: Fauna Assemblages

Faunal Group	No. of Species Recorded	No. of Introduced Species Recorded	No. of Threatened Species Recorded
Bird	145	2	17
Frog	12	0	0
Reptile	10	0	0
Mammal	40	7	10
Total	207	9	27

Threatened Fauna

Twenty-seven (27) threatened fauna species have been recorded (including historical records) in Huntlee to date, as shown below in Table 3-3 and graphically presented in Figure 3-4. An assessment of individual threatened fauna species distribution and abundance within the study area is detailed in Appendix 1.

Table 3-3: Threatened Fauna Species Recorded within Huntlee

Species	Legislative Status		Occurrence on Site
	TSC Act	EPBC Act	
Grey-crowned Babbler	Vulnerable		Relatively common and widespread species across the entire study area, except where <i>Bursaria spinosa</i> constitutes thick understorey.
Brown Treecreeper*	Vulnerable		Only recorded from a small area in the centre of south western portion of Study Area A.
Black-chinned Honeyeater	Vulnerable		Only recorded on a single occasion and likely to be seasonal resident / nomadic visitor to larger forested remnants.
Speckled Warbler	Vulnerable		Widespread records across Study Area A where well-developed shrub layers exist.
Varied Sitella	Vulnerable		Recorded within the site. Point data unavailable (listed as threatened post fieldwork).
Scarlet Robin	Vulnerable		Recorded within the site. Point data unavailable (listed as threatened post fieldwork).
Glossy Black-Cockatoo*	Vulnerable		Favoured foraging trees exist (<i>Allocasuarina spp.</i>), but few records. Likely to use the site on irregular basis.
Painted Honeyeater	Vulnerable		Historical record from 1977, probable aberrant record.
Regent Honeyeater	Endangered	Endangered	Historical record from 1977, possible vagrant.
Little Lorikeet	Vulnerable		Occasional visitor, especially during the winter flowering of Spotted Gums in the locality. This species was often found travelling and feeding with other lorikeet species and Swift Parrots during winter bird surveys, however Little Lorikeets were the least observed lorikeet species on site.
Swift Parrot	Endangered	Endangered	Seasonal migrant, especially during the winter flowering of Spotted Gums in the locality. In winter 2005, flocks representing approximately 3% of the total national population were recorded using Study Area A for foraging and roosting. Subsequent surveys in the winter of 2007 - 2009 found that relatively small numbers of Swift Parrots used the site during 2007, suggesting that the Huntlee lands are unlikely to support large numbers of Swift Parrots in every season.
Turquoise Parrot*	Vulnerable		Recorded on several occasions within Study Area A.
Powerful Owl*	Vulnerable		Historical record from 1977, areas of site may represent part of larger territory.
Barking Owl*	Vulnerable		Historical record from 1977, portions of site may represent part of larger territory.
Little Eagle	Vulnerable		Recorded within the site. Point data unavailable (listed as threatened post fieldwork).
Spotted Harrier	Vulnerable		Recorded within the site. Point data unavailable (listed as threatened post fieldwork).
Square-tailed Kite	Vulnerable		Recent Atlas of NSW Wildlife record (2006) from the western edge of North Rothbury township. Areas of the site may represent part of a larger territory.
Squirrel Glider*	Vulnerable		Recorded consistently during surveys where hollows exist, but not in high numbers.

Species	Legislative Status		Occurrence on Site
	TSC Act	EPBC Act	
Koala	Vulnerable		Record from 2004 in Hanwood Estate. Potential habitat occurs throughout the site.
Grey-headed Flying-fox	Vulnerable	Vulnerable	Nomadic forager for Eucalypt blossom and likely to visit the site when such resources are available. No communal camps known from the locality.
Yellow-bellied Sheath-tail-bat*	Vulnerable		Known and potential roosting and foraging habitat throughout.
Little Bentwing-bat	Vulnerable		Known and potential foraging habitat throughout, but no preferred roosting habitat (eg. Caves) found within the study area.
Eastern Bentwing-bat	Vulnerable		Known and potential foraging habitat throughout, but no preferred roosting habitat (eg. Caves) found within the study area.
Eastern Freetail Bat*	Vulnerable		Known and potential roosting and foraging habitat throughout.
Greater Broad-nosed Bat*	Vulnerable		Known and potential roosting and foraging habitat throughout.
Large-footed Myotis*	Vulnerable		Prefers to reside and forage in close proximity to water, including creeklines. Potential habitat over large areas of the site.
Eastern Cave Bat	Vulnerable		Known and potential foraging habitat throughout, but no preferred roosting habitat (eg. caves). One Atlas of NSW Wildlife record (accessed 2010) from 2006 in the north-eastern edge of the wider study area.

* Hollow dependent species (source: Gibbons & Lindenmayer 2002).

This assemblage of threatened fauna (excluding historical records) provides a typical portrayal of the species known from the larger forest remnants within this part of the Hunter Valley (eg. such as Belford & Werakata National Parks) and of the dry woodland and open forest habitats characteristic of the study area.

Despite extensive fauna surveys over the Huntlee Study Area A, a number of threatened fauna species that, based on habitat assessment, have a moderate or higher chance of occurring on the site, were not recorded. Although unobserved, these species could possibly use the site on a relatively continuous or discontinuous basis and their apparent absence may be a function of their general scarcity, the site only encompassing a portion of their range or their seasonal use of the study area not coinciding with times when fauna surveys have been carried out. Alternatively they may not be utilising the site at all. Such species include:

- *Litoria aurea* (Green and Golden Bell Frog) – Once widespread species occurring in permanent water bodies and swamps including disturbed sites. Potential habitat exists within the study area. Targeted surveys have not revealed this species.
- *Litoria brevipalmata* (Green-thighed Frog) – Previously recorded along drainage lines within the HEZ and north of Kurri Kurri and may occur in similar habitat within the study area. Detection difficult outside of heavy summer rainfall events. Targeted surveys have not revealed this species.
- *Heleioporus australiacus* (Giant Burrowing Frog) - A single record exists within 10km,

which is approximately 1.3km north of the Study Area. Potential habitat exists within the study area, particularly along Black Creek and other drainage lines and habitats with a sandy substrate. Targeted surveys have not revealed this species.

- *Tyto novaehollandiae* (Masked Owl) – Recorded within 10km of the study area and scattered records exist from across the Hunter region. Roosting and foraging habitat present on site. Targeted surveys have not revealed this species.
- *Melanodryas cucullata* (Hooded Robin) – Recorded to the west of the site in the Singleton area and previously recorded at Quorrobolong (Authors pers. Obs.). Suitable habitat present within the study area. Not recorded during extensive site survey efforts.
- *Callocephalon fimbriatum* (Gang-Gang Cockatoo) – May visit the area on a seasonal basis. Not recorded during extensive site survey efforts.
- *Stagonopleura guttata* (Diamond Firetail) – Records exist within the Hunter Region and this western slopes species is historically known to occur further east. Potential habitat for this species occurs within the study area, which may be utilised seasonally for seeding grasses. Not recorded during extensive site survey efforts.
- *Phascogale tapoatafa* (Brush-tailed Phascogale) – A number of records exist to the west of the site within the Singleton LGA (mainly on the northern side of the Hunter River) and potential habitat occurs within the study area. Targeted surveys have not revealed this species.
- *Dasyurus maculatus* (Spotted-tailed Quoll) – Records exist to the north of the site and one record also exists within the Hanwood Estate, which is bounded by the site. Potential habitat occurs within the study area; however targeted surveys have not revealed this species.
- *Petaurus australis* (Yellow-bellied Glider) – Previously recorded within the HEZ and Werekata NP and may occur in similar habitat within the study area. Targeted surveys have not revealed this species.
- *Chalinolobus dwyeri* (Large-eared Pied Bat) – Most records further east but cannot be discounted due to the mobility of this species. Targeted surveys have not revealed this species.
- *Nyctophilus timoriensis* (Greater Long-eared Bat) – Limited number of records within the Hunter Region but use of the study area cannot be discounted due to the mobility of this species. Targeted surveys have not revealed this species.

3.1.3 Detailed Survey & Habitat

Over 25,000 points (e.g. hollow-bearing trees), lines (e.g. creeklines) and regions (e.g. grid variables) of ecological information have been collected as part of RPS's detailed survey & habitat investigations within Study Area A. The majority of this information is summarised in Table 3-4 and Table 3-5.

Keystone Mature Tree Species

A total of 20,768 keystone mature trees were detailed within Study Area A (see Table 3-4). The most common tree species detailed were the Spotted Gum (5,645), Narrow-

leaved Ironbark (3,139), Forest Red Gum (2,752), Grey Box (2,137) and Broad-leaved Ironbark (2,179).

The higher densities of mature trees occurred in lower lying areas bordering Black Creek and in scattered mature remnant patches along Terrace Ridge and near the township of Branxton. As shown in Table 3-4, densities of mature trees reached up to 46 per hectare.

This data shows that whilst mature trees were relatively widespread throughout the majority of the site, previous and ongoing land-use activities including historical and ongoing 'pit-prop' timber getting, pastoral practices and ongoing firewood collection have reduced the density and distribution of mature trees. This is also evidenced by the relatively low number of mature hollow-bearing trees, indicating that large areas of the site are of a single age cohort that is for the most too young to produce hollows suitable for vertebrate fauna.

Hollow-bearing Trees

A total of 1,692 hollow-bearing trees containing 3,469 hollows including 579 large ($\phi > 20\text{cm}$), 1,174 medium ($\phi 11\text{-}20\text{cm}$) and 1,716 small hollows ($\phi 2\text{-}10\text{cm}$) were detailed within Study Area A.

Generally low densities of hollow-bearing trees were recorded. The highest densities are located in three groupings within the study area; the southern end of the site's central ridge (western section), to the northwest of this area on the eastern flanks of the central ridge and then in the north-eastern section of the western section (see Table 3-4). Many areas, such as the western and eastern slopes of Terrace Ridge, displayed abnormally low densities, which may be a function of a sustained history of timber getting in this area.

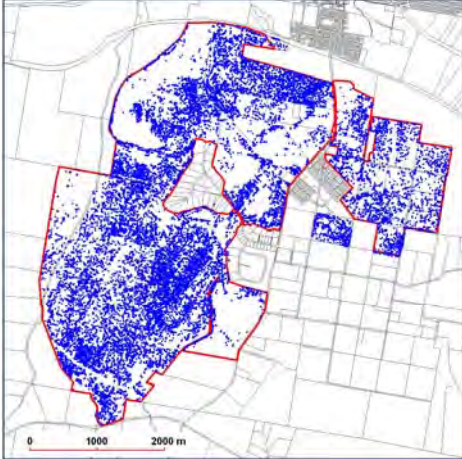
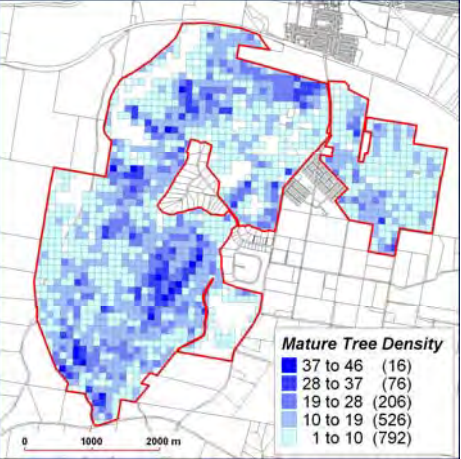
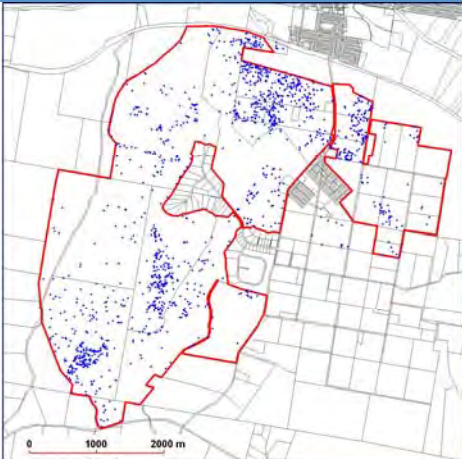
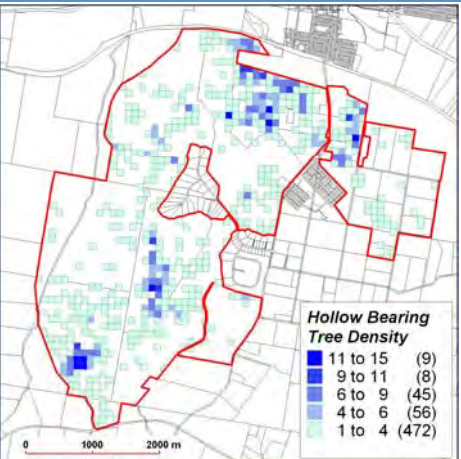
The highest numbers of hollows occur in mature Spotted Gum trees with both Red Gum and Ironbark species displaying generally low numbers of recorded hollows.

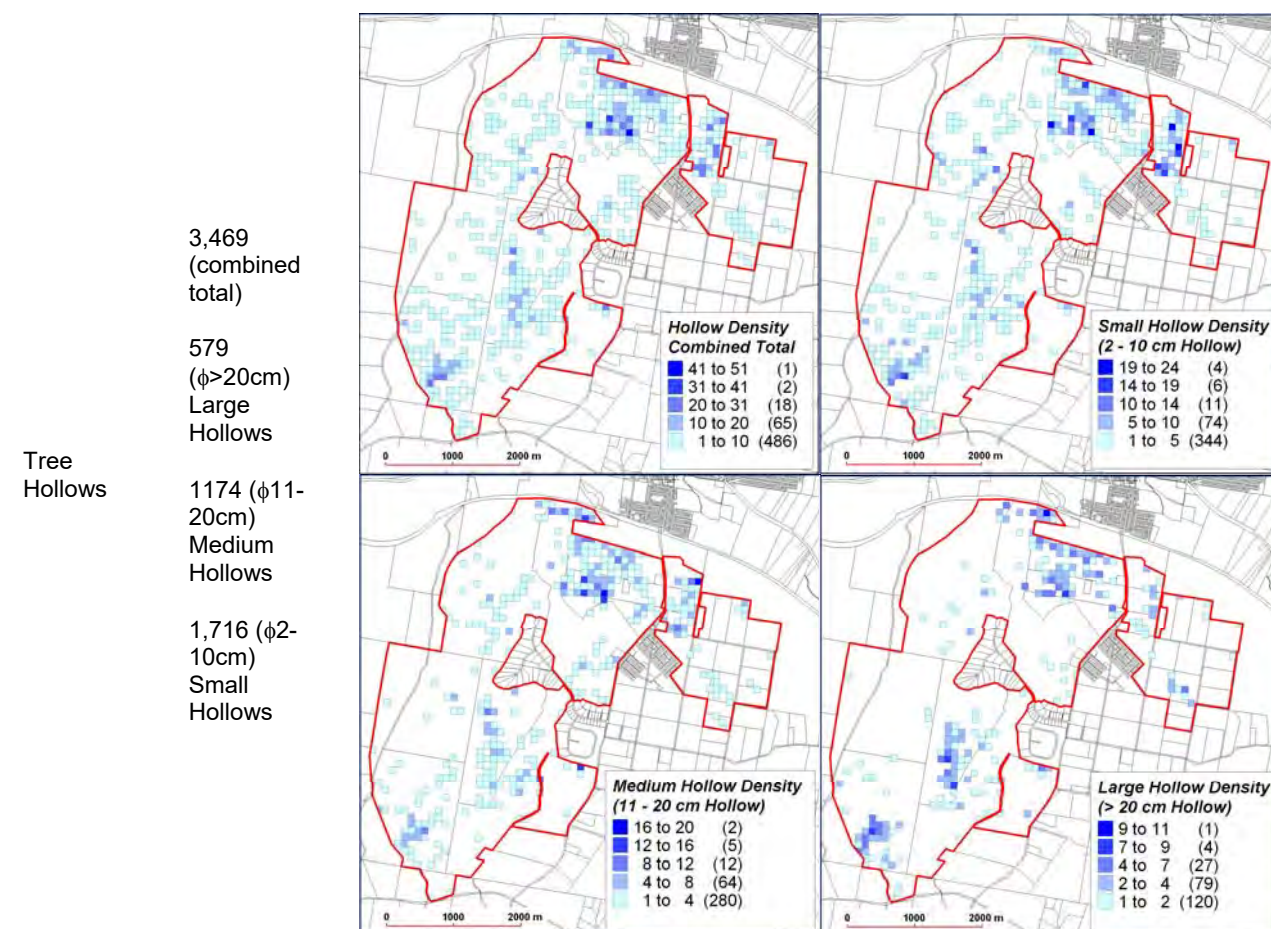
The data shows that previous and ongoing land-use activities including historical mining activities and ongoing timber getting appear to have impacted upon the density of occurrence of this habitat resource.

An average of 1.08 hollow-bearing trees per hectare was obtained for Study Area A and this would place it at a lower range for the estimates of the number of hollow-bearing trees used by vertebrate fauna in Australia, which ranges from 0.4 – 14 trees per hectare (Gibbons and Lindenmayer 2002). In the forests of south-east Queensland, Smith (1998) estimated that demand for hollows by hollow dependent fauna was 9.9 per hectare in dry Spotted Gum Forest, which is significantly higher than the availability of hollows within the site. From this information it can be inferred that the demand for hollows is likely to exceed that which is currently available and as such the availability of hollows is likely to be a limiting factor for the size and distribution of hollow dependant fauna populations, such as the Squirrel Glider.

The extent of this habitat resource can be utilised to model the potential habitat and occurrence of the ten (10) threatened fauna species recorded within the Wider Study Area that are reliant on tree hollows for at least one aspect of their lifecycle.

Table 3-4: Mature and Hollow-bearing Tree Data

Feature	Number Recorded	Map(s)
Mature Trees	20,768 (total)	  Raw Point Data Density per 100m x 100m Grid
Hollow-bearing Trees	1,692 (total)	  Raw Point Data Density per 100m x 100m Grid



Grid Pattern Habitat Investigations

The results of the 200m x 200m grid pattern habitat investigations are shown in Table 3-5. These variables were collected to obtain an overview of a broad range of ecological and environmental variables for the study area, which can be utilised for strategic planning purposes, threatened species modelling and ongoing land management (such as the rehabilitation of degraded areas).

The results show that whilst habitat resources are present for a number of species, degradation regimes have impacted upon a number of these resources and led to an overall reduction in the quality of habitat across the study area.

Threatened Species Surveys

During the course of these surveys by RPS, threatened species most commonly recorded included:

Flora – *Persoonia pauciflora* and *Eucalyptus glaucina*.

Fauna – Grey-crowned Babbler, Speckled Warbler, Swift Parrot and Turquoise Parrot.

Two species of threatened honeyeater, namely the Regent Honeyeater and the Black-chinned Honeyeater, were not observed on the site by RPS despite extensive diurnal bird

surveys coinciding with a spattering of winter blossoms on the site in 2005 & 2007. Furthermore, over the period of the surveys in 2005, Black-chinned Honeyeaters were observed in relative abundance elsewhere in the Cessnock LGA and a small number of Regent Honeyeaters were observed in Aberdare State Forest (Authors, pers. Obs.).

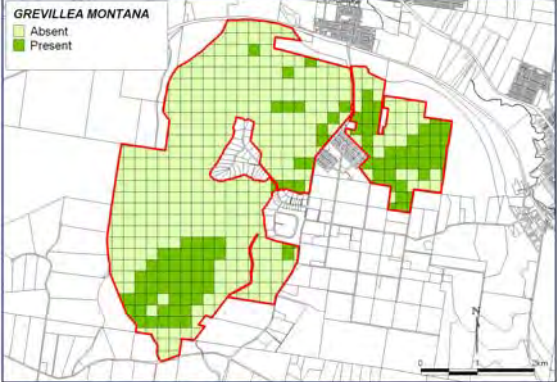
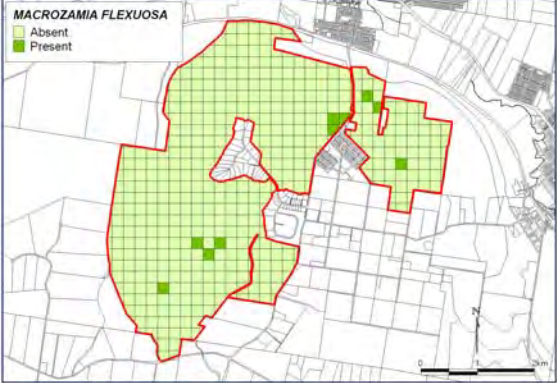
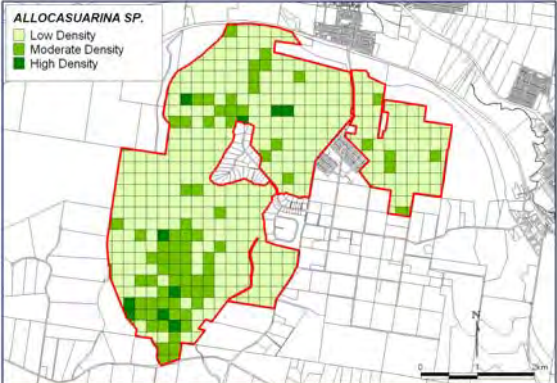
It is possible that the absence of Black-chinned Honeyeaters from Huntlee throughout the study period, might be a function of blossom distribution, as Swift Parrots were noted foraging primarily on lerps and not blossom, although lerps also represent a component of the Black-chinned Honeyeater's diet. Scant records from the area do exist, but it is quite possible that Huntlee is not used by this species on a frequent basis.

The Regent Honeyeater is largely a western slopes species, but varying numbers move to the east during winter to take advantage of more coastally occurring eucalypt blossom. Easterly movements are largely tied to the dependability of western food resources and consequently Regent Honeyeaters are either absent or observed in only small numbers in the Hunter Region during most years. However, most records are from the Valley range fringes, and rarely in the centre of the Valley.

Also of note, was a lack of further records of five (5) other threatened species, namely Powerful Owl, Barking Owl, Painted Honeyeater, Glossy Black-cockatoo and Square-tailed Kite, which have been previously recorded from the study area. The first three species were recorded in 1977 and may not be currently extant within the study area. The Painted Honeyeater record may also be an accidental record. Glossy Black-cockatoos may be irregular visitors to the site, as they were not observed during current surveys despite the availability of *Allocasuarina* sp. fruit during extensive diurnal bird surveys. The Square-tailed Kite record is from the Atlas of NSW Wildlife 2006, near the Rothbury memorial.

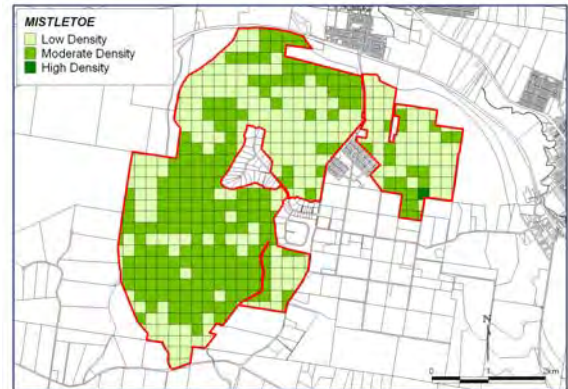
Irrespective of presence / absence, threatened species habitats within Study Area A have been detailed as part of the ECMP investigations and further information on individual threatened species occurrences is provided in Appendix 1. It is noted that in the time since the majority of surveys were undertaken, additional fauna species have been listed as threatened under the TSC Act (e.g. Varied Sitella, Little Lorikeet, Scarlet Robin and Little Eagle). Where there is a paucity of specific records and details for these species within Study Area A, a conservative approach has been taken and consideration is given to the habitat attributes important to each species. In many cases such attributes overlap with other threatened species previously assessed and recorded in more detail.

Table 3-5: Results of Grid Pattern Surveys

Feature / Attribute	Results	Map
<i>Grevillea montana</i>	Relatively widespread across the central ridge of the southern portion of the Huntlee study area. Largely absent or limited to small numbers of individuals on the western and eastern slopes of Terrace Ridge. Lower densities and a more patchy distribution exist in the northern portion of site (west of Wine Country Drive) and the greatest densities exist in the southern portion of the study area to the east of Wine Country Drive.	
<i>Macrozamia flexuosa</i>	Very sparsely distributed along the central ridge of the study area's southern portion (west of Wine Country Drive). One individual was located within the study area to the east of Wine Country Drive.	
<i>Allocasuarina</i> sp.	Occurrence noted due to status as primary feeding resource for Glossy Black-cockatoo. Two <i>Allocasuarina</i> sp. important to Glossy Black-cockatoos as feed trees; namely <i>A. torulosa</i> and <i>A. littoralis</i>. There are a number of patches of <i>A. torulosa</i> on the slopes of the central ridge within the southern portion of the Huntlee study area (west of Cessnock Road). Elsewhere densities of <i>Allocasuarina</i> sp. are low or absent. The most common <i>Allocasuarina</i> sp. on the site, namely <i>A. luehmannii</i>, was found to be an indicator plant species for the distribution of the threatened Grey-crowned Babblers within the Huntlee study area, due to it providing suitable nesting sites.	

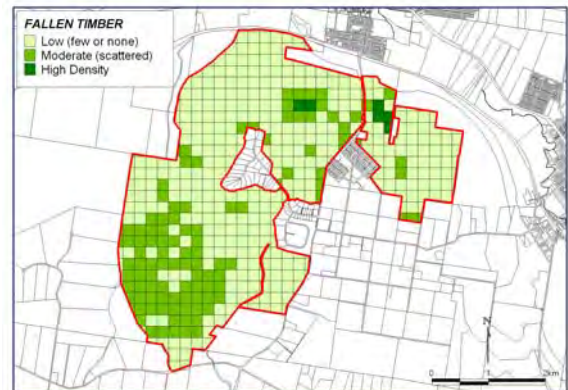
Occurrence noted due to status as a preferred foraging resource for the threatened Painted Honeyeater and the threatened Regent Honeyeater.

Mistletoe is widely distributed across Study Area A within *Eucalyptus* sp., *Melaleuca* sp. and *Casuarina* sp. Densities are generally moderate to low although some trees, particularly *Melaleuca* sp., may carry several mistletoes.



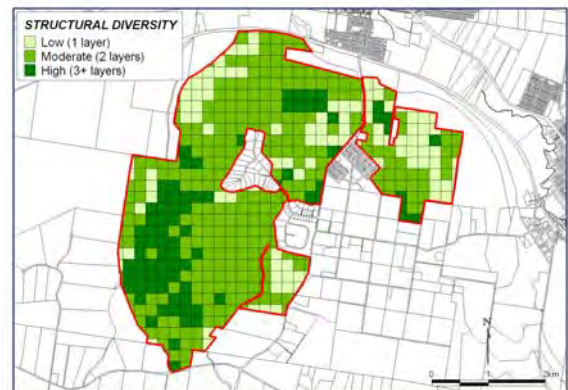
The occurrence of this habitat resource within the Huntlee site is generally sparse due to firewood collecting and the mulching or burning of forest debris within large portions of the site.

Those areas that have not been subjected to recent land management practices show evidence of a sustained history of timber getting and within these areas there are sometimes densities of fallen timber that approach those that would be expected in undisturbed areas.



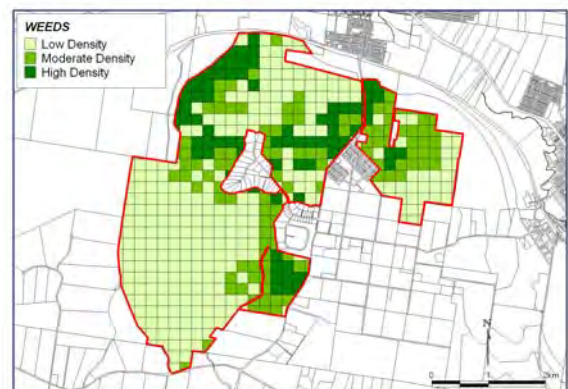
Generally the wooded habitat areas within the site showed a moderately diverse ground layer and often contained a light – moderately dense shrub layer. In some areas an upper-mid stratum of *Allocasuarina* sp. (forest and woodland) or *Casuarina* sp. (drainage lines) was also present, such as along Terrace Ridge.

Both historical and recent land management practices had impacted upon structural diversity over the majority of the site, however most of these areas have the ability to regenerate in diversity and complexity over time (with the appropriate management regimes).



Weeds are largely widespread but in low to moderate densities across Study Area A. Vegetation management practices have obscured the status of weeds in some areas. High densities of weeds exist along Black Creek.

Weed species showing the greatest densities include Paddy's Lucerne, Farmers Friend, Balloon Vine, Cat's Claw Creeper, Green Cestrum and Wandering Jew.



Much of the study area exhibits a long history of human activity, which includes coal mining, landfill in the form of domestic garbage disposal, pastoral activities, timber getting, firewood collection, vintage transport storage / renovation and gravel quarrying.

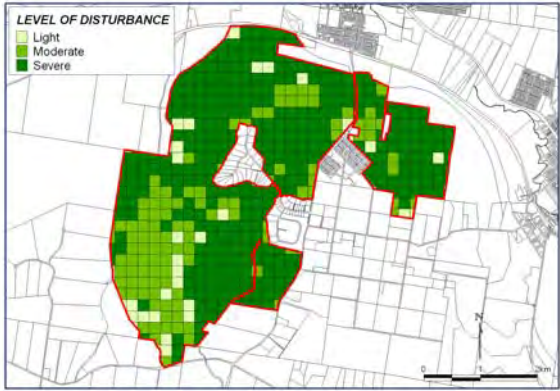
Pastoral land-use / grazing is evidenced over much of the site, which in turn has impacted upon ecological attributes of the study area.

Level of Disturbance

Timber getting has altered the age class of the forest / woodland areas and has reduced the densities of mature & hollow bearing trees.

Understorey shrub layers, ground cover layers and the number of immature / maturing trees have been eliminated over much of the site through ongoing land management regimes.

Only small pockets of land show little disturbance and these exist in the southern portion of the study area on the eastern side of Wine Country Drive and the gullies draining the eastern flanks of Terrace Ridge.



3.2 Aquatic

3.2.1 Threatened Species

Database searches revealed no threatened species of aquatic fauna considered of relevance to freshwater aquatic stream habitats within the Hunter Valley, as shown in Table 3-6 below.

Table 3-6: Fish listed on the *FM Act* or *EPBC Act* with potential to occur in the Local Area

Species		Status	Habitat and Distribution	Possibility of presence
Scientific Name	Common Name			
<i>Bidyanus bidyanus</i>	Silver Perch	<i>FMA</i> (v)	Population inhabits faster flowing and open reaches of rivers, especially where there are rapids and races within the Murray Darling River system.	No
<i>Prototroctes maraena</i>	Australian Grayling	<i>EPBC</i> (v)	Inhabits clear, gravel-bottomed streams with alternating pools and riffles, and granite outcrops. Species noted in coastal streams from the Grose River west of Sydney, southwards through NSW, Vic. and Tas.	No

FMA – Fisheries Management Act 1994

EPBC – Environment Protection and Biodiversity Conservation Act 1999

(v) – vulnerable species

Based on the outcomes of the initial threatened species assessment, it is not considered that any further assessments under the 7 part test are warranted for the Huntlee site for aquatic species.

However, there are a number of important recreational and migratory aquatic species which are known to occur in the mid Hunter Catchment. These include the Australian Bass (*Macquaria novemaculeata*) and the Freshwater Catfish (*Tandanus tandanus*) both of which are protected from commercial fishing under the FM Act. Both of these species have been previously recorded within Black Creek (Local Residents, *pers. comms.*). However, there is no commercial fishing proposal associated with the Huntlee development.

3.2.2 Habitat Classes

Black Creek

Black Creek is a permanent waterway with a clearly defined channel. During the fieldwork period the creek was flowing, however during drier conditions the creek is likely to exist as a series of permanent and largely connected pools and wetlands. Evidence of the recent extreme flood event was present with debris observed in trees as high as 10m above the creek bed.

Vegetation in the riparian zone exhibited characteristic Riparian Forest species including *Casuarina glauca* and *C. cunninghamiana*. Other species including *Juncus* sp, *Lomandra longifolia* and *Typha orientalis* were present fringing the creek.

Black Creek was identified as having *Moderate Fish Habitat* (Class 2), due to known periods of non-permanent flow, however fish species including Perch, Bass and Catfish are known to inhabit the system (K. Nicholls, pers comm).



Large Intermittent Creeks

The vast majority of watercourses on the site are represented as intermittent creeks on 1:25,000 topographic maps. Those defined as Large Intermittent Creeks in this assessment are generally second or third order creeks. Due to suitable physical attributes, some first order creeks, particularly those west of North Rothbury, have also been defined as Large Intermittent Creeks.



The quality of aquatic habitat within each is largely a factor of catchment. Defined stream channels are present on the majority, particularly those nearest to Black Creek. During the survey these creeks were presenting as a series of interconnected pools. It is likely that while some larger remnant pools and wetlands are maintained near permanently on these creeks, flow only occurs during and immediately after high events.



Vegetation surrounding Larger Intermittent Creeks exhibited similar characteristic to that of Black Creek include species including *Casuarina glaucina* and *C. cunninghamiana*, grading out into Eucalypt forest. Other species including *Juncus* sp, *Lomandra longifolia* and *Typha orientalis* were present fringing the pools in isolated areas.



These watercourses are likely to provide *Minimal Fish Habitat* due to their intermittent flows, however have some potential to provide refuge, breeding or feeding areas for some resilient aquatic fauna.

Small Intermittent Creeks

Small Intermittent Creeks were identified on topographical maps as generally first order streams located within the sub catchment headwaters that drain to Black, Anvil and Sweetwater Creeks. These creeks often have no or minimal defined channel and exist as unconnected, non permanent pools. It is likely that these creeks are often totally dry, with no remnant standing water.



Above ground flow between wet areas only occurs during and immediately after high rainfall events. Often there is no defined channel or riparian vegetation associated with these watercourses, as water traversal is associated with largely in descript overland flow paths.

These watercourses have been classified as being *Unlikely Fish Habitat* (Class 4).



Dams / Artificial Wetlands

A number of dams have been constructed on the sites in line with the intermittent creeks, to provide stock watering points and / or water supply for past mining operation uses. The dams range in size up to approximately 1.5ha, and in some instances support aquatic vegetation and act as artificial wetlands.

A range of aquatic vegetation species was present within and at the fringes of the larger dams.

It is likely that common fish species have been introduced and have persisted within at least some of these dams. However it is unlikely that the dams provide important native fish habitat in a wider context due to their isolated nature away from interconnecting viable aquatic linkages. The dams would provide potential habitat for other aquatic species as well as a number of bird species that were observed using the dams.



4 Significant Ecological Attributes

This chapter provides an assessment of the significant ecological attributes contained within the Huntlee Study Area.

4.1 Vegetation Communities

Approximately 44% of the wider study area and 61% of the Huntlee study area contains EEC vegetation. Approximately 47% of the original Wider Study Area is devoid of any native vegetation of note. Ecological input into the original site conceptual planning process has resulted in the majority of the EEC vegetation being retained within the current proposal.

As with most sizeable remnant vegetation patches within the Hunter Valley, Huntlee includes vegetation communities and flora species that are generally poorly reserved. Both LHCCREMS (2003) and Peake (2005) advise that many additional vegetation communities occurring in the Hunter Valley may qualify for listing as EEC's under Commonwealth and / or state legislation.

Further information on the conservation significance and distribution of vegetation communities within Huntlee is provided in Appendix 2 and the vegetation map of Huntlee is presented in Figure 3-1.

4.2 Threatened Species

Surveys to date have identified four (4) threatened flora species and twenty-seven (27) threatened fauna species within the Wider Huntlee Study Area, with potential for a number of other threatened species to occur. The threatened species recorded are known or would be expected to also occur in other larger remnants in the central to upper Hunter Valley, including Belford and Werakata National Parks.

Of the species known to occur within Huntlee, the following are considered of particular note within the Huntlee locality:

- ***Acacia bynoeana*** (Bynoe's Wattle) – northern extent of known occurrence, however this species was recorded within the wider study area only and will not be affected by the Huntlee proposal.
- ***Eucalyptus glaucina*** (Slaty Red Gum) – Huntlee / Molly Morgan Range area contains large stands of varying genetic examples of *E. glaucina* (X *E. tereticornis*).
- ***Eucalyptus parramattensis* ssp. *decadens*** – northern extent of known occurrence.
- ***Persoonia pauciflora*** (North Rothbury Persoonia) – entire known population occurs within the Wider Study Area.
- ***Pomatostomus temporalis temporalis*** (Grey-crowned Babbler) – large areas of occupied habitat with established breeding populations.

- ***Chthonicola sagittata*** (Speckled Warbler) – resident population within intact areas of the site.
- ***Lathamus discolor*** (Swift Parrot) – seasonal use of Hunter Valley for foraging / roosting.
- ***Neophema pulchella*** (Turquoise Parrot) – occupied habitat at or near eastern extent of standard distribution.

Whilst the threatened bird species have distributions, population(s) and habitats that are relatively widespread throughout the locality and further abroad, the threatened flora species are comparatively more restricted. For example, the total known population of *Persoonia pauciflora* is contained within the Wider Huntlee Study Area and accordingly it is of the highest conservation priority.

4.3 Terrestrial Habitats and Land Class

The vegetation of the study area has been subject to an ongoing degradation regime from present and past land uses such as rural / residential development, cattle grazing, mining activities, weed invasion, partial clearing, motocross bike riding and other illegal / unauthorised activities. The majority of the study area occurs in private tenure and rural – residential development / occupation forms the predominant land use.

Despite the disturbance factors and large areas of the site occurring as cleared pasture, the areas of remnant vegetation on the site and in the wider locality provide some viable habitat resources for flora and fauna. Some areas contain a higher density of mature and hollow bearing trees and an intact understorey.

As noted below approximately 566ha (33%) of the Huntlee Study Area is cleared of native vegetation, whilst 1,041ha (61%) of vegetation is listed as an Endangered Ecological Community.

Table 4-1: Land Class & Areas

Land Class	Area on Site	Comment
Endangered Ecological Communities (EEC's)	1,660ha	Comprised mainly of Central Hunter Ironbark – Spotted Gum – Grey Box Forest. The other EEC's include 'Hunter Lowland Redgum Forest', 'River-Flat Eucalypt Forest' and 'Lowland Rainforest', which predominately occur as linear areas along Black Creek and associated creeklines and in patches in associated areas of suitable topography / soils.
Cleared Areas	1,754ha	Approximately 47% of the Study Area is devoid of any significant intact native vegetation.
Other	345ha	Majority of remnant vegetation within the Study Area consists of disturbed areas with only canopy species remaining or as regrowth, which do not readily conform to a described ecological community. Water and Phragmites Rushland comprise the remainder of this land class.

Parcels of significant lands have been identified within the Wider Huntlee Study Area, including:

- Area bounded by Tuckers Lane, Littlewood Road and proposed Stage 5 of Hanwood Estate (these areas (previously) conserving the majority of the population of *Persoonia pauciflora*, and likely to contain valuable seedbank resources);
- Areas containing EEC vegetation, particularly when in good condition;
- Areas along Black Creek and immediate surrounding flats; and
- Larger remnant forest patches such as between Black Creek / Terrace Ridge and south of the main northern railway (containing habitats and threatened species populations). These areas would have importance on a wider scale by offering habitat resources as a component of the wider matrix, as well as comprising a large proportion of the extant EEC's.

On a wider scale, areas offering important habitat resources would include Belford and Werakata National Parks, forested foothills around Elderslie and Glendon Brook, forest along the Molly Morgan Range, and remnant forest areas to the west leading to the densely forested Broken Back Ranges (Pokolbin and Corrabare State Forests).

4.4 Wildlife Corridors

In their regional corridor mapping, NPWS (2003) have identified two regional corridors (the Allandale and Sweetwater corridors) merging within the study area. The Allandale corridor links to Werakata National Park in the south-east, while the Sweetwater corridor links with Belford National Park to the north and Pokolbin State Forest in the south-west. In addition, two sub-regional corridors have been identified, the Rothbury Creek corridor running to the south and the Branxton corridor running between the townships of Branxton and North Rothbury.

Corridors mapped by NPWS (2003) are broad in nature and, in general, have not been assessed on the ground for their suitability to facilitate the movement of plant pollinators and propagules and other fauna migrations. In addition, some sections of designated corridors require the co-operation of many landholders to either retain remnant vegetation that may occur on their properties, or to revegetate vital linkage areas. Consequently, any development proposed for the land at Huntlee will need to address the issue of wildlife corridors previously identified in the area by NPWS (2003), including on-ground inspection of corridor proposals and collaboration with affected neighbours [extracted from Bell & Driscoll 2005].

In respect of the positioning of the site in the wider locality, Huntlee is a largely discrete area of habitat. To the north of the site lies rail, New England Highway, Branxton and extensive areas of cleared farmland. Rail and the Highway also occur to the east along with Greta and cleared agricultural areas leading down to the Hunter River. Connections to the southeast along Molly Morgan Range are discontinuous and disjunct and linkages to the south are broken by agricultural and vineyard areas. Lands west of Huntlee support

some linear connections along creeklines through cleared agricultural lands. There are no direct vegetated linkages to Belford National Park to the west of the site.

The southern conservation area of Huntlee represents the most direct habitat linkages between the site and other areas of adjacent habitat, which tentatively link to larger areas of habitat, including Werakata National Park and Belford National Park. It is noted that the proposed development area will remove an area of the Branxton corridor, however no areas of habitat will be completely isolated by this outcome. Note that the planned F3 alignment will sever this corridor in any case.

4.5 Aquatic Habitats & GDEs

The Huntlee Plan (Figure 1-2) shows the extent of proposed urban and conservation land use zones within the site. As previously described the majority of the site is located in an area that drains directly into Black Creek. The ridgeline that runs northwest through North Rothbury separates the Anvil Creek Catchment to the east and Terrace Ridge separates the Sweetwater Creek Catchment in the far west of the site (Figure 1-3).

The majority of proposed urban areas are located directly east, north and west of North Rothbury. Watercourses that exist in this area include Large and Small Intermittent Creeks. Watercourses in the western portion of the areas flow in a generally west or northwesterly direction into Black Creek. To the east, watercourses flow generally north towards Anvil Creek, which is located outside the northern boundary of the site. The area also contains a number of small to large dams that have been constructed inline with the intermittent creeks.

The majority of the Black Creek riparian zone, being the most important aquatic habitat identified in the entire study area, is contained within a wide dedicated Conservation Area that will act as a natural interface between open space associated with the Huntlee development to the north (areas largely constrained by flooding), and the proposed conservation area to the south.

In the southern section of the site Large and Small Intermittent Creeks drain to Black Creek. While the majority of these watercourses are within proposed Conservation Areas, two urban areas exist along the southern and south-eastern boundaries of the site. The southern most of these areas only contains Small Intermittent Creeks.

The part of the site on the western boundary that is within the Sweetwater catchment is all contained within proposed Conservation areas.

Although not fully detailed at this stage, it is apparent that there is substantial scope for aquatic habitat creation and improvement works within key areas of the site, and in particular within and fringing the Black Creek corridor and its primary feeder tributaries.

Given the broad definition covering all ecosystems which are dependent upon groundwater either permanently or occasionally to survive (DLWC, 2002), several of the vegetation communities within the Study Area have been identified as potential

Groundwater Dependant Ecosystems (GDEs), being (Refer to Figure 3-1 and Figure 3-2):

- Central Hunter Riparian Forest;
- Hunter Lowland Redgum Forest; and
- Wollombi Redgum – River Oak Woodland.

These vegetation communities occur on the lower lying areas and depressions generally associated with creeklines across the Study Area. In the absence of detailed groundwater and geological investigations to determine the likelihood of groundwater or surface water dependence these communities have been considered as GDEs based on the precautionary principle.

Given that retention of creeklines and depressions will generally be achieved within the proposed development and conservation framework, coupled with the maintenance of existing surface water flow rates, it is considered that minimal impact upon the GDEs present within the Study Area are likely to occur. This can generally be achieved by appropriate water sensitive urban design (WSUD).

In conclusion several of the vegetation communities within the Huntlee Study Area have been classed as GDEs. However, it must be noted that whilst some communities are generally reliant on surface water runoff, when groundwater is available these communities are likely to utilise this water source for their moisture requirements. To this end development activities should incorporate best practice WSUD to ensure surface and groundwater hydrological regime maintenance.

5 Ecological Implications of the Huntlee Development

This chapter details the ecological implications that would result from the proposed Huntlee SSS Rezoning.

5.1 Conservation Context Overview

The proposed SSS Rezoning for the Huntlee site is consistent with the outcomes of the Lower Hunter Regional Strategy and the Lower Hunter Regional Conservation Plan.

The land uses depicted in the overall SSS Rezoning proposal, when viewed with the proposed conservation offset measures (occurring both on and off site), are the logical progression of regional planning documents that aim to achieve sustainable development within the Lower Hunter.

In addition to these beneficial conservation outcomes, the proponent, Huntlee Pty Ltd, has also committed to a range of other ongoing environmental protection, enhancement and management measures to ensure that the created Huntlee site exists within an environmentally sustainable, healthy and aesthetic setting.

The previous ECMP document (2005) outlined key factors that were suggested to be taken into consideration in determining an appropriate development / conservation framework for the study area. These factors were:

- Retention of adequate threatened species population(s) and endangered ecological communities;
- Appropriate siting of land use units to be compatible with retained open space and green corridor areas (eg. Urban, rural-residential, commercial and industrial);
- Implementing principles of habitat conservation, wildlife corridors and habitat linkages (e.g. minimizing edge and fragmentation effects) by appropriate marriage of urban design and ecological theory;
- Maximising development densities in the extensive cleared and degraded areas; and
- Rehabilitation, revegetation and management of adopted key conservation areas post development.

It is considered that the Huntlee plan, when viewed holistically with the proposed conservation measures, both on and off site, more than adequately addresses the above factors. Such conservation measures include:

On-site

- Dedication of a conservation area south of Black Creek (575ha);
- Dedication of an additional conservation area that incorporates a large proportion of the known *Persoonia pauciflora* population north of Hanwood Estate (18ha);
- Dedication of 'Persoonia Park', being a dedicated conservation reserve targeting the recovery of this Critically Endangered species (17ha), including a monetary contribution of \$100,000 towards the management of the species.
- Riparian buffers will be established in consultation with the NSW Office of Water as underpinned by the *Water Management Act* and guidelines.
- Retention of all *Persoonia pauciflora* individuals with a 30m buffer for so long as such plants persist in situ.

Off-site

- Dedication of 2,287.45ha of conservation lands at Mt Popong & Pickle Bottle Creek;
- Dedication of 429.15ha of conservation lands at Howes Valley;
- Dedication of 228.05ha of conservation lands as in-holdings within Yengo National Park;
- Dedication of 101.21ha of conservation lands at Mount Warrawalong;
- Dedication of 440.08ha of conservation lands at Corabare Forest;
- Dedication of 1002.84ha of conservation lands at Cedar Creek; and
- Dedication of 499.63ha of conservation lands at Elderslie.

The dedication of such large areas of green lands for conservation provides an excellent start to achieving the long term aims of the LHRCP, and provides an enduring green legacy for future generations.

5.2 Threatened Flora

Aside from *Persoonia pauciflora*, which presents a significantly unusual management consideration and is discussed further in detail below, all of the remaining threatened flora species currently recorded within Huntlee are considered to be well catered for within the SSS plan.

Table 5-1: Impacts on Threatened Flora

Species	Huntlee Impact Details	Reasoning
<i>Acacia bynoeana</i>	Occurs well outside the extent of proposed development and as such will not be affected by the proposal.	Total occurrence noted to date will not be directly affected. One small population noted, though potential for others to occur in the Wider Study Area on lands not surveyed in detail to date. These lands are not within the areas proposed to be developed.
<i>Eucalyptus glaucina</i>	Some areas containing Redgum trees may be lost as a result of future development, however, the majority of areas containing potential <i>E. glaucina</i> specimens / genes will be retained within conservation reserves and riparian corridors within the development.	Conservation of adequate areas of Redgum Eucalypts ensures a suitable level of representation of <i>E. glaucina</i> genes remains. Retention of areas containing this species on site combined with reservation of additional offsite Red Gum occurrences (such as at Elderslie) will ensure continued viability of this species both on site and in the wider locality.
<i>Eucalyptus parramattensis</i> subsp. <i>decadens</i>	Specimen occurs in the southern area proposed to be dedicated for conservation, and as such there will be no direct impact on this species or its habitat.	One specimen only noted, and retained with suitable buffering habitat in a conservation zone. In any case, future viability of population (sic) extremely questionable due to single individual only.

5.2.1 *Persoonia pauciflora*

In response to the status of *P. pauciflora* in the North Rothbury locality, in October 2005 the proponent commissioned RPS to undertake a detailed inventory of individual plants occurring within or immediately adjacent to lands under their control. At this time an estimated maximum population of approximately 550 individual plants (Patrick 2006) existed within the North Rothbury population. Updated survey results in 2006 reported some 631 extant plants (Patrick 2006). Since that time some 277 plants have been lost from the population as a result of actions of an unrelated third party on land outside Huntlee land holdings. It is therefore estimated that approximately 354 individual plants, often isolated in context to other members of the population, remain extant, of which the entirety occurs within private land holdings.

The July 2007 *P. pauciflora* survey, of all known plants within the Huntlee lands at North Rothbury, found that out of the existing 28 plants, 11 had increased in size or foliage cover, 11 had decreased in size or foliage cover or exhibit no improvement and five additional plants (one plant found dead in October 2005 survey) were found to be dead (of these two show evidence of disturbance). Investigation of those plants not increasing in condition or dying suggests that the main cause for loss of condition is likely grazing pressures by macropods or to a lesser degree grazing by domestic stock. Follow up surveys have also been undertaken in 2009 and 2010. Both of these surveys found that out of the existing 28 plants, 21 had increased in size or foliage cover, one had decreased in size and foliage cover and six plants had been found dead (the same 6 deceased plants as in July 2007 surveys). Thus 22 plants remain alive within the Huntlee lands and of these the majority will be retained either within Persoonia Park or within the proposed

conservation area to the north of Tuckers Lane or will remain in situ. This area will also provide extra habitat retention for *Persoonia pauciflora*.

As a result of these surveys it has become clear that conservation initiatives will be critical to maintaining viable habitat for this species. Key to the conservation strategy, envisioned by Huntlee Pty Ltd was the establishment of a 'Persoonia Park' reserve, which would be maintained to guarantee a secure and viable future for this species. This will now be augmented by addition of other areas containing specimens that have been identified as important by DECCW, such as to the north of Tuckers Lane.

Persoonia Park will reserve 17ha of *Persoonia pauciflora* habitat and retain insitu specimens of *Persoonia pauciflora*. The ecology of this species is largely unknown and the idea of Persoonia Park is to reserve habitat and provide an area in which further research could be performed. Such research could cover all facets of the life cycle, and the species response to fire. Other species within this genus are obligate seeders; this is where the adult plants are killed by fire with resprouting occurring after fire from the soil stored seed bank. Further research into the longevity of the soil seed bank and fire ecology of *Persoonia pauciflora* to ensure proper fire management techniques are employed is vital to the survival of this species in the future. This is just one of the many areas of research which could be performed within Persoonia Park.

A Draft National Recovery Plan has been prepared for *P. pauciflora* (DECCW 2009). This document outlines specific recovery objectives for the species, and these heads of consideration are outlined below.

Specific Recovery Objectives (DECC 2009), namely:

- Minimise the loss and fragmentation of *P. pauciflora* habitat;

Comment: All known specimens of *P. pauciflora* will be protected and buffered within the proposal. Key areas will be dedicated as conservation land. Such areas will remain linked via riparian and habitat corridor retention within the design.

- Distribute information that assists in conserving and managing *P. pauciflora*;

Comment: The proponent will ensure that all project personnel and incoming purchasers are provided with an information pack relating to the species, its importance, and how to manage it and the habitat present for conservation.

- Raise awareness of *P. pauciflora* and facilitate community involvement in the recovery program;

Comment: Huntlee is willing to both participate and contribute to education programs relating to the conservation of *P. pauciflora*.

- Facilitate conservation of *P. pauciflora* on private property

Comment: Huntlee provides the catalyst for significant conservation outcomes on private property for this species, by conserving all known individuals and by dedication of key known habitat areas for conservation.

- Identify and minimise the threats operating at sites where *P. pauciflora* occurs and ensure appropriate ecological restoration where necessary and feasible;

Previous threats on the Huntlee lands relating to agricultural and land management practices have been minimised with individual plants now being protectively fenced, and important habitat areas are being managed to ensure natural regeneration can occur.

- Develop and implement a survey and monitoring program that will provide information on the extent and viability of *P. pauciflora*

Comment: The survey and monitoring of the *P. pauciflora* plants on the Huntlee site since 2005 has provided an excellent scientific baseline for continued survey and monitoring of this component of the local population. Potential exists to extend this monitoring program in terms of scope and coverage of the entire known population (noting that other landholder's consents will be required).

- Obtain the necessary prerequisite knowledge required to implement ex-situ conservation and in-situ translocation projects.

Comment: Huntlee has committed to assisting increase the knowledge of this species, via both dedication of funds for research and also by proposed dedication of Persoonia Park to be utilised for conservation based research studies.

From the above, it is apparent that Huntlee has the potential to significantly assist in achieving the specific recovery objectives of the Draft National Recovery Plan.

5.3 Threatened Fauna

A total of twenty-seven (27) threatened fauna species have been recorded to date within the Huntlee site.

Table 5-2: Impacts on Threatened Fauna

Species	Huntlee Development Impact Details	Reasoning
Grey-crowned Babbler	Loss of some habitat areas in northern section, including breeding habitat. Retention of quality foraging and breeding habitat in the south, with linkages along Black Creek retained that will allow movement within northern areas.	Given habitat retention and management proposed within the site, it is considered probable that the species would persist on site after development. This species is known to be tolerant of habitat modification to a degree, and likely to persist in family groups within retained areas and utilise surrounding areas via vegetated linkages. Proposed linkages will provide movement between larger retained areas and future developed areas that this species is known to utilise as part of a larger home range. In addition, this species has also been confirmed on the Elderslie property that forms the offset package in this instance. Other offset areas such as Howes Valley provide potentially suitable habitat as well.
Brown Treecreeper	No impact of note likely with area containing noted pair of this species and surrounding habitat to be retained.	The known area of habitat for this species on site (including foraging and breeding habitat) falls within the Huntlee conservation area to the south of Black Creek. Furthermore it is considered the regional conservation lands provide adequate areas of representative habitat for this species. Other offset areas such as Howes Valley and Elderslie provide potentially suitable habitat as well.
Varied Sitella	Loss of some potential habitat areas in northern section. Retention of quality foraging and breeding habitat in the south, with linkages retained to allow movement within northern areas.	Given habitat retention and management proposed within the site, it is considered probable that the species would persist on site after development. This species was recorded throughout the site in all areas exhibiting a relatively intact forest structure. Hence, occupied habitat for this species on site (including foraging and breeding habitat) falls within the Huntlee conservation area to the south of Black Creek. Proposed linkages will provide movement between larger retained areas and future developed areas that this species is known to utilise as part of a larger home range. Offset areas such as Howes Valley provide potentially suitable habitat as well.
Scarlet Robin	Loss of marginal habitat with retention of quality foraging and breeding habitat with linkages retained to allow movement.	This winter resident was identified to be utilising the southwestern portion of the study area, with additional infrequent sightings across the remaining study area. Known populations of this species are considered unlikely to be impacted on given the onsite retention of known habitat for this species. Offset areas such as Howes Valley and the Elderslie site may offer potential habitat as well.
Black-chinned Honeyeater	No impact of note likely with significant area of potential habitat to be retained.	Surveys have only revealed a single record of this species, but movements and habitat usage are linked strongly to flowering periods. Significant habitat will be retained and managed on site for this species, as will other areas under the proposed regional conservation outcome. Other offset areas such as Howes Valley and Elderslie provide potentially suitable habitat as well.

Speckled Warbler	Loss of habitat marginal with retention of quality foraging and breeding habitat with linkages retained to allow movement.	This species was identified to be utilising the southwestern portion of the study area, with additional infrequent sightings across the remaining study area. Known populations of this species are considered unlikely to be impacted on given the onsite retention of known habitat for this species. In addition, the Elderslie site is known to support a population of this species, and Howes Valley may offer potential habitat as well.
Glossy Black-Cockatoo	Loss of potential foraging resources for this species marginal, with retention of known foraging habitat.	Site appears sporadically to rarely be utilised by this species and as such it is difficult to conclude the site is important for this species. Given the retention of the majority of habitat for this species including area of known foraging habitat it is unlikely that this species would be impacted on to any great degree under the proposal. Appropriate supplementation through landscape rehabilitation with feed species is also encouraged. Additional potential habitat will be provided within the regional conservation lands at most of the offset lands.
Painted Honeyeater	No impact of note likely with significant area of potential habitat utilisation to be retained.	Loss / modification of potential habitat is noted in a regional context. However, outside standard range of the species. Elderslie, Yengo Holdings and Howes Valley within offset package would provide additional protected opportunities for this species.
Regent Honeyeater	No impact of note likely with significant area of potential habitat utilisation to be retained.	Difficult to conclude site is of significance to this species, given paucity of records and siting within the central valley floor area. It is considered the conservation proposed conservation lands within Huntlee provide long term secure opportunity for any birds visiting this area. Other offset properties such as Elderslie, Howes Valley and Yengo Holdings would also be viewed in the same light.
Little Lorikeet	Areas of potential habitat to be removed, though large areas of known habitat will be retained as conservation reserves.	With the retention of the southern area for conservation no known habitat loss to occur within area known to be utilised, mostly in response to winter flowering eucalypts. The size of the conservation reserve is such that protection will ensure a viable habitat area will remain in the locality for seasonal usage by transient birds. Other offset properties such as Elderslie provide some protected lowland Spotted Gum habitat. All other proposed conservation reserves also offer some suitable resources.
Swift Parrot	Areas of potential habitat to be removed, though the preferred areas of known habitat will be retained as conservation reserves.	With the retention of the southern area for conservation no known habitat loss to occur within area known to be utilised on an unknown seasonal basis by this highly mobile species. The size of the conservation reserve is such that protection will ensure a viable habitat area will remain in the locality for seasonal usage by transient birds. Other offset properties such as Elderslie provide some protected lowland Spotted Gum habitat. All other proposed conservation reserves offer some suitable resources, albeit less favoured than lowland habitat.

Turquoise Parrot	No impact of note likely with significant area of potential habitat utilisation to be retained.	All records of this species were confined to the southwestern area of the site within the proposed conservation retention area. It is considered the proposed conservation lands within Huntlee provide long term secure opportunity for resident birds. Other offset properties such as Elderslie, Howes Valley and Yengo Holdings would also offer suitable conserved resources on a regional basis.
Little Eagle	No impact of note likely with large habitat areas to be retained and the ability for this species to use a range of habitats, including cleared areas.	Retention of majority of potential hunting habitat for this species, which is likely to utilise the site on a transient basis. All conservation offset properties would provide protected resources for this species, which occurs in a number of forest and woodland habitat types.
Spotted Harrier	No impact of note likely with large habitat areas to be retained including the open grassy western ridge, where some of the most suitable on-site habitat exists.	Retention of majority of potential hunting habitat for this species, which is likely to utilise the site on a transient basis. All conservation offset properties would provide protected resources for this species, which occurs in a number of forest and woodland habitat types.
Square-tailed Kite	No impact of note likely with large habitat areas to be retained, and favoured creekline hunting areas to be retained and managed.	Retention of majority of potential hunting habitat for this species, which is likely to utilise the site on a transient basis. All conservation offset properties would provide protected resources for this species, which occurs in a number of forest and woodland habitat types.
Powerful Owl	No impact of note likely with significant area of potential habitat to be retained.	Retention of majority of potential hunting habitat, including areas of higher quality habitat for roosting and hunting. All other conservation reserve offset areas would provide protection for habitat suitable for this species.
Barking Owl	No impact of note likely with significant area of potential habitat to be retained.	Retention of majority of potential hunting habitat including areas of higher quality habitat for roosting and hunting. Elderslie and other areas within offset package would provide additional hunting and potentially roosting habitat for this species.
Squirrel Glider	No significant impact likely with all records occurring in proposed conservation areas.	Any habitat loss to occur within the area is considered marginal due to the area of retention and retained linkages to occur within known habitat. All other conservation reserve offset areas would provide protection for habitat potentially suitable for this species.
Koala	No impact of note likely with significant area of potential habitat to be retained.	Any habitat loss to occur within the area is considered marginal due to the area of retention and retained linkages to occur within known habitat.

Grey-headed Flying-fox	No impact likely with significant area of potential habitat to be retained. No communal camps will be impacted upon.	Area of retention will contribute significantly to conserved habitat for this wide-ranging species within the wider locality on a seasonal basis (such as the flowering of Eucalypts). Ongoing usage of the site (both conserved natural areas and landscaped areas) would be expected. All other conservation reserve offset areas would provide protection for habitat suitable for this species, including some possible camp site habitats.
Yellow-bellied Sheathtail-bat	No impact of note likely with significant area of potential habitat to be retained. Only record is within proposed conservation area.	Though the status of population size and degree of dependency on the site remains unclear, any habitat loss to occur within the area is considered marginal due to the area of retention and retained linkages to occur within known habitat. All other conservation reserve offset areas would provide protection for habitat potentially suitable for this species.
Little Bentwing-bat	No impact of note likely with significant area of potential habitat to be retained. Only record is within proposed conservation area. No known preferred roosting habitat to be affected.	Though the status of population size and degree of dependency on the site remains unclear, any habitat loss to occur within the area is considered marginal due to the area of retention and retained linkages to occur within known habitat. All other conservation reserve offset areas would provide protection for habitat potentially suitable for this species.
Eastern Bentwing-bat	No impact of note likely with significant area of potential habitat to be retained. Only records are within proposed conservation area. No known preferred roosting habitat to be affected.	Though the status of population size and degree of dependency on the site remains unclear, any habitat loss to occur within the area is considered marginal due to the area of retention and retained linkages to occur within known habitat. All other conservation reserve offset areas would provide protection for habitat potentially suitable for this species.
Eastern Freetail Bat	No impact of note likely with significant area of potential habitat to be retained. Records from the locality, but no records within proposed development area.	Though the status of population size and degree of dependency on the site remains unclear, any habitat loss to occur within the area is considered marginal due to the area of retention and retained linkages to occur within known habitat. All other conservation reserve offset areas would provide protection for habitat potentially suitable for this species.
Greater Broad-nosed Bat	Known and potential roosting and foraging habitat throughout. Only one record, being within lands within the southern end of the site. These lands are adjacent to the proposed conservation area south of Black Creek, which will provide suitable protected habitat.	Though the status of population size and degree of dependency on the site remains unclear, any habitat loss to occur within the area is considered marginal due to the area of retention and retained linkages to occur within known habitat. All other conservation reserve offset areas would provide protection for habitat potentially suitable for this species.

Large-footed Myotis	No impact of note likely with significant area of potential habitat to be retained. Only record is within proposed conservation area. No known preferred roosting habitat to be affected.	Though the status of population size and degree of dependency on the site remains unclear, any habitat loss to occur within the area is considered marginal due to the area of retention and retained linkages to occur within known habitat. Some habitat recreation (eg. waterbodies, dams, lakes) will occur as part of the development. All other conservation reserve offset areas would provide protection for habitat potentially suitable for this species.
Eastern Cave Bat	No impact of note likely with significant area of potential habitat to be retained. Only records are within proposed conservation area. No known preferred roosting habitat to be affected.	Though the status of population size and degree of dependency on the site remains unclear, any habitat loss to occur within the area is considered marginal due to the area of retention and retained linkages to occur within known habitat. All other conservation reserve offset areas would provide protection for habitat potentially suitable for this species.

It is considered that adequate habitat will be protected within the proposed Huntlee and Persoonia Reserve conservation areas, and within the wider offset conservation lands package for all fauna species.

Furthermore, proposed Parks, Public Open Space and riparian corridors will contribute additional habitat resources and aid in the maintenance of local linkages.

5.4 Vegetation Communities

Impacts could occur to the majority of extant vegetation within the proposed Huntlee development precincts, which includes areas of EEC's, mainly the Central Hunter Ironbark - Spotted Gum - Grey Box Forest. Two other EEC's namely Central Hunter Riparian Forest and Hunter Lowlands Redgum Forest, occur predominately within the development area, however open space and riparian corridors has been allocated over large proportions of these communities to see the majority retained and managed for their ecological value. The Wollombi Redgum - River Oak Woodland and Hunter Valley Dry Rainforest will most likely be entirely retained within the conservation lands and a riparian corridor along Black Creek.

Table 5-3: Impacts on Vegetation Communities

Community	Huntlee Impact Details	Reasoning
Hunter Valley Dry Rainforest (EEC)	Reserved in entirety within proposed conservation area.	Reserved in entirety. Potential for weed removal and rehabilitation of known occurrence to significantly improve the condition of this community.
Central Hunter Riparian Forest (EEC)	Approx 62ha of this community occurs at Huntlee outside proposed conservation zones. This figure is likely to include Open Space areas and retained creekline corridors, so the actual figure is likely to be approximately half this figure (i.e @27ha.) In addition to this figure, approx 38ha is contained within dedicated conservation reserve areas on site.	Approx 2/3rds of occurrence likely to be retained within the Huntlee site, including 38ha within dedicated conservation reserves. This community is also likely to be enhanced in extent via proposed revegetation works in key areas around Black Creek, associated tributaries and floodplain area. However, with information to hand it does not appear that this community type occurs within any of the proposed conservation offset lands. This community specific shortfall needs to be considered against the numerous beneficial holistic outcomes provided by the development conservation offsets package, including large positive conservation excesses for the vast majority of vegetation communities relevant to the package.
Wollombi Redgum - River Oak Woodland (EEC)	Approx 13ha of this community occurs at Huntlee outside dedicated conservation zones. This figure includes Open Space areas and retained creekline corridors, which are planned to also be retained in entirety. In addition to this figure, approx 14ha is contained within dedicated conservation reserve areas.	The majority of this community at Huntlee is likely to be retained within the proposal, with over half occurring within proposed conservation reserve areas. This community is also likely to be enhanced in extent via proposed revegetation works in key areas around Black Creek, associated tributaries and floodplain area.
Hunter Lowland Redgum Forest (EEC)	Approx 5ha of this community occurs at Huntlee outside dedicated conservation zones. This figure includes Open Space areas and retained creekline corridors, which are planned to also be largely retained. It is likely that development losses of this community will be minimal (<1ha). In addition to this figure, approx 1ha is contained within dedicated conservation reserve areas.	<1ha of this vegetation community could be removed by development at Huntlee. This community is also likely to be enhanced in extent via proposed revegetation works in key areas around Black Creek, associated tributaries and floodplain area, creating a relatively neutral outcome.

Community	Huntlee Impact Details	Reasoning
Central Hunter Ironbark - Spotted Gum - Grey Box Forest (EEC)	This is the dominant vegetation community at Huntlee. Approx 341ha of this community occurs outside dedicated conservation zones, including other areas where some vegetation retention is likely (i.e. open space areas, ephemeral creekline areas). Approx 568ha occurs within proposed conservation zones.	Conservation of approx 60% of the Huntlee occurrence of this community will occur, including the most intact areas of this community within proposed southern conservation area. This outcome greatly increases the conservation level of this community, with only Belford National Park currently providing protected areas of this community. Additional stands of this community will be provided at Elderslie under the proposed conservation lands dedications. Despite this, there could be an overall net loss of this community. This community specific shortfall needs to be considered against the numerous beneficial holistic outcomes provided by the development conservation offsets package, including large positive conservation excesses for the vast majority of vegetation communities relevant to the package. .
Phragmites Rushland	This community largely occurs as an opportunistic coloniser of man made dams. Habitat largely restricted to man-made waterbodies (eg. dams), many of which will be retained and enhanced within the development.	Excellent potential for habitat retention, enhancement and creation (eg. waterbodies, dams, lakes) as part of the development. This community is known to occur within several of the conservation offset properties, again as an opportunistic coloniser of man made dams

5.5 Aquatic Habitats

While the watercourses that are present on the site are highly unlikely to contain threatened species, the habitat value that they provide at a local level is of importance. With the exception of Small Intermittent Creeks (Class 4 watercourses), most of the watercourses are likely to provide at least some habitat opportunities for aquatic species. The majority of intermittently flowing watercourses contribute to larger watercourses, and would represent opportunistic feeding and dispersal habitat, and contribute to maintaining main stream water quality.

Recognition of these areas as terrestrial and aquatic habitat corridors is also important and therefore appropriate levels of protection need to be considered to ensure that they are adequately maintained.

In regard to the Small Intermittent Creeks, it is not considered that these are an issue of any particular significance in regards to aquatic habitat directly; more so the main potential concern relates to the water transport and water quality contribution these small features make during times of high rainfall. The degree that the potential loss of these features can be suitably compensated for within the development will be a matter for detailed consideration by drainage engineering studies; however it is encouraged that the points made within this report are fed into future design considerations matrix to ensure that

appropriate outcomes are achieved that protect the downstream aquatic habitat values identified in this report.

Development activities such as vegetation removal, physical modification of riparian areas and alterations to catchment hydrological characteristics of the site has the potential to impact on aquatic habitats. These activities can result in impacts that cause the decline in habitat value through:

- Reduced water quality (nutrient and sediment input)
- Increased peak and reduced durational stream flow following rainfall events
- Loss of instream and riparian habitat
- Barriers to fish movement

It is considered that all of these factors are readily managed with appropriate design, best practice construction management, restoration works, and ongoing management regimes. It is expected that such management programs will be further detailed at later stages of the development process.

As previously mentioned, there is also excellent scope to enhance existing key aquatic habitat features within the development, and supplement these habitats by targeted creation and placement of complementary habitat areas. Such areas, if appropriately designed, will provide and extend habitat opportunities for both aquatic and terrestrial fauna, and offer visually appealing features within passive open space areas.

5.6 Other Ecological Attributes

As would be expected with a project of this magnitude, a reduction in the amount and availability of habitat resources could occur as a result of approvals to clear on a localised scale, including the loss of mature trees and hollow-bearing trees, as well as a number of other components of the existing local ecosystem. Such impact will lead to changed ecological system extent and function in some areas within the site.

However, such impacts will be offset by:

- significant onsite habitat retention;
- targeted retention of the areas containing the most intact and structurally diverse vegetation, and hence resident fauna assemblages;
- other regional ecological offsets aimed at strengthening the conservation status of regional biodiversity; and
- rehabilitation, improvement and ongoing management of retained areas of the site outside of dedicated conservation reserves, including areas associated with the ecologically important Black Creek riparian system. Such works will be focused on the improvement of local biodiversity.

5.7 Conservation Offsets

Irrespective of the overall holistic ecological benefits of such large land dedications as described above, the following tables provides an overview of outcomes for the key species / communities of note that could be directly affected by future development of the Huntlee lands if it is rezoned.

These land dedications in conjunction with the other mitigatory measures provide a substantial offset package against likely impacts associated with site rezoning and development.

Table 5-4: Vegetation Development and Conservation Outcomes

Vegetation Type <i>Regional Vegetation Community Vegetation Mapping</i> <i>LHCCREMS = Lower Hunter Central Coast Regional Environmental Management Strategy (NPWS 2000, House 2002)</i> <i>HRVP = Hunter Remnant Vegetation Project (Peake 2006)</i> <i>YNP = The Native Vegetation of Northern Yengo National Park (DEC 2006)</i>	Development Total (ha)	Conservation Total (ha)	Site									
			Huntlee Development Area	Huntlee Reserve	Persoonia Reserve (Huntlee)	Mt Popping & Pickle Bottle Creek	Howes Valley	Yengo Holdings	Mount Warrawalong	Corabare Forest	Cedar Creek	Elderslie
LHCCREMS MU 1a – Coastal Warm Temperate - Subtropical Rainforest (EEC)	-	19.40									✓	✓
LHCCREMS MU 3 – Hunter Valley Dry Rainforest (EEC)	-	0.22		✓								
LHCCREMS MU 6 – Coastal Narrabeen Moist Forest	-	184.09							✓		✓	✓
LHCCREMS MU 8 – Sheltered Blue Gum Forest	-	74.00						✓			✓	
LHCCREMS MU 9 – Coastal Ranges Open Forest	-	47.62							✓			
LHCCREMS MU 10 – Sandstone Grey Myrtle Sheltered Forest	-	21.68						✓				
LHCCREMS MU 13 – Central Hunter Riparian Forest (EEC)	62.30	37.48	✓	✓								
LHCCREMS MU 14 – Wollombi Redgum - River Oak Forest (EEC)	12.46	14.58	✓	✓								
LHCCREMS MU 18 – Central Hunter Ironbark-Spotted Gum - Grey Box Forest (EEC)	341.24	568.36	✓	✓	✓							
LHCCREMS MU 19 – Hunter Lowlands Redgum Forest (EEC)	3.66	1.07	✓	✓								
LHCCREMS MU 21 – Hunter Range Gum Forest	-	374.81						✓	✓	✓	✓	
LHCCREMS MU 23 – Broken Back Grey Gum - Stringybark Forest	-	4.08						✓			✓	
LHCCREMS MU 24 – McDonald Exposed Ironbark Woodland	-	1.06						✓				
LHCCREMS MU 25 – Sheltered Dry Hawkesbury Woodland	-	2.948						✓	✓			
LHCCREMS MU 26 – Exposed Hawkesbury Woodland	-	4.10							✓			
LHCCREMS MU 27 – Exposed Yellow Bloodwood Woodland	-	59.18						✓				
LHCCREMS MU 40a – Phragmites Rushland	>0.1	0,24	✓	✓								
HRVP MU 23 – Barrington Foothills White Mahogany Forest	-	162.50										✓
HRVP MU 25 – Barrington Foothills Dry Spotted Gum Forest	-	1.40										✓
HRVP MU 27 – Central Hunter Ironbark - Spotted Gum – Grey Box Forest		208.30										✓
HRVP MU 30 – Hunter Valley River Oak Forest (EEC)	-	1.60										✓
Riparian & Tall Moist Forests (Not ground truthed)	-	435.50				✓						
Dry Sclerophyll Woodland – Forest (Not ground truthed)	-	1946.50				✓						
YNP MU 6 – Hunter Range Narrabeen Sheltered Tall Forest	-	157.43					✓					
YNP MU 8 – Hunter Range Dry Ironbark Forest	-	224.40					✓					
YNP MU 12 – Exposed Narrabeen Stringybark Woodland	-	15.17					✓					

Table 5-5: Threatened Species Habitat and Conservation Outcomes

Site	Potential Habitat																															
	Fauna																															
	<i>Acacia bynoeana</i>	<i>Eucalyptus glaucina</i>	<i>Eucalyptus parramattensis</i>	<i>Persoonia pauciflora</i>	<i>Calyptrorhynchus lathamii</i>	<i>Climacteris picumnus victoriae</i>	<i>Pomatostomus temporalis</i>	<i>Daphoenositta chrysoptera</i>	<i>Chthonicola sagittata</i>	<i>Petroica multicolour</i>	<i>Lathamus discolour</i>	<i>Neophema pulchella</i>	<i>Glossopsitta pusilla</i>	<i>Ninox connivens</i>	<i>Ninox strenua</i>	<i>Melithreptus gularis gularis</i>	<i>Grantella picta</i>	<i>Xanthomyza phrygia</i>	<i>Lophoictinia isura</i>	<i>Aquila morphnoides</i>	<i>Circus assimilis</i>	<i>Petaurus norfolcensis</i>	<i>Pteropus poliocephalus</i>	<i>Phascolarctos cinereus</i>	<i>Saccolaimus flaviventris</i>	<i>Miniopterus australis</i>	<i>Miniopterus schreibersii</i>	<i>Mormopterus norfolkensis</i>	<i>Scoteanax rueppelli</i>	<i>Myotis adversus</i>	<i>Vespadelus troungtoni</i>	
Huntlee Development Area	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
Huntlee Reserve		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
Persoonia Reserve (Huntlee)				✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
Mt Poppong & Pickle Bottle Creek	✓	✓			✓		✓		✓			✓		✓				✓	✓	✓			✓	✓	✓	✓	✓	✓	✓	✓	✓	
Howes Valley	✓				✓	✓	✓	✓	✓			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Yengo Holdings	✓				✓	✓	✓	✓	✓			✓	✓	✓			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓			✓
Mount Warrawalong	✓				✓		✓		✓			✓	✓	✓			✓	✓	✓	✓			✓	✓								
Corabare Forest	✓				✓		✓	✓	✓			✓		✓			✓	✓	✓	✓			✓	✓					✓			
Cedar Creek	✓	✓			✓		✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Elderslie		✓			✓	✓	✓		✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

6 Mitigation Measures

The intent of this section is to provide the principal mitigation considerations that can be adopted at the development phase to supplement the biodiversity protection measures mentioned earlier in the report. Future phases of more detailed development assessment and design will need to provide further details in regards to the finer points of design and in situ habitat retention and management relating to direct and indirect impacts within the development and conservation lands.

6.1 General

The following mitigation measures are recommended to minimise the potential impacts of future development proposals:

- A high level of hygiene should be adopted in respect to vehicle and machinery to help prevent soil-borne disease transmission and weed seed dispersal;
- Strict erosion and sediment control measures should be installed, monitored and maintained to prevent the erosion and sedimentation impact on adjacent areas;
- Dust control measures should be implemented to protect adjacent retained vegetation communities;
- Development should be designed to minimise the amount of clearing as a general objective of the Proposal, particularly within those areas that currently contain identified threatened species or ecological communities. These areas have been described within this report;
- Construction areas should be fenced to protect adjoining vegetation prior to construction activities in order to reduce potential damage from uncontrolled or accidental access;
- Stockpiling of materials should occur within already disturbed areas and not within retained vegetation;
- All *Persoonia pauciflora* individuals should be retained until such time that they senesce with a minimum 30m vegetated buffer per Bell (2005) report recommendations;
- A Statement of Interim Management (SIMI) should be prepared for the built and biophysical management interface to be implemented prior to construction and managed until hand over to conservation.
- Strict weed management, monitoring and control practices should be implemented to minimise the spread of exotic species into natural areas within the site. Some minor weed invasion in recently disturbed areas was observed and should be controlled;
- A tree felling protocol will need to be developed to minimize harm to all fauna species during the clearing of trees for the Proposal. The tree felling protocol should be developed by a suitably qualified and licensed ecologist with previous experience

supervising the felling of trees. The tree felling protocol should involve as a minimum the following key steps of: establishment of the best time of the year for felling (depends on the likely species to be affected), pre-felling mapping of habitat trees, inspections of trees on the day of felling, procedures for the safe removal of fauna species from trees prior to and post felling, a relocation/release protocol, leaving the tree overnight where it fell, and a protocol for the salvaging of tree hollows for rehabilitation works where necessary. Where possible, tree felling should be undertaken during the best time of year as identified in the tree felling protocol. All tree felling should be supervised by the ecologist that developed the tree felling protocol (and in accordance with the tree felling protocol) or by another suitably qualified and licensed ecologist;

- Where trees are to be removed as part of the Proposal an assessment of the surrounding level of tree hollow provision should be undertaken by a suitably qualified ecologist. The ecologist would determine the need for local supplementing of tree hollows (using salvaged tree hollows or nest boxes) based on the number of hollows lost during felling and the surrounding provision of remaining natural hollows. If the ecologist recommends the establishment of nest-boxes to compensate for the loss of tree hollows;
- One nest box should be installed for every hollow-bearing tree removed;
- A range of nest box sizes and shapes should be installed to encompass the range of hollow sizes to be removed;
- Nest boxes should be installed prior to the commencement of vegetation clearing;
- A nest box monitoring and maintenance (repair and replacement) program should be developed and implemented for at least 10 years from commencement of construction;
- Mature and hollow-bearing trees should be retained wherever feasible within the site;
- Vegetation to be removed is to be clearly marked in the field using temporary fencing (flagging tape or similar exclusion tape) so that boundaries are clearly established and to minimise the potential for equipment to accidentally enter areas to be retained;
- Where possible, the timing of clearing activities should be undertaken at such times to avoid removal of hollow-bearing trees during breeding season of threatened species;
- Regular monitoring of the vegetation within the subject site and within the offset areas is to be undertaken in order to enable effective management of the vegetation with regard to rehabilitation (planting), regeneration, watering, fencing and weed control;
- A Vegetation Management Plan should be developed for the site which details the rehabilitation, restoration and ongoing maintenance (including weed management) of vegetation retained within the site;
- Vegetation to be removed should be clearly marked in the field using temporary fencing (flagging tape or similar exclusion tape) so that boundaries are clearly established and to minimise the potential for equipment to accidentally enter areas to be retained;
- A Water Management Plan should be prepared for the site which details water storage, drainage, erosion and sediment controls and specifies appropriate mitigation measures for preventing offsite impacts on aquatic habitats;

- It is recommended that any long-term water storage dams which are proposed to be constructed within the site are landscaped with freshwater wetland species so as to be suitable for occupation by frog species, and that ongoing weed management of areas adjacent to wetlands occurs under a Vegetation Management Plan;
- The Water Management Plan is to be adhered to at all times to prevent potential impacts to aquatic areas;
- Where possible felled trees should be placed on the ground amongst existing trees to provide habitat for ground cover dependent species;
- An annual fauna monitoring program should be developed and implemented. The monitoring program should start immediately, prior to the beginning of mining operations, to establish baseline population levels;
- No fill is to be placed within the drip line of trees;
- No stockpiling or parking of machinery is to occur within 4m of any tree.

6.2 Aquatic

It is considered that the Hunter-Central Rivers CMA - Catchment Action Plan provides a suitable guiding management framework for aquatic habitat management, and such parameters should be considered further as the development design and implementation process progresses. Following are some of the relevant Management Targets and intents contained therein.

- **Protect Native Vegetation** – to protect existing Regionally Significant Vegetation (RSV) in the long term, using formal conservation agreements. It is expected that this occurs via conservation of areas of the site, including the dedication of a New National Park area south of Black Creek, and the Black Creek riparian zone and flood plain being protected.
- **Regenerate Native Vegetation** – using formal means and on ground activities. Targeted rehabilitation and regeneration works should occur in identified areas, including along the Black Creek riparian zone.
- **Treat Weeds** – to manage and control weeds using on-ground work. Areas of Black Creek and other parts of the site will require active weed management works to remove problematic species, including Cestrum and Lantana.
- **Threatened Species Work** – to manage threats to, and habitats of, threatened species with on-ground work. Threatened species will benefit from targeted rehabilitation and regeneration works, and by creation of new habitat areas / features.
- **Protect Wetlands** – to preserve good quality existing wetland areas that provide important ecosystems services.
- **Enhance Wetlands** – to rehabilitate degraded wetlands that provide important ecosystem services.
- **Treat Pest Animals** – to manage land, fresh water and marine based pests using on-ground actions together with educational and awareness programs.

- **Erosion and Sediment Control** – all development areas, particularly during construction, need to be managed using current best practice to reduce risk of pollution.
- **Revegetate Highly Erodible Soils** – to reduce the risk of erosion by increasing the amount of vegetation covering cleared land that is prone to erosion.
- **Stabilise Actively Eroding Soils** – rehabilitate existing active erosion with on-ground work.
- **Manage Nutrient Runoff** – to implement appropriate current best practice land management across a number of agricultural activities and urban areas to reduce the amount of land generated runoff with high nutrient concentrations.
- **Stabilise Salt Affected Areas** – to rehabilitate salt affected areas.
- **Protect Native Vegetation** – to protect good quality native vegetation along stream banks of third order and above streams.
- **Restore Fish Passage** – to reduce impediments to the movements of fish caused by in-stream man-made structures.
- **Instream Foreshore Stabilisation** – provide more stable environments in degraded stream-beds and on the banks of streams and their estuaries.
- **Restore In-Stream Habitat** – improve the variety of habitats, including pool, riffles and large woody debris in streams.
- **Urban Stormwater Management** – to use current best practice of urban stormwater management for the benefit of natural resources in existing developed urban, commercial and industrial areas.
- **Effluent Management** – to ensure that onsite effluent management systems are managed so that they do not degrade natural resources.

6.2.1 Maintenance of Riparian Buffers

Riparian Buffers are retained corridors of land along either side of a watercourse reserved with the intent of retaining existing vegetation and the environmental integrity of the watercourse, as well as allowing large flows to be safely conveyed. As a general rule where possible, buildings, roadways and other significant infrastructure should not be sited within buffer areas. However, soft items such as landscaping, seating, educational signs, footpaths and service infrastructure (including stormwater drainage treatments), if they have minimal impact upon the existing vegetation and hydrological function, may be acceptable within the buffer area.

Appropriate buffer widths for significant watercourses vary, depending on the size or significance of the watercourse, the existing environmental integrity of the watercourse and the potential for either improving or maintaining desirable environmental outcomes. Typical buffer area widths prescribed under the Water Management Act 2000 by the NSW Office of Water range from 10 – 60m from the top of bank on either side of the water course. These are generally determined via consideration of site specific factors. The general principles of the WM Act in this regard should be considered as part of a rigorous environmental assessment.

As noted previously, the 1:25000 topographic map of the Cessnock region shows multiple watercourses potentially requiring riparian buffer zones within the site. While it would be environmentally ideal to buffer all watercourses, Small Intermittent Creeks, particularly those located within sub-catchment headwaters, do not represent significant riparian areas and should not require buffer protection. Larger Intermittent Creeks are however more likely to possess riparian zone attributes and therefore are more likely to require buffer zones that adequately represent and protect those attributes.

Black Creek, which is the only permanent watercourse within the site, is likely to require a substantial buffer zone. However, it is also likely that much of this area will fall inside the 1% Annual Exceedance Probability (AEP) flood level.

Controls to assist in the protecting the integrity of the site's riparian zones for future development may include:

- Where possible, avoiding development and vegetation removal in riparian areas.
- Protection of riparian vegetation by fencing, or other appropriate barriers to avoid damage during construction periods.
- Where possible avoid modification to watercourses such as piping and channelling.
- Rehabilitation of watercourses back to natural or a near natural state where modification has occurred.

To enhance aquatic habitats on the site, and to improve riparian corridor connectivity, management may also include enhancement of currently degraded riparian areas. The types of actions outlined in the Hunter Catchment Action Plan should be considered for application on this site in this regard.

Generally the proposal seeks to maintain riparian corridors within the urban areas, however the exact watercourses and required buffers will be derived via consultation with the NSW Office of Water as future proposals for development are made.

6.2.2 Runoff Management

Run-off generated through development of the site has the potential to impact on on-site and downstream aquatic environments. To avoid these impacts, site stormwater management should, where practical, comply with industry best practice principles for water sensitive urban design (WSUD) and sustainable water use, as well as Council's development guidelines (where relevant). For future development, the design and construction of stormwater infrastructure within the subject site should therefore generally adhere to the following guidelines:

- Holistic management of stormwater generated from the developed site with allotment scale measures integrated into the wider subdivision context. Ideally, this should involve the use of collection and treatment measures on individual lots, overflowing during larger rainfall events into a street trunk drainage system.

- The design of the trunk drainage system being sensitive to maintaining the natural condition of retained watercourses within the subject site.
- Peak flows from developed areas designed to match pre-developed peak flows, as best as possible, to maintain the existing flow regimes of the system.
- The use of source control devices (grassed swales, infiltration/retention trenches, rainwater tanks, bioretention swales, permeable paving etc) to control water quality, instead of large traditional end of line controls.
- Dispersed release of runoff to drainage lines should be encouraged to reduce scour at outlet points. Discharge of concentrated, high velocity, high erosive potential flow should be avoided.

6.2.3 Stormwater Quality

It is expected that runoff from future residential development on the study area will contain certain amounts of pollutants. As such, stormwater runoff will need to be treated to minimise any adverse impacts upon the ecology of the on-site watercourses and downstream catchment areas.

Litter, coarse sediments, fine particles, oils and greases, total phosphorus and total nitrogen are typical pollutants likely to be generated from urban development. In line with current best practice, the design of future stormwater management systems for the site should set the targets for pollutant removal in keeping with the table below.

Table 6-1: Pollutant Removal Target

Target Pollutant Removal Efficiencies					
Suspended Solids	Total Phosphorus	Total Nitrogen	Litter / Gross Pollutants	Course Sediment	Oil % Greases
85% of Annual Load	45% of Annual Load	45% of Annual Load	100% in 3 month event	100% in 3 month event	100% in 3 month event

Meeting these targets should ensure that an acceptable level of water quality is maintained, thus maintaining appropriate conditions for ongoing health of aquatic habitats. Notably achievement of such will be guided by the appropriate agency and specialist.

6.2.4 Watercourse Crossings

Construction of watercourse crossings should be avoided where possible. Where crossings of retained watercourses are necessary, construction should be in line with the Guidelines for Fish Friendly Roads (NSW DPI, 1998). In regard to the Stage 1 Development area, most watercourses represent either Class 3 or 4 Fish Habitat. Following is the minimum engineering solutions required for these watercourses.

Class 3 - Culverts required and designed to allow fish passage. Invert should be investigated to ensure it is below the bed level of the waterway, and that ponding can occur. Velocity of flow within the stream should remain unaltered from original flow conditions. The invert should also be roughened to increase turbulence to allow formation of eddies to assist fish passage.

Class 4 -Causeway, floodway or culvert with allowance for flow of water to downstream areas unhindered (e.g. pipe or pipes).

The above standards need to be applied in a realistic fashion. There is little gain in applying the above measures to creek sections that are isolated from permanent water supplies.

7 Part 3A Considerations

7.1 Potential Impacts under Part 3A of the EP&A Act

7.1.1 Flora

The development of Huntlee as proposed will involve the removal of native vegetation, including listed EEC's. However, increased levels of protection for all vegetation communities is proposed by dedication of conservation lands, both on-site and elsewhere within the region.

No threatened flora species are proposed to be removed by the proposal. All specimens will be retained in either dedicated conservation areas, or within retained open space areas connected to riparian and habitat linkages.

However, the development of the Huntlee lands will remove areas recognised as potential habitat within the range of the Critically Endangered *Persoonia pauciflora*. This incremental loss of potential habitat is proposed to be offset by increasing protection to all known specimens, known key areas of occupied habitat, and by contribution of \$100,000 to research projects associated with the conservation of *P. pauciflora*.

7.1.2 Fauna

The development of Huntlee as proposed will involve the modification of areas of native vegetation, which provide habitat resources of varying degrees for native fauna species. 27 threatened fauna species have been documented as occurring within the Wider Huntlee Study area.

The dedication of conservation lands on-site will provide permanent protection for a large area of native forest, providing secure long term habitat for such species. Conservation of other large land holdings in the region will provide further improved outcomes for many native fauna species, including the target threatened species.

7.1.3 Key Threatening Processes

Key Threatening Processes (KTPs) are listed under Schedule 3 of the *TSC Act*. Of the currently listed 34 KTPs the following are relevant to the Proposal:

- Clearing of native vegetation;
The resulting level of native vegetation clearing is likely to significantly contribute to the operation of the KTP – 'clearing of native vegetation'. However, this impact needs to be considered in regards to the long term increased conservation outcomes achieved for native vegetation on lands proposed to be permanently secured.
- Infection of native plants by *Phytophthora cinnamomi*;

The movement of earth moving machinery as part of construction may result in the movement of soil that contains *Phytophthora cinnamomi*. Any spread of *Phytophthora cinnamomi* would contribute to the KTP - Infection of native plants by *Phytophthora cinnamomi*. To minimise such risks, appropriate management controls should be generated and instigated as a part of future applications for development stages on the site.

- Anthropogenic climate change; and

The Proposal is likely to contribute to the KTP “human caused climate change” due to impacts resulting from the clearing of native vegetation. The extent to which the Project could contribute to this process is unknown at the stage of rezoning.

- Removal of dead wood and dead trees.

The removal of native vegetation will result in the removal of some dead wood, and this is likely to contribute towards the KTP - Removal of dead wood and dead trees, particularly for species dependent on such resources. However, proposed conservation areas will over time see an increase in the amount of such features, thus mitigating any long term impact.

7.2 Key Thresholds Assessment

As required by the Draft Guidelines for Threatened Species Assessment for Part 3A Applications (DEC/DPI 2005), an assessment against the Key Thresholds is provided for the Huntlee development.

Whether or not the proposal, including actions to avoid or mitigate impacts or compensate to prevent unavoidable impacts will maintain or improve biodiversity values.

It is considered that the information presented within this document, and in particular the proposal that includes the proposed conservation area and ‘Persoonia Park’ for the Huntlee site, when viewed holistically with the proposed conservation measures, both on and off site as detailed within the EAR is likely to result in a maintained if not an improved outcome for biodiversity values within the region.

Whether or not the proposal is likely to reduce the long-term viability of a local population of the species, population or ecological community.

Persoonia pauciflora occurs within areas proposed for development as well as within proposed conservation zones. At present, the viability of this population long term is unclear after the large scale reduction of this population from illegal clearing on adjacent lands. *Persoonia pauciflora* 2007-2010 status report checks indicate grazing pressure from both native and domestic animals as a main threat to the remaining plants long term viability and potential threat if left. Such considerations would encourage a proactive approach to increase the viability of this population. The establishment of the proposed ‘Persoonia Park’, the preservation of other areas identified by DECCW as important and known to contain specimens, and a monetary contribution of \$100,000 towards to management of the North Rothbury Persoonia, to assist in research studies and

management is likely to increase the long-viability of the local population beyond that of a 'do nothing' approach.

The remaining threatened species considered within the report and populations occurring within the area of the proposal and ecological communities are well represented in the proposed conservation area south of Black Creek, and are also represented within or have potential habitat within other conservation offset lands and considered unlikely to reduce the long-term viability of a local population of species or endangered ecological community.

Whether or not the proposal is likely to accelerate the extinction of the species, population or ecological community or place it at risk of extinction.

The large scale reduction of the *Persoonia pauciflora* population from illegal clearing on adjacent lands is likely to have placed this population at considerable further risk of extinction. Though having potential to accelerate the extinction of *Persoonia pauciflora*, as discussed above it is likely that the proposal that includes the establishment of 'Persoonia Park', reservation of other areas containing *P. pauciflora* on the proponents land, and a monetary contribution of \$100,000 towards to management of the North Rothbury Persoonia, to assist trialling measures is key to maintain the majority of the remaining individuals and to guarantee a secure and viable future for this species.

The remaining species considered within the report and their communities are well represented in the proposed conservation area south of Black Creek, and are also represented or have potential habitat within other conservation offset lands and considered unlikely to be placed at risk of extinction.

Whether or not the proposal will adversely affect critical habitat.

There is no declared "Critical Habitat" within the Huntlee locality, and as such the proposal will not adversely affect any such habitat.

8 EPBC Act Considerations

8.1 Background

A previous referral and approval process (2007/3557) was undertaken for the Huntlee project (when submitted as a Part 3A Concept Plan), which involved considered liaison and negotiation with the Department (then DEWHA).

On the 29th June 2009, an approval was granted with conditions. This proposal was very similar in size to the new Huntlee proposal herewith, with the key difference being that proposed removal of some individuals of *Persoonia pauciflora* was sought and approved. The new Huntlee proposal provides improved outcomes for *P. pauciflora* (and other matters of NES) to that which was previously approved.

This approval was subject to revocation on 1st December 2009 following an approach by the proponent to the Department.

8.2 Environment Protection and Biodiversity Conservation Act 1999

An EPBC Act Protected Matters Database Search was undertaken using the DEWHA on-line database (accessed 24 September 2010) to generate a list of relevant matters of National Environmental Significance (NES) within the study area.

The matters of NES relevant to this flora and fauna assessment are:

- Wetlands of International Significance (RAMSAR sites);
- TECs;
- Threatened species;
- Migratory species; and
- Critical Habitats.

These matters of NES are consistent with that previously assessed for Huntlee. Following is an assessment of whether the Proposal is likely to impact on any of the above matters of NES.

8.2.1 Wetlands Protected by International Treaty (the RAMSAR Convention)

The EPBC Act Protected Matters Database Search revealed that Huntlee sits in the Hunter Catchment and drains via Black Creek to the Hunter River, and the lower estuary reaches of the Hunter River contain RAMSAR listed wetlands (Hunter Estuary Wetlands). Impacts on such wetlands are considered to be minimal from Huntlee, given the significant distance of the site from the lower Hunter estuary, and the proposed implementation of WSUD within the development of Huntlee.

This outcome was as previously agreed by DEWHA.

8.2.2 Nationally Listed Threatened Species and Ecological Communities

The EPBC Protected Matters Database Search identified one TEC and 25 threatened species as potentially occurring within the study locality. Based on the detailed ecological work undertaken between 2005 – 2010 over the Huntlee lands, the following are confirmed as requiring assessment for this proposal due to their known occurrence:

- Three threatened flora species (*Eucalyptus glaucina*, *Eucalyptus parramattensis* ssp. *decadens*; *Persoonia pauciflora*); and
- Three threatened fauna species (Regent Honeyeater, Swift Parrot, Grey-headed Flying-fox).

Each of these species is dealt with separately below.

Eucalyptus glaucina

Occurs with hybrid red gum stands throughout the site. Conservation of this species is probably best achieved through a landscape approach of conserving larger stands of red gum eucalypts. While some areas containing red gum trees will be removed, adequate conservation outcomes will be achieved by retaining and conserving the majority of habitat for this species.

Eucalyptus parramattensis* ssp. *decadens

Currently only a single specimen is known from the study area and this is in the southern area proposed for conservation.

Persoonia pauciflora

All known specimens of *P. pauciflora* will be protected and buffered within the proposal. Key areas will be dedicated as conservation land. Such areas will remain linked via riparian and habitat corridor retention within the design. However, loss of some areas of potential habitat within the restricted range of this species will occur.

Swift Parrot

Seasonal winter migrant with the potential to use the locality on an annual basis due to the large areas of potential habitat. Recorded in flocks of up to 60-80 individuals in 2005. Surveys in 2007 - 2009 confirm that use of the Huntlee area (& others) is sporadic in regards to location and numbers of birds. Protection and conservation of large areas of habitat where the birds have been recorded will occur.

Regent Honeyeater

One historical record only. Likely to only be an irregular visitor to the locality, given that birds in the Hunter Valley tend to be found along the timbered fringes of the valley rather than in the centre where Huntlee lies. Protection and conservation of large areas of potential habitat will occur.

Grey-headed Flying-fox

Whilst the Huntlee area would provide seasonal foraging resources for this mobile species, there are minimal records in the locality. No suitable camp sites occur within Huntlee. Protection and conservation of large areas of potential habitat will occur.

8.2.3 Nationally Listed Migratory Species

A total of three migratory species listed under the *EPBC Act* have been recorded within the study area, namely White-throated Needle-tail, Rainbow Bee-eater and regent Honeyeater.

The Proposal is unlikely to substantially modify, destroy or isolate an area of important habitat, result in an invasive species that is harmful to the migratory species becoming established in an area of important habitat or seriously disrupt the lifecycle of an ecologically significant proportion of the population of a migratory species.

8.2.4 EPBC Act Summary Statement:

As outlined above, the previous development proposal at Huntlee was approved under the EPBC Act. A new referral under the EPBC Act will be required, particularly in regards to impacts on *Persoonia pauciflora*, at the time of lodging future applications for development.

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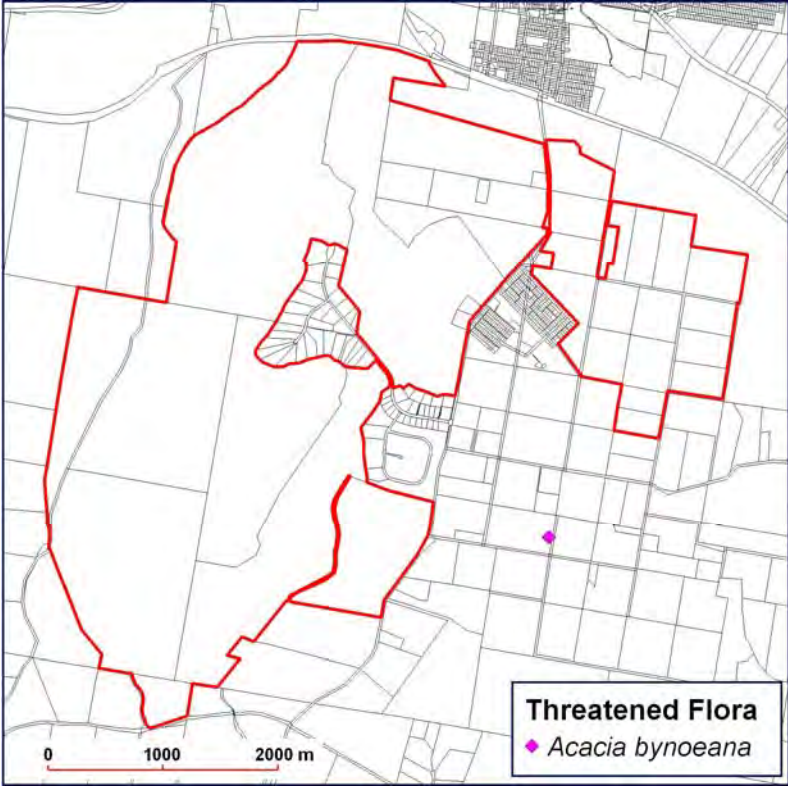
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Appendix I

Threatened Species Habitat Profiles

Threatened Species Profiles:

▪ <i>Acacia bynoeana</i>	Bynoe's Wattle
▪ <i>Eucalyptus glaucina</i>	Slaty Red Gum
▪ <i>Eucalyptus parramattensis</i> subsp. <i>decadens</i>	Drooping Red Gum
▪ <i>Persoonia pauciflora</i>	North Rothbury Persoonia
▪ <i>Calyptorhynchus lathamii</i>	Glossy Black-Cockatoo
▪ <i>Climacteris picumnus victoriae</i>	Brown Treecreeper
▪ <i>Daphoenositta chrysoptera</i>	Varied Sittella
▪ <i>Pomatostomus temporalis temporalis</i>	Grey-crowned Babbler
▪ <i>Chthonicola sagittata</i>	Speckled Warbler
▪ <i>Petroica multicolour</i>	Scarlet Robin
▪ <i>Glossopsitta pusilla</i>	Little Lorikeet
▪ <i>Lathamus discolor</i>	Swift Parrot
▪ <i>Neophema pulchella</i>	Turquoise Parrot
▪ <i>Lophoictinia isura</i>	Square-tailed Kite
▪ <i>Ninox connivens</i>	Powerful Owl
▪ <i>Ninox strenua</i>	Barking Owl
▪ <i>Melithreptus gularis gularis</i>	Black-chinned Honeyeater
▪ <i>Grantiella picta</i>	Painted Honeyeater
▪ <i>Xanthomyza phrygia</i>	Regent Honeyeater
▪ <i>Aquila morphnoides</i>	Little Eagle
▪ <i>Circus assimilis</i>	Spotted Harrier
▪ <i>Petaurus norfolcensis</i>	Squirrel Glider
▪ <i>Phascolarctos cinereus</i>	Koala
▪ <i>Pteropus poliocephalus</i>	Grey-headed Flying-fox
▪ <i>Saccolaimus flaviventris</i>	Yellow-bellied Sheath-tail-bat
▪ <i>Miniopterus australis</i>	Little Bentwing-bat
▪ <i>Miniopterus schreibersii</i>	Eastern Bentwing-bat
▪ <i>Mormopterus norfolkensis</i>	Eastern Freetail Bat
▪ <i>Scoteanax rueppellii</i>	Greater Broad-nosed Bat
▪ <i>Myotis adversus</i>	Large-footed Myotis
▪ <i>Vespadelus troughtoni</i>	Eastern Cave Bat

<i>Acacia bynoeana</i> Bynoe's Wattle	
Status: Endangered (TSC Act) Vulnerable (EPBC Act)	Distribution and Mapping
<i>A.bynoeana</i> is a small shrub to 1m high which grows prostrate. Golden yellow flowers are apparent from September until March and seedpods mature from November to January. The determination of <i>Acacia bynoeana</i> as an endangered species under the TSC Act states that most populations comprise 1-5 individuals, with perhaps 300-500 plants within the State. However, these estimates are almost certainly not based on field assessment, as recent studies have confirmed that most populations in the northern parts of the known range comprise at least 200 plants, occasionally up to 2000 plants (Bell & Driscoll in review). This species was recorded at one location off Littlewood Road and the population at North Rothbury is considered significant, for two reasons: - It extends the known distribution of this species a further 15km to the north of the previous limit at Kurri Kurri; - It occurs in a completely new habitat type not previously recognised as supporting the species. Bell & Driscoll (in review) have documented the known population of this species from the Central Coast and lower Hunter Valley area and no other known populations occur in a low woodland of <i>Eucalyptus</i> sp. aff. <i>agglomerata</i> (or related species). This new habitat type has affinities to the Central Hunter & Lower Hunter Spotted Gum Ironbark Forest described by NPWS (2000) and it could be broadly included within either of these communities.	Survey Methods: - Targeted surveys by Bell & Driscoll (2005) across Study Area A and Bell (2005) across Wider Study Area (see Appendix 2); - RPS Detailed Habitat Investigations across Study Area A (see Section 2.4). Modelling (variables): Extent of Map Unit 18s: <i>Eucalyptus</i> sp. aff. <i>agglomerata</i> Heathy Low Forest Map:  Notes: Further surveys to estimate population sizes within the wider Huntlee study area are required and elsewhere within the Cessnock LGA. Records / Population within Huntlee: 1 population (currently only known to contain less than 10 individuals)

Eucalyptus glaucina Slaty Red Gum

Status: Vulnerable (TSC Act)
Vulnerable (EPBC Act)

Distribution and Mapping

Hill (2002) describes *Eucalyptus glaucina* as a tree to 30 m in height, locally frequent but sporadic in grassy woodland on deep moderately fertile and well-watered soils near Casino and from Taree to Broke. Populations of *Eucalyptus glaucina* are known from part of Werakata National Park.

Many individual redgum trees across the wider study area show characteristics of the vulnerable *Eucalyptus glaucina*. Study Area A supports various intergrading forms of this species with *Eucalyptus tereticornis*.

As with most other occurrences of this species in the Hunter Valley, all sites have been grazed in the past, leaving an open grassy understorey with only scattered shrubs. As in the population of *Eucalyptus glaucina* within the Hunter Economic Zone, it would be a very difficult task to provide accurate population counts of the species without examining every tree, supported by genetic studies.

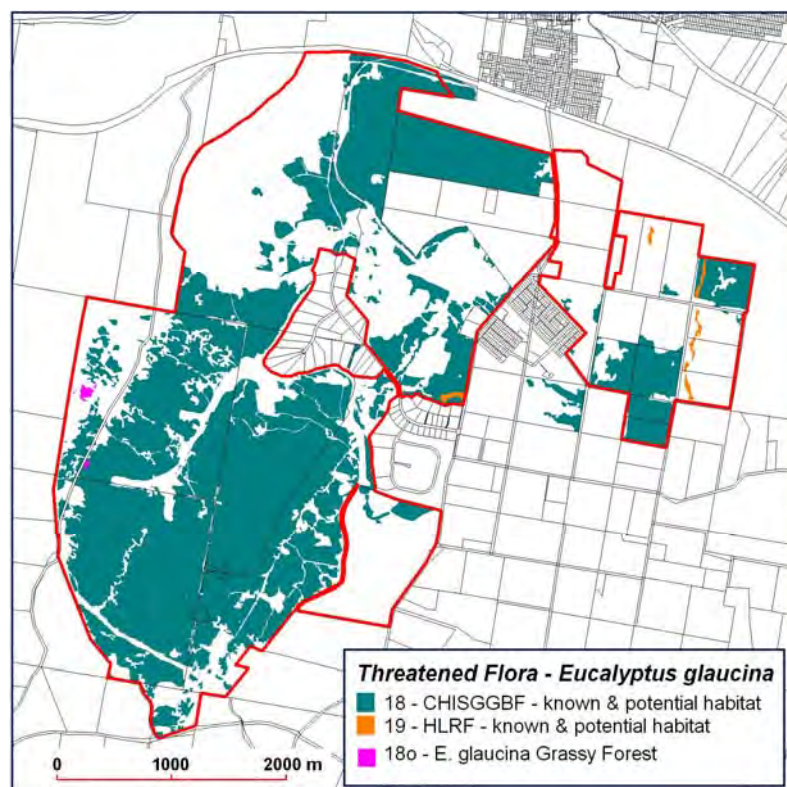
As such, conservation of this species is probably best achieved through a landscape approach of conserving larger stands of redgum eucalypts.

Survey Methods:

- Targeted surveys by Bell & Driscoll (2005) across Study Area A and Bell (2005) across Wider Study Area (see Appendix 2);
- RPS Detailed Habitat Investigations across Study Area A (see Section 2.4).

Modelling (variables): Vegetation mapping including River Flat Eucalypt Forest on Coastal Floodplains.

Map:



Notes:

- Hybridisation occurring widely within the Huntlee study area with *E. tereticornis*;
- Relatively pure stands of this species exist on the western and eastern slopes of Terrace Ridge in the study area southwest.
- Very difficult task to provide accurate population counts of the species without examining every tree, supported by genetic studies.

Records / Population within Huntlee: Potential habitat generally, but not always, associated with stands of *E. tereticornis* and scattered individuals and small stands occur within Central Hunter Ironbark – Spotted Gum – Grey Box Forest.

Eucalyptus parramattensis* subsp. *decadens

Drooping Red Gum

Status: Vulnerable (TSC Act)
Vulnerable (EPBC Act)

Distribution and Mapping

Extracted from Bell & Driscoll (2005): *Eucalyptus parramattensis* subsp. *decadens* is a small tree to 15m in height, occurring in dry sclerophyll woodland on sandy soils in low, often wet, sites, from Tomago to Kurri Kurri (Hill 2002).

Conserved populations occur within Werakata National Park near Cessnock (Bell 2004), with the Tomago populations present within Crown Reserve but subject to water extraction activities by Hunter Water.

A single, healthy individual of *Eucalyptus parramattensis* subsp. *decadens* was discovered in the southern part of the Study Area A, in a small drainage line associated with sandstone bedrock material and surrounded by Central Hunter Ironbark – Spotted Gum – Grey Box Forest. This find is considered to be significant, as the specimen occurs well north (at least 10km) of the currently accepted distributional range of this taxon and is also present in currently undocumented habitat for the species.

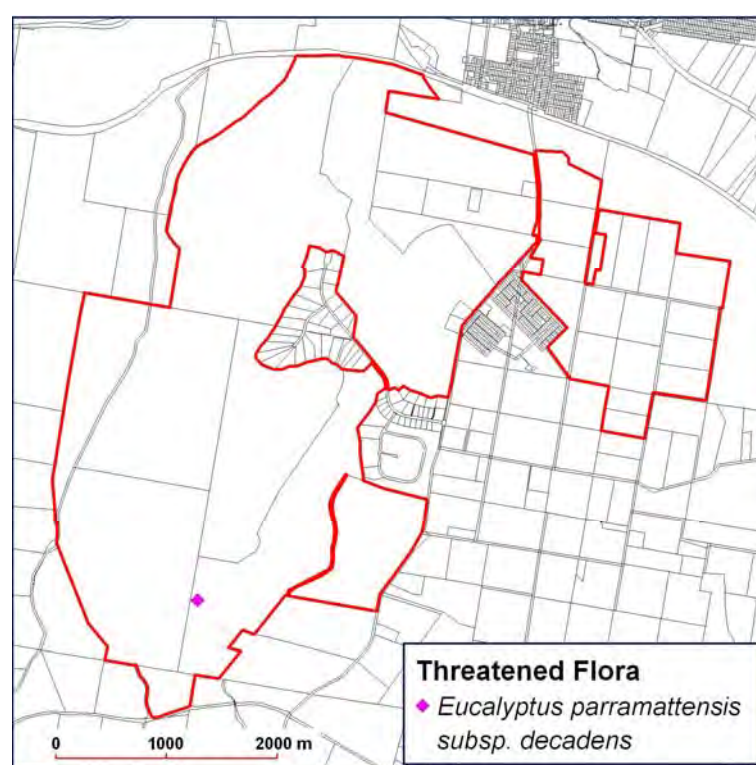
The main populations of this taxon occur in the Cessnock-Kurri region to the south and also on the Tomago Sandbeds to the east in Port Stephens Shire. At both of these locations, *Eucalyptus parramattensis* subsp. *decadens* occurs on deep sand or clay substrates, generally well above any bedrock material. The single specimen recorded for the Huntlee site may represent a vestige of what may have occurred prior to European settlement, which may have been a small disjunct population at the northern limit of the main population.

Survey Methods:

- Targeted surveys by Bell & Driscoll (2005) across Study Area A and Bell (2005) across Wider Study Area (see Appendix 2);
- RPS Detailed Habitat Investigations across Study Area A (see Section 2.4).

Modelling (variables): Actual occurrence

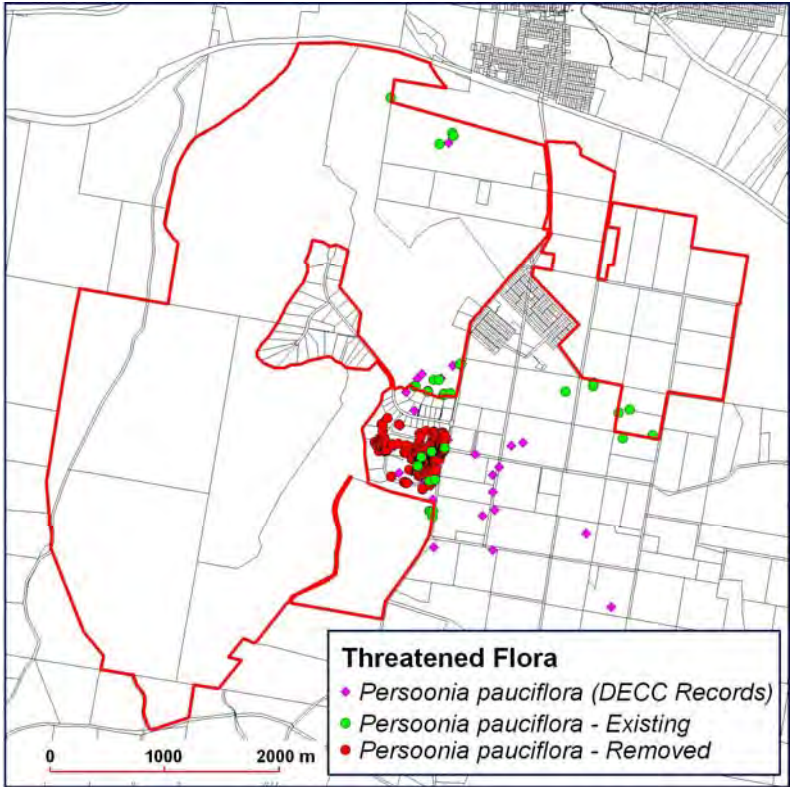
Map:



Notes:

- Individuals may occur elsewhere within the Wider Huntlee Study Area.

Records / Population within Huntlee: Currently only a single specimen is known from the study area.

<i>Persoonia pauciflora</i> North Rothbury Persoonia	
Status: Endangered (TSC Act) Critically Endangered (EPBC Act)	Distribution and Mapping
Extracted from Bell & Driscoll (2005). <i>Persoonia pauciflora</i> is a highly endemic species known only from the North Rothbury area (Weston 1999) and is subject to a number of threats including land clearing and agricultural activities. There are currently no known populations within secure conservation reserves and the total known population (of about 250 plants) occurs within a radius of 2 km of North Rothbury. Weston (1999) described the habitat for this species as dry sclerophyll forest dominated by <i>Eucalyptus fibrosa</i>, <i>Eucalyptus moluccana</i>, <i>Eucalyptus punctata</i> and <i>Corymbia maculata</i>, over a grassy understorey. Further studies on the ecology of this species are in progress (G. Patrick, <i>pers. comm.</i>). The bulk of the population of <i>Persoonia pauciflora</i> is centred within the wider Huntlee study area, such as along Tuckers Lane. However, a small number of plants are present within Study Area A, mostly occurring as single individuals or small, loose groups. All plants occur within the Central Hunter Ironbark – Spotted Gum – Grey Box Forest. The largest aggregation of plants within the Huntlee study area is a loose grouping of eleven plants straddling the creekline adjacent to the northern boundary of the Hanwood estate within a few hundred metres of Wine Country Drive (Authors <i>pers. obs.</i>).	Survey Methods: - Targeted surveys by Bell & Driscoll (2005) across Study Area A and Bell (2005) across Wider Study Area (see Appendix 2); - RPS Detailed Habitat Investigations across Study Area A (see Section 2.4), including detailed 2007 inventory surveys. Map: Actual occurrence (potential further records within the wider Huntlee Study Area). 
Notes: - This species is currently the subject of a draft recovery plan by DECCW. - The proposal involves the creation of a 'Persoonia Park' reserve.	Records / Population within Huntlee: The entire known population is contained within the wider Huntlee Study Area. Within Study Area A, 23 individuals are known to occur.

Calyptorhynchus lathamii Glossy Black-Cockatoo

Status: Vulnerable (TSC Act)

Distribution and Mapping

Glossy Black-cockatoos are found in a range of forest and woodland habitats that contain mature hollow bearing trees of adequate size for breeding and sufficient densities of *Allocasuarina* trees, whose seeds constitute their predominant food resource.

There have been three records of this species on the site. One record is historical, from 1977, another from 2001 (Atlas of NSW Wildlife data) and Conacher Travers (2001) found evidence of their use of the site in the form of chewed *Allocasuarina* cones. No direct observation or indirect evidence of their using the site was made during recent extensive diurnal bird censuses (Authors *pers. obs.*).

There are six (*Allo*)*Casuarina* sp. present on the Huntlee site, but the most abundant species is *C. glauca*, a species not favoured by *C. lathamii* as a food resource. Despite the presence of *A. torulosa* and *A. littoralis* within the study area and individual trees carrying mature fruit no evidence was found to suggest that Glossy Black-cockatoos have been using the site recently.

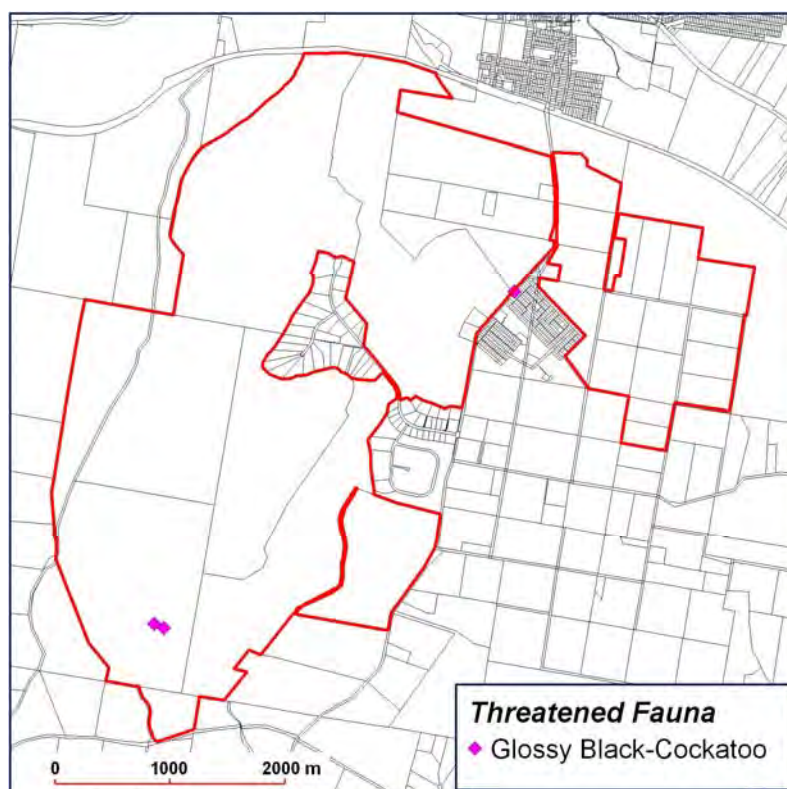
A number of records for this species exist across the Hunter region, with the majority of records coming from sites within or proximate to the forested ranges on the periphery of the valley (HBOC; Atlas of NSW Wildlife data). The closest records, apart from those attributable to the site, exist from Werakata NP and Pokolbin SF (Atlas of NSW Wildlife 2005; Birddata 2005).

Survey Methods:

- Feed tree species (*Allocasuarina* sp.) noted as presence absence index within 200m x 200m grids within Study Area A.
- Extensive diurnal bird census including searches for *C. lathamii* feeding debris under *Allocasuarina* sp.

Modelling (variables): Huntlee site Presence / Absence index for feed tree species (*Allocasuarina* sp.).

Map:



Notes:

- Some individual groups of Glossy Black-cockatoos are relatively sedentary, while other groups appear to be nomadic, which is likely to be a function of habitat reliability in a given area.

Records / Population within Huntlee: Irregular visitor, occasional records.

Climacteris picumnus victorae Brown Treecreeper

Status: Vulnerable (TSC Act)

Distribution and Mapping

This species frequents drier forests and woodlands, particularly woodland lacking a dense understorey. It is also known to occur within more open areas where there are sufficient logs, stumps and dead trees nearby. Feeds on invertebrate larvae and small insects, particularly ants. Utilises hollows for roosting/nesting and despite its tree frequenting habits it sometimes forages on the ground.

Within the Lower Hunter, Brown Treecreepers can be locally common, such as the Tomalpin forests and those adjacent to Ellalong Lagoon, but at the Huntlee site this species was recorded at only one location. A single pair was observed in residence within grid areas M23, M22 and N22. At this location the forest is composed of a high diversity of canopy species and borders an area of CHISGGBF exhibiting high densities of *Eucalyptus fibrosa*. The sedentary nature of this species suggests that the observed pair is likely to breed in the vicinity of the sightings made during the winter of 2005 (Authors *pers obs.*).

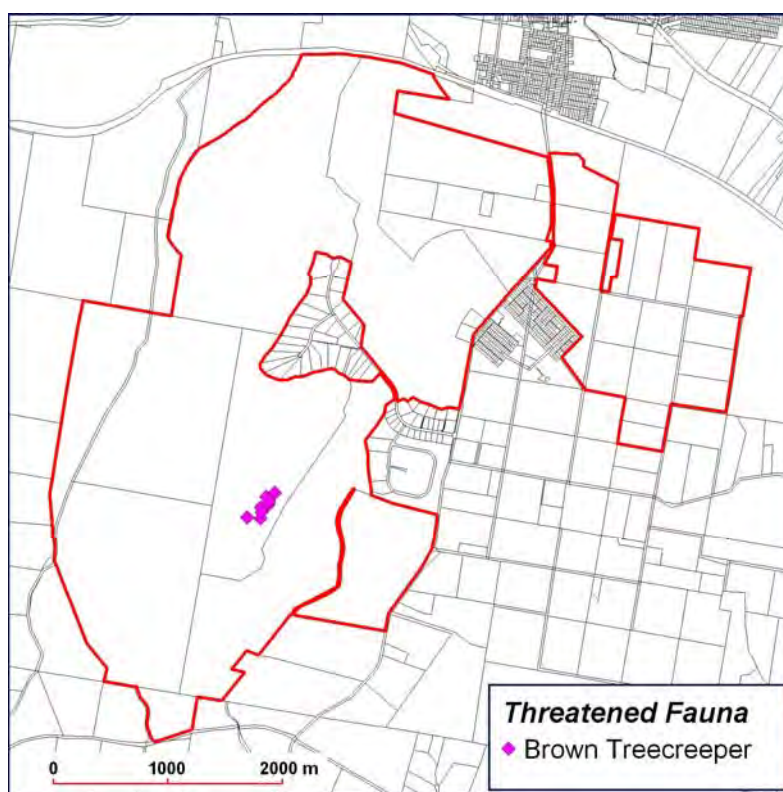
The call of this species is distinctive and conspicuous and although potential habitat for this species appears to be widespread across the site no other individuals were observed during extensive diurnal bird censuses in 2005. No sign of this species could be noted at all during 2007 despite targeted searches.

Survey Methods:

- Extensive diurnal bird census. Previous survey effort shown in Table 2-1.

Modelling (variables): None shown although most likely to occur within Central Hunter Ironbark – Spotted Gum – Grey Box Forest containing higher density of tree hollows.

Map:

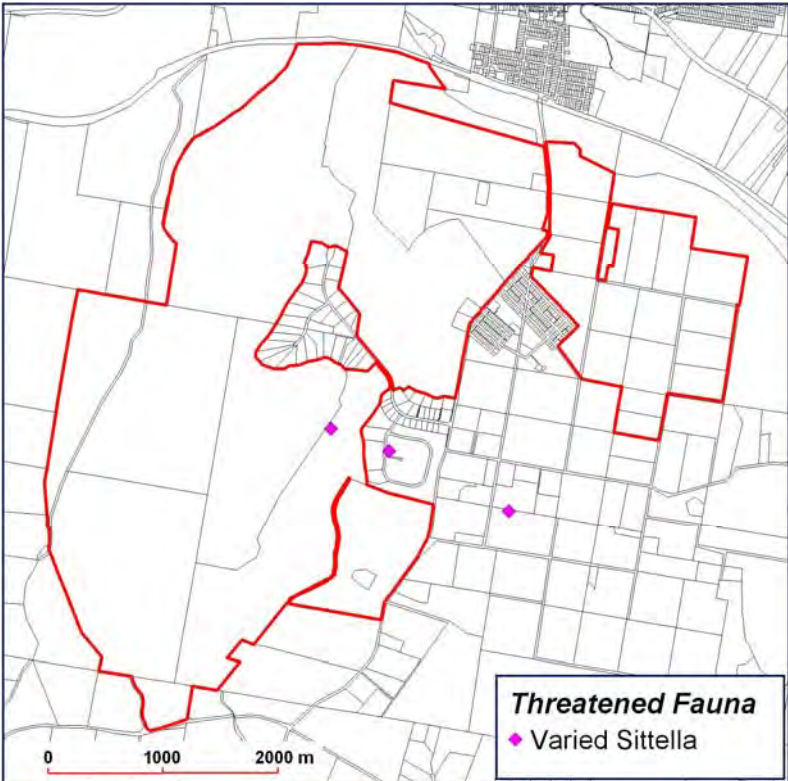


Notes:

- This species is threatened by loss, fragmentation and degradation of its habitat and an inability to persist in areas reduced to less than 300ha in size.

Records / Population within Huntlee: Records of the distribution of this species in the central Lower Hunter Valley are limited, although it is possible that a fragmented population exists within the forest remnants in the Huntlee area.

Daphoenositta chrysoptera Varied Sittella

Status: Vulnerable (TSC Act)	Distribution and Mapping
Open eucalypt forests and woodlands are the preferred habitat, but this species may also be found in mallee, coastal tea-tree scrubs, inland acacia communities, golf courses orchards and scrubby gardens. Feeds on invertebrate larvae and small insects. The nest of <i>D. chrysoptera</i> consists of deep cup of bark which is well camouflaged with spiders web and lichen. They favour the use of tree species for nesting such as Eucalypts, paperbarks, she-oaks and tea-trees. Within the Lower Hunter, Varied Sittellas can be locally common. This species was noted as occurring commonly throughout the study area, however given its only recent listing under the TSC Act, specific records were not obtained during the majority of the surveys.	Survey Methods: - Extensive diurnal bird census, however extensive recording was not undertaken. Previous survey effort shown in Table 2-1. Modelling (variables): None shown although most likely to occur within Central Hunter Ironbark – Spotted Gum – Grey Box Forest. Map: Due to this species being listed under the TSC Act subsequent to surveys, few specific records for this species currently exists. 
Notes: - This species is threatened by loss, fragmentation and degradation of its habitat.	Records / Population within Huntlee: This species was noted as occurring commonly throughout the study area.

Pomatostomus temporalis temporalis **Grey-crowned Babbler**

Status: Vulnerable (TSC Act)

Distribution and Mapping

This species occupies woodlands with tall shrubs, regenerating trees and intact ground cover. It appears unable to persist in cleared and fragmented habitats (although this trend is not apparent within the Hunter Valley). Also threatened by aggressive competitors, such as Noisy Miners and nest-competitors, such as Pied Currawongs and Australian Ravens. It often occurs in family groups and several birds within each group assist with nesting activities.

Grey-crowned Babblers are plentiful at Huntlee, but habitat preferences limit their widespread distribution. Most dreys are found in *Melaleuca decora*, *Allocasuarina luehmannii* or Eucalypts adjacent to stands of these species. In the site's northeast Grey-crowned Babblers also build dreys in stands of *Melaleuca nodosa*, *M. lineariifolia* and in one location *Backhousia myrtifolia*. The size of the stand appears to be linked positively to the size of associated Grey-crowned Babbler colonies. This species does not occur in those areas where *Bursaria spinosa* occurs in high densities, as is the case on the ridges and gullies draining the eastern slopes of Terrace Ridge in the site's southwestern quarter.

Three separate breeding events were recorded during fauna surveys in grids R6, AA13 and P25 and nest building activity / mating was observed in N10.

This species is widely distributed across the Hunter Valley (Birddata 2005) and records exist from Quorrobolong, Ellalong, Mulbring, Pokolbin, HEZ, north of Maitland, the greater Singleton area and at other sites in the North Rothbury vicinity (Atlas of NSW Wildlife 2005 & 2007; HSO 2003; Birddata 2005; HBOC; HSO pers obs.).

Notes:

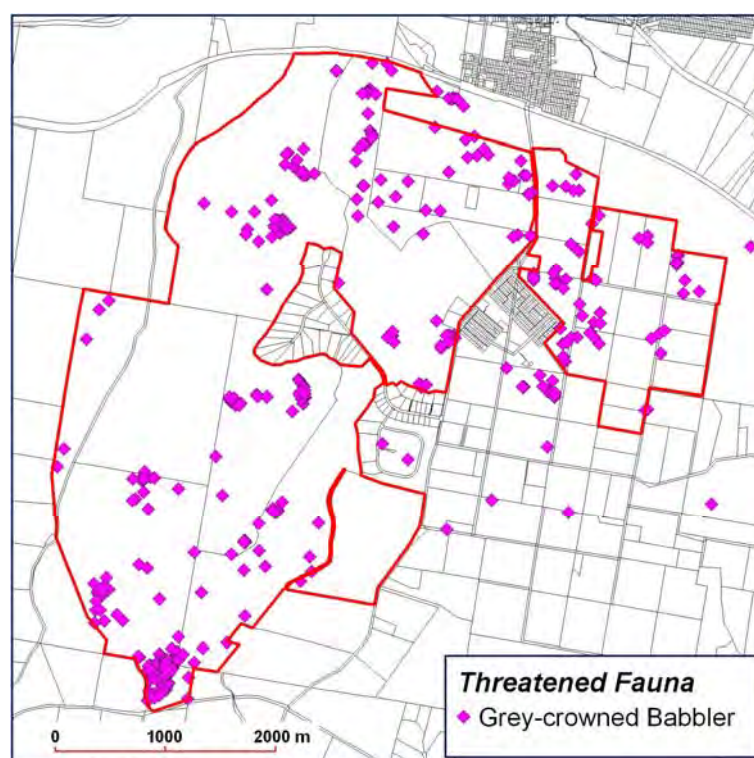
- Species is relatively common in the LGAs surrounding the Huntlee locality.

Survey Methods:

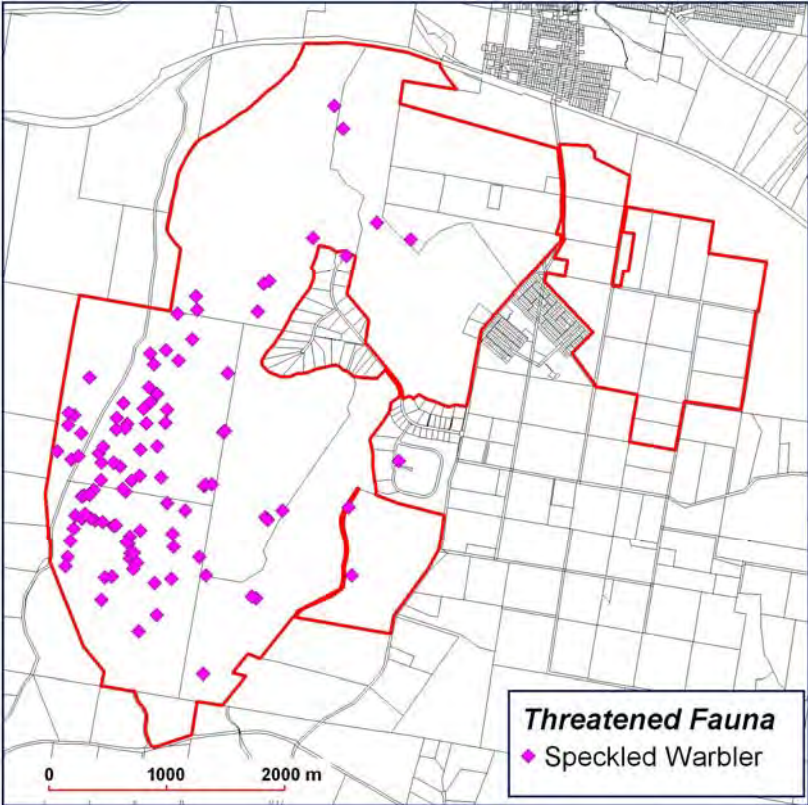
- Extensive diurnal bird census. Previous survey effort shown in Table 2-1.

Modelling (variables): None shown, although mostly associated with mature *Melaleuca* and *Allocasuarina* sp.

Map:



Records / Population within Huntlee: Generally widespread and common across the site, except the Eastern slopes of Terrace Ridge. >20 family groups recorded ranging from 3 to 12 individuals.

<i>Chthonicola sagittata</i> Speckled Warbler	
Status: Vulnerable (TSC Act)	Distribution and Mapping
This species frequents woodland habitats with a diverse ground cover layer and shrubby understorey. It feeds on insects, their larvae and small seeds. Nests are constructed of dried grasses and bark strips and are placed below fallen branches, shrubs or tufts of grass. Speckled Warblers are widespread and relatively common across the western woodlands of Study Area A where there is a well-developed understorey of <i>Bursaria spinosa</i>. In other areas of the site this species is sparse and uncommon. A pair was observed collecting nesting material in grid P6 and due to the sedentary nature of this species many of the pairs encountered on the site would be proximate to their breeding territories. There are also records of Speckled Warblers from the immediate locality outside of the Huntlee Study Area (Birddata 2005). Other sightings of this species have been recorded in Belford & Werakata NP's, Aberdare SF, Quorrobolong, Ellalong, Paxton South, Kurri Kurri, Mulbring and the Surveyors Creek / Buttai area around the northern extreme of the Sugarloaf Range (HSO 2004; Atlas of NSW Wildlife 2005 & 2007; HBOC records).	Survey Methods: - Extensive diurnal bird census. Previous survey effort shown in Table 2.1. Modelling (variables): None shown, although most likely to occur within Central Hunter Ironbark - Spotted Gum – Grey Box Forest with a shrubby understorey. Map: 
Notes: - Requires habitat containing shrubby understorey for shelter / breeding.	Records / Population within Huntlee: Common resident on the eastern slopes of Terrace ridge where stands of <i>Bursaria spinosa</i> remain largely intact. Elsewhere it persists where sizeable stands of shrubby habitat remain.

Petroica boodang **Scarlet Robin**

Status: Vulnerable (TSC Act)

Distribution and Mapping

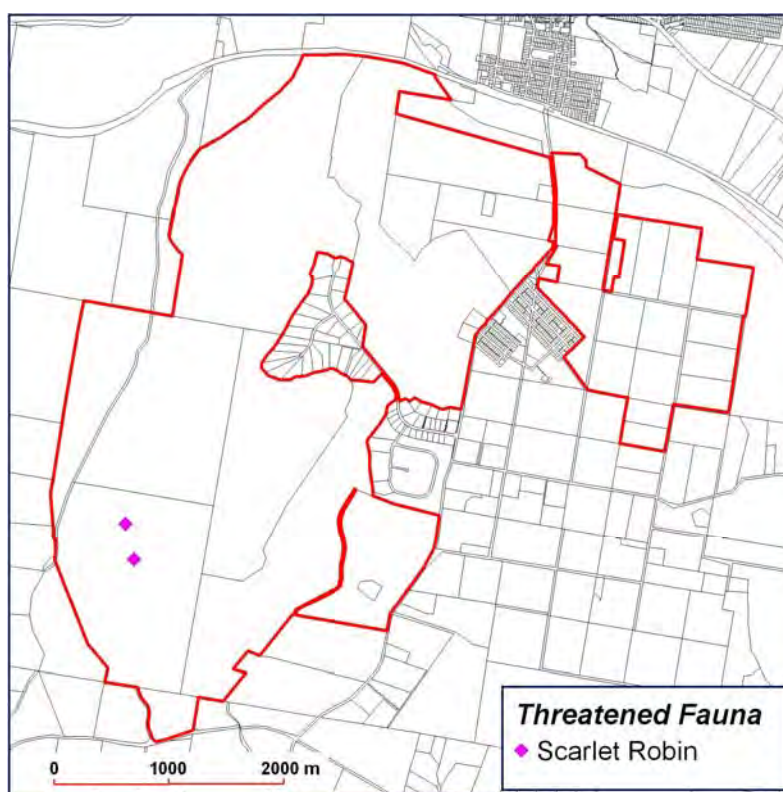
P. boodang occur in single, pairs, in summer, forages in stringybark, other eucalypt woodland, from stumps, low branches (Pizzey 2007). Perches prominently, flying down swiftly to seize prey. Is part migratory in which in autumn/winter moves to more open habitats. Habitat includes foothill forests, woodlands, watercourses, in autumn/winter more open habitats, river red gum woodlands, golf courses, parks, orchards and gardens (Pizzey 2007).

Survey Methods:

- Extensive diurnal bird census. Previous survey effort shown in Table 2.1.

Modelling (variables): None shown.

Map: Due to this species being listed under the TSC Act subsequent to surveys, few specific records for this species currently exists.



Notes:

Records / Population within Huntlee: Common winter visitor around Terrace ridge.

Lathamus discolor **Swift Parrot**

Status: Endangered (TSC Act)
Endangered (EPBC Act)

Distribution and Mapping

Swift Parrots are a nomadic species that forage for blossom and lerps within southeast Eucalypt woodlands and forests on mainland Australia during the austral winter. The population moves to Tasmania during September for the breeding season and returns to the mainland in March and April. Their nomadic habits are largely governed by cyclic distribution of food resources often occurring over several years and as a consequence the birds may not be present in the same mainland sites on an annual basis.

Swift Parrots were observed at a number of locations on Huntlee during the winter of 2005 (flocks up 60-80 individuals). The birds were observed roosting at three locations (Grids H30, M22 and N19) on at least 7 nights through June 2005 (Author *pers. obs.*). Although individual *Corymbia maculata* were flowering on the site from May to August most of the feeding activity observed of the Swift Parrots were limited to lerping in a range of tree species including *C. maculata*, *Eucalyptus crebra* and to lesser extent *E. punctata* (Author *pers. obs.*).

In recent history a number of Swift Parrot sightings have been made in the greater Cessnock area to the south of the Huntlee site, including the HEZ, Aberdare SF and Werakata NP with many sightings made during the winter of 2000 (Atlas of NSW Wildlife 2005 & 2007). Recent Swift Parrot records in the central to Lower Hunter Valley during the winter of 2005 include Singleton Army Base (HBOC), Aberdare SF near Pelton (HSO, *pers. comm.*), Werakata NP to the north of Aberdare (Authors *pers. obs.*) and Fern Bay (HSO, *pers. comm.*).

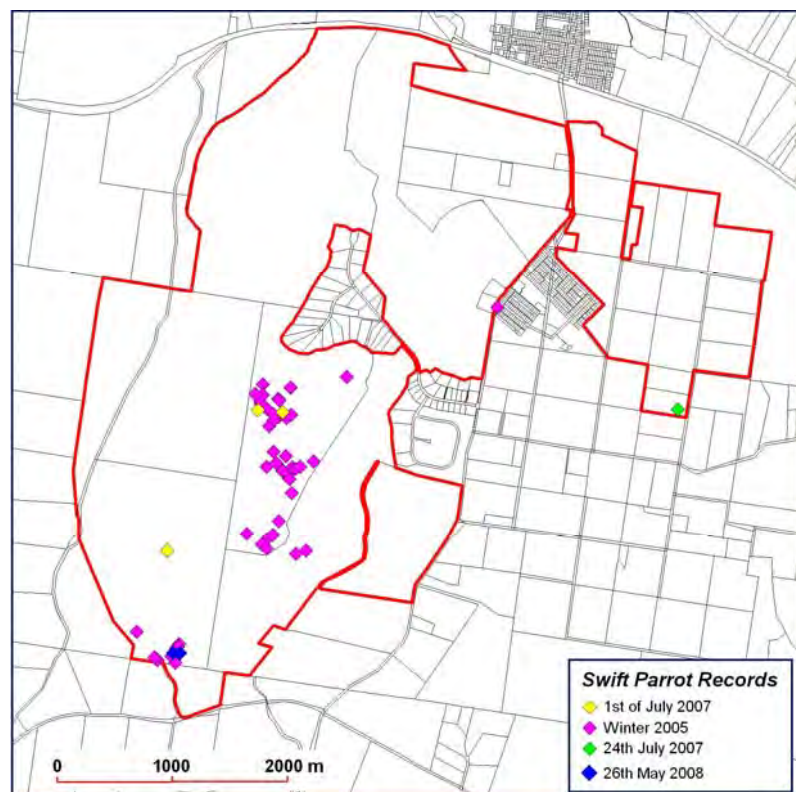
Evidence suggests that the Lower Hunter area has always been utilised by Swift Parrots on a regular basis (Saunders 2002). In the Hunter the prevalence of Spotted Gum on the valley floor and Swamp Mahogany in the coastal belt are important winter food resources for Swift Parrots in this region.

Survey Methods:

- Extensive diurnal bird census, incorporating the winter months of 2005 & 2007. Previous study effort shown in Table 2.1.
- Extensive targeted Swift Parrot searches in Aberdare SF, Werakata NP and bushland remnants in the Ellalong / Quorrobolong area.
- Targeted surveys, including call playback techniques and habitat assessment in Aberdare SF, Werakata NP, the HEZ and bushland remnants in the lower to central Hunter Valley by National Swift Parrot Recovery Officer (Debbie Saunders 2005). Swift Parrot annual surveys ongoing.

Modelling (variables): Distribution of Central Hunter Ironbark - Spotted Gum - Grey Box Forest and Hunter Lowland Redgum Forest.

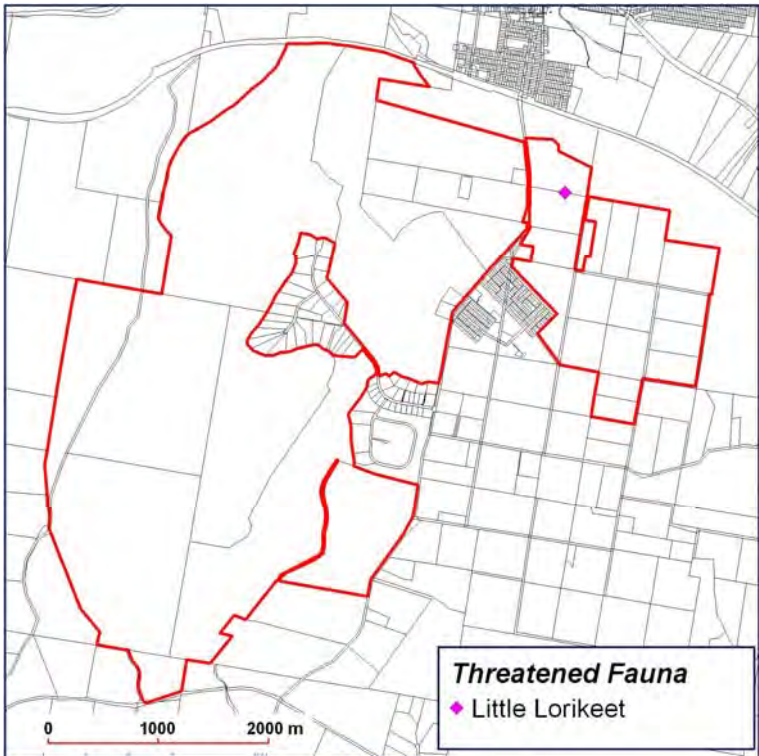
Map:



Notes:

- Total Population < 1000 breeding pairs

Records / Population within Huntlee: Seasonal winter migrant with the potential to use the locality on an annual basis due to the large areas of potential habitat. Recorded in flocks of up 60-80 individuals in 2005. Recent (2007) surveys confirm that use of the Huntlee area (& others) is sporadic in regards to location and numbers of birds.

<i>Glossopsitta pusilla</i> Little Lorikeet	
Status: Vulnerable (TSC Act)	Distribution and Mapping
<i>G. pusilla</i> ranges from about Cooktown in Qld, coastally and to the west of the ranges down to Victoria and occasionally into South Australia. This species is more commonly encountered in near coastal habitats and on the divide. Habitat is mainly dry, open sclerophyll forests and woodlands, usually dominated by Eucalyptus, sometimes in plantations of <i>Eucalyptus cladocalyx</i> (Sugar Gum) (Higgins 1999). <i>G. pusilla</i> can be found in large flocks of hundreds of birds spread out across blossoming eucalypts, such feeding congregations have been recorded within areas such as Werrekata N.P. at Cessnock when <i>Corymbia maculata</i> (Spotted Gum) has abundant flowering periods (authors pers. obs.). <i>G. pusilla</i> can be found feeding with other lorikeets species such as <i>Trichoglossus haematodus</i> (Rainbow Lorikeet), <i>Glossopsitta porphyrocephala</i> (Purple-crowned Lorikeet) and <i>Glossopsitta concinna</i> (Musk Lorikeet). In the Hunter Valley they are often found with flocks of <i>G. concinna</i> (authors pers. obs.). <i>G. pusilla</i> prefers to feed in the upper canopy and rarely comes below the uppermost blossom. Movements of <i>G. pusilla</i> is largely unknown, but the belief is that they follow abundant blossom. Some areas they are sedentary and move within the local area in response to blossom. Nesting of <i>G. pusilla</i> consists of holes, including knotholes, in bend, top or side of limb, usually living or in main trunk of tree, occasionally over water, recorded in <i>Eucalyptus camaldulensis</i> (River Red Gum), <i>Eucalyptus grandis</i> (Flooded Gum) and <i>Casuarina cunninghamiana</i> (River Oak) (Higgins 1999).	Survey Methods: - Extensive diurnal bird census, incorporating the winter months of 2005 & 2007. Previous study effort shown in Table 2.1. Modelling (variables): Distribution of Central Hunter Ironbark - Spotted Gum - Grey Box Forest and Hunter Lowland Redgum Forest. Map: Due to this species being listed under the TSC Act subsequent to surveys, no specific records for this species currently exists. 
Notes:	Records / Population within Huntlee: Use of the Huntlee area (& others) is sporadic in regards to location and numbers of birds. This species was recorded occasionally during Swift Parrot surveys.

Neophema pulchella **Turquoise Parrot**

Status: Vulnerable (TSC Act)

Distribution and Mapping

This species occurs in Eucalypt woodlands and open forests exhibiting a grassy ground cover and a low understorey of shrubs. From either August to December or April to May breeding pairs select small nesting hollows in Eucalypts or dead stags often within a metre of the ground. Their movements tend to be toward woodland habitats during the breeding cycle, followed by dispersal of family groups into more grassy habitats.

Turquoise Parrots were observed three times on the Huntlee site in 2005. The records were confined to the south-western section of the site; two on the eastern slopes of Terrace Ridge and the third record on the west facing hillside to the east of the above habitat. The habitat where the birds were recorded is largely Central Hunter Ironbark – Spotted Gum – Grey Box Forest with a shrubby understorey. The ground cover is largely composed of native herbs and grasses.

Each of the three observations of Turquoise Parrots made on the Huntlee site were made in areas exhibiting only light to moderate disturbance of woodland habitat, which is the habitat of greatest importance to this species. Areas subject to vegetation management operations did not yield any records of this species.

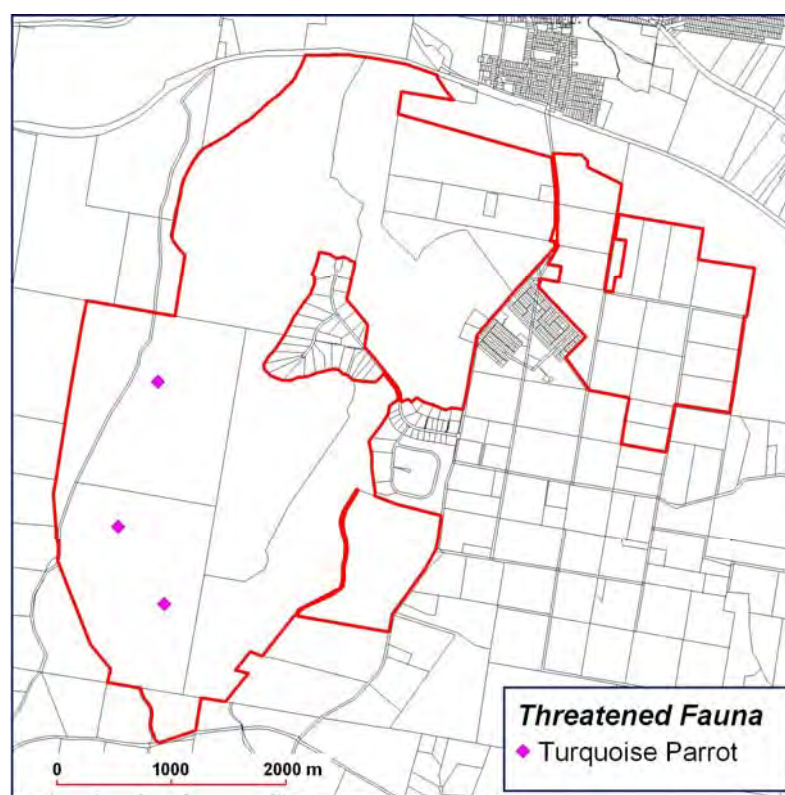
Widely dispersed records exist for Turquoise Parrots in the central Hunter Valley (Atlas of NSW Wildlife 2005; Birddata, 2005) and their sparse status appears to be linked with reductions in woodland and open forest habitats, which they require for breeding.

Survey Methods:

- Extensive diurnal bird census. Previous survey effort shown in Table 2.1.

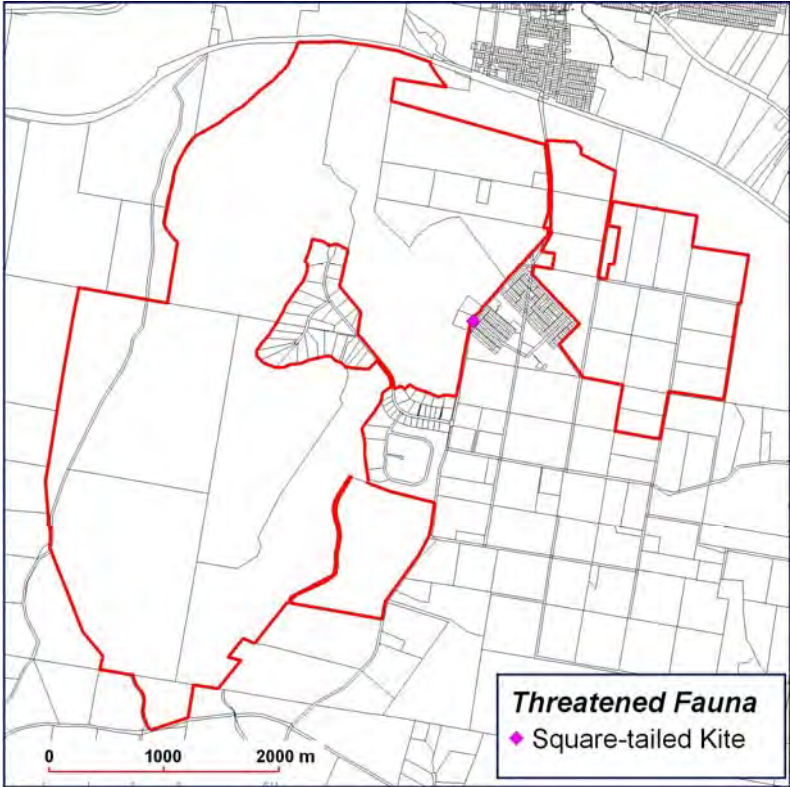
Modelling (variables): None shown, although most likely to occur in Central Hunter Ironbark - Spotted Gum – Grey Box Forest containing a grassy understorey and discontinuous shrub layer.

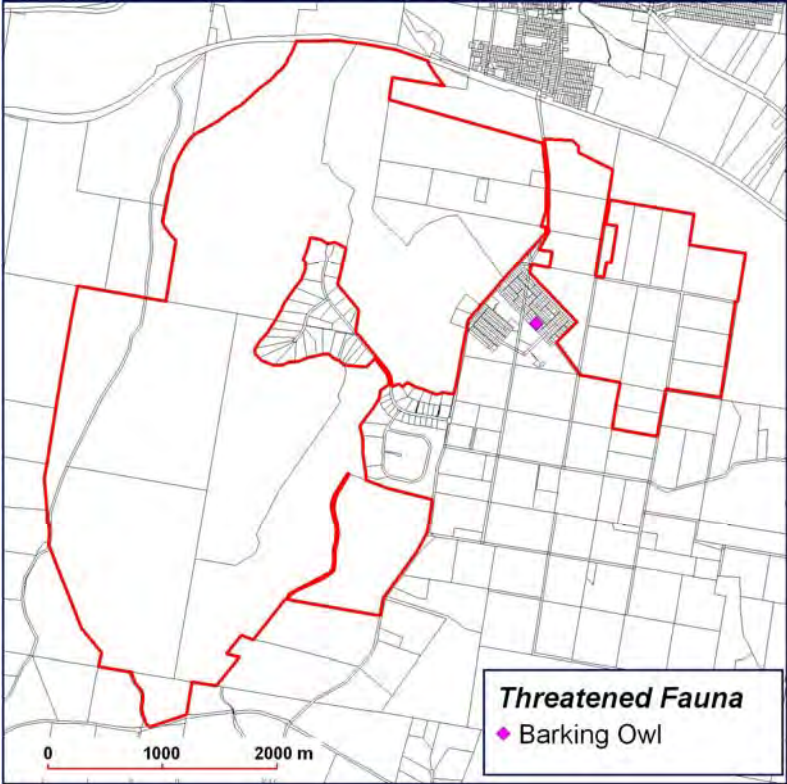
Map:

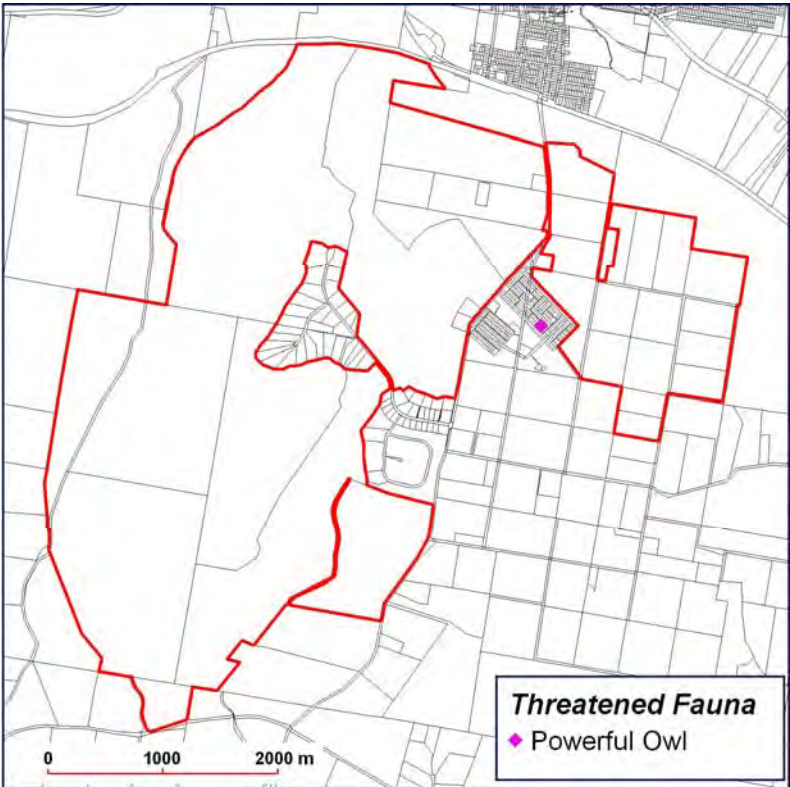


Notes:

Records / Population within Huntlee: Sparsely distributed population that may utilise the site's woodlands and open forest habitats for breeding.

<i>Lophoictinia isura</i> Square-tailed Kite	
Status: Vulnerable (TSC Act)	Distribution and Mapping
This raptor is endemic to Australia and is widespread throughout the mainland (absent from Tasmania). It is recorded mainly in coastal and sub-coastal regions, although it has been observed inland. The species is migratory throughout its range and is a spring-summer breeding migrant to south-eastern, southern and south-western Australia. The Square-tailed Kite inhabits open forests and woodlands, particularly those on fertile soils with abundant passerines. They may also range in nearby open habitats but not into extensive treeless regions. This species is notably absent from alpine regions and small isolated remnant woodlands in large open areas. Within NSW the species has been recorded in a range of forest and woodland communities. The Square-tailed Kite hunts mostly passerines and foliage insects, though it also known to take mammals and lizards. Most prey is taken from the canopy and rarely from shrubs or in the air. Breeding occurs from July to February with an average clutch size of 3 eggs. Nests are built as a platform or bowl of sticks lined with green <i>Eucalyptus</i> leaves in forks or large horizontal branches of <i>Eucalypts</i>, <i>Angophora</i> or <i>Melaleuca</i> trees and may be used in successive years. Except when breeding this species tends to be a solitary bird, usually seen hunting alone high within, or just above the tree canopy in coastal or sub-coastal rainforest, forest or woodland. Nests have been reported in <i>Eucalyptus</i> spp., <i>Angophora</i> spp. and native pine forests. Prey taken has included fledging birds, insects, rabbits and lizards.	Survey Methods: - Extensive diurnal bird census. Previous survey effort shown in Table 2.1. Map: Actual occurrence - DECC Wildlife Atlas 2007 (potential further records within the wider Huntlee Study Area). 
Notes:	Records / Population within Huntlee: Irregular visitor?

<i>Ninox connivens</i> Barking Owl	
Status: Vulnerable (TSC Act)	Distribution and Mapping
Barking Owls inhabit open forest, woodlands and swamp woodlands particularly where wooded areas adjoin cleared areas. In inland areas their distribution is often associated with watercourses where the dense vegetation they prefer to roost in occurs. They require mature hollow bearing trees for breeding and take a range of prey including arboreal and terrestrial mammal species and other bird species including waterbirds. There is one record (Atlas of NSW Wildlife 2005) of a Barking Owl in North Rothbury from 1977, but this species was not recorded during nocturnal bird census or extensive diurnal bird censuses within the Huntlee study area. Suitable habitat occurs on the Huntlee site, for this species, due to the widespread distribution of open forest and woodlands adjacent to open grassland areas. Roosting habitat in the form of dense vegetation occurs intermittently along Black Creek and its tributaries and the site represents habitat areas of sufficient size to constitute a significant part of the territories of more than one resident pair. A limited number of records from the Hunter Region exist from Watagan NP near Quorrobolong, the forests between East Maitland and Black Hill, Ellalong and Watagan SF (Atlas of NSW Wildlife 2005 Birddata 2005). HBOC list the species as rare within the Hunter Valley with regional breeding records existing from the past.	Survey Methods: - Hollow bearing trees (potential nests for the species) detailed within Study Area A. - Nocturnal bird census. Previous survey effort shown in Table 2.1. Modelling (variables): Although not shown, potential habitat within the Study Area A may be based on the distribution of hollows and interfaces between wooded and cleared lands. Map: 
Notes: - Potential roosting / breeding and hunting habitat occurs over much of Huntlee.	Records / Population within Huntlee: Rare visitor?

<i>Ninox strenua</i> Powerful Owl	
Status: Vulnerable (TSC Act)	Distribution and Mapping
Powerful Owls frequent a range of wooded habitats encompassing wet Eucalypt forests with rainforest understoreys to dry forests and woodlands. It roosts in the canopy of dense forest trees or within other dense vegetation often along creeklines. This species requires mature forests exhibiting large hollows for nesting and ample shelter for arboreal mammals, which are its favoured prey. There is one record (Atlas of NSW Wildlife 2005) for Powerful Owls in North Rothbury from 1977, but this species was not recorded on the Huntlee site during nocturnal bird census or extensive flora and fauna surveys. Other regional records exist from east and northeast of Singleton (Birdata 2005), within the HEZ (HSO 2004), Heddon Greta, Pokolbin SF, Werakata NP and, more distantly, Heaton SF (Atlas of NSW Wildlife 2005 & 2007). The relatively high density of mature hollow bearing trees, in some areas of the Huntlee site, provide breeding hollows suitable for breeding and potential roosting sites exhibiting dense vegetation exist intermittently along Black Creek and its tributaries. Despite these habitat components much of the southwestern forest portions of the site exhibit a sustained history of timber getting, which has reduced the densities of mature hollow bearing trees in these areas. As a consequence the numbers of arboreal mammals appear to be low, which would reduce the forest's suitability for hunting Powerful Owls. This species is widely distributed in the Hunter Region, having been recorded from a range of habitats throughout the area (HBOC records; Birdata 2005; Atlas of NSW Wildlife data 2005 & 2007).	Survey Methods: - Hollow bearing trees (potential roosts / nests for the species and its arboreal prey) detailed throughout the Huntlee site. - Nocturnal bird census. Previous survey effort shown in Table 2.1. Modelling (variables): Although not shown, potential habitat within the Huntlee site is based on distribution and density of hollows. Map: 
Notes:	Records / Population within Huntlee: Irregular visitor / study area represents portion of larger territory?

Melithreptus gularis gularis **Black-chinned Honeyeater**

Status: Vulnerable (TSC Act)

Distribution and Mapping

This species occurs in dry Eucalypt open forest and woodland within an annual rainfall range of 400-700 mm, particularly within wooded habitats exhibiting Ironbark / Box associations. They favour areas of habitat over 200ha in size and feed predominantly upon nectar, insects and lerp.

This species was recorded within the Sweetwater study area during flora surveys (Driscoll *pers. comm.*) and although extensive diurnal bird censuses, incorporating winter flowering Eucalypts, were carried out, no other observations of this species were made during the winter of 2005 or 2007. Many of the Hunter Valley records for this species occur within the areas adjacent to the valley's southern boundary, but large areas of the Huntlee site are covered by Ironbark / Box associations, which are favoured by this species.

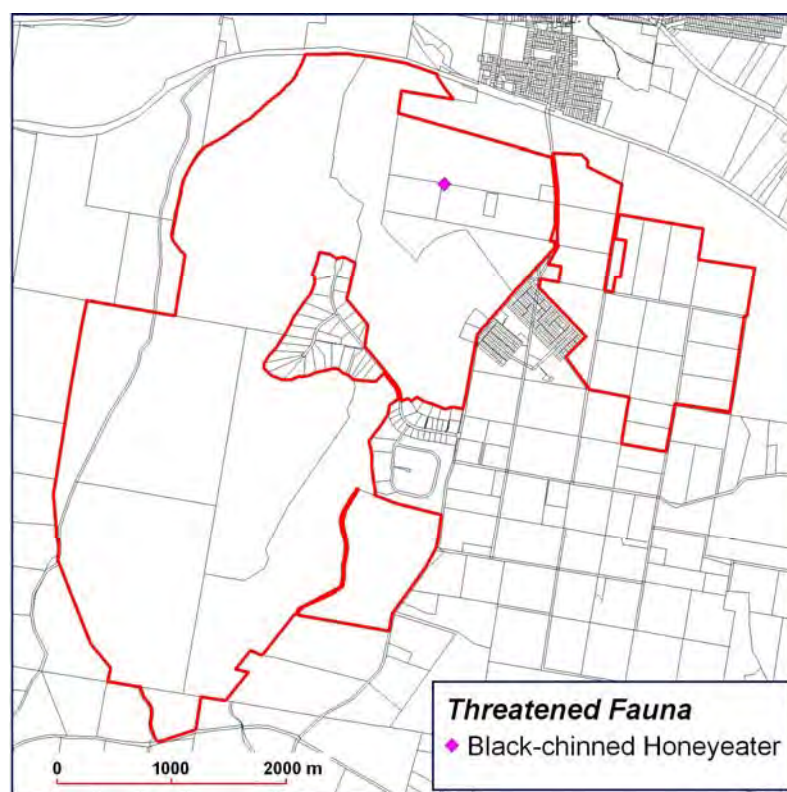
This species has been recorded from the HEZ, Ellalong, Aberdare SF and Werakata NP (Authors *pers obs.*; Atlas of NSW Wildlife 2005 & 2007). There is also a breeding record from Buchanan to the north of the Sugarloaf Range (HBOC records). Large numbers of this species were recorded in localised areas in the Cessnock area during the winter of 2005 (HSO, *pers comm.*) and may utilise potential habitat at the Huntlee site under different variations in the distribution and sequence of flowering trees.

Survey Methods:

- Extensive diurnal bird census. Previous survey effort shown in Table 2.1.

Modelling (variables): Although not shown, most likely to occur within Central Hunter Ironbark - Spotted Gum – Grey Box Forest.

Map:



Notes:

- Possible nomadic habits within the Hunter in response to variations in blossom distribution.

Records / Population within Huntlee: Uncommon or seasonal resident / visitor

Xanthomyza phrygia Regent Honeyeater

Status: Endangered (TSC Act)
Endangered (EPBC Act)

Distribution and Mapping

This species occurs in drier open forest and woodland containing its preferred foraging tree species. Within the region, mostly recorded in box-ironbark Eucalypt associations along creek flats, river valleys and foothills, but stands of coastal Swamp Mahogany in the Lower Hunter are important at times when blossom at other sites fail.

There is one record of a Regent Honeyeater in North Rothbury from 1977 and another record exists within 10km of Huntlee (Atlas of NSW Wildlife 2005). This species was not recorded on the Huntlee site during an extensive diurnal bird census through the winter of 2005 or 2007.

Potential feed species are widespread across the Huntlee site within Central Hunter Ironbark – Spotted Gum – Grey Box Forest, which includes significant areas of *Eucalyptus tereticornis*. The open forests and woodlands on the site are likely to represent potential food resources for Regent Honeyeaters during cyclic (albeit irregular) seasonal blossoming events.

Within the region there are records from the HEZ (Atlas of NSW Wildlife data; Authors pers obs.), Aberdare SF (HSO pers obs.; Birdata 2005), Quorrobolong and further a field at Buttaba, Morisset and Wyee Point (Authors pers obs.).

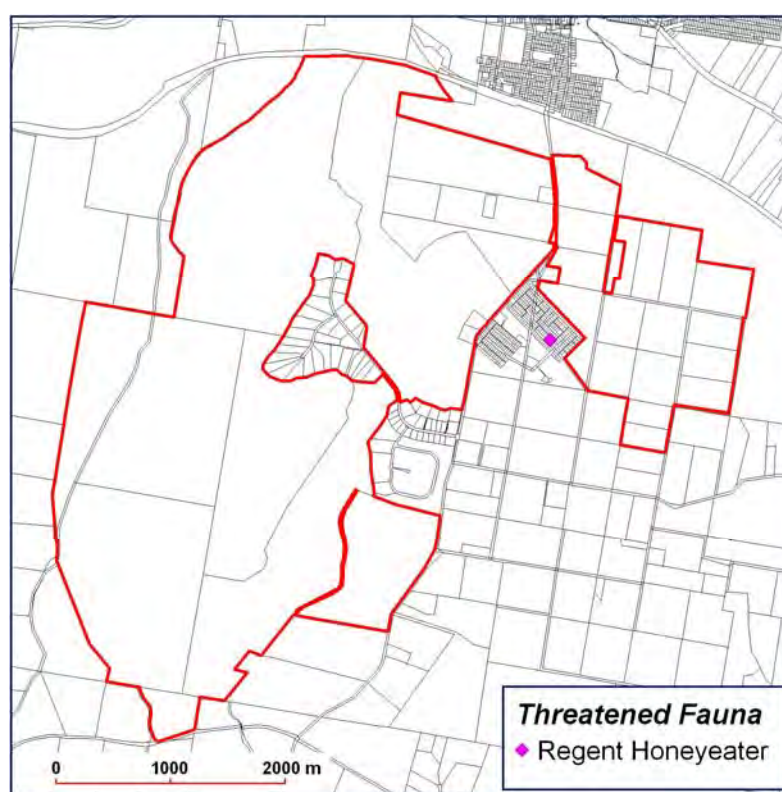
Regularly (although spasmodically) reported in the Hunter Valley during winter months in areas of locally blossoming Eucalypt species during that period, with most records from areas adjacent to the valley's southern extremity and coastal swamp forest in the Lower Hunter and Lake Macquarie area.

Survey Methods:

- Extensive diurnal bird census throughout the winter months. Previous survey effort shown in Table 2.1.

Modelling (variables): Extent of habitat based on the distribution of Central Hunter Ironbark – Spotted Gum – Grey Box Forest and Hunter Lowland Redgum Forest.

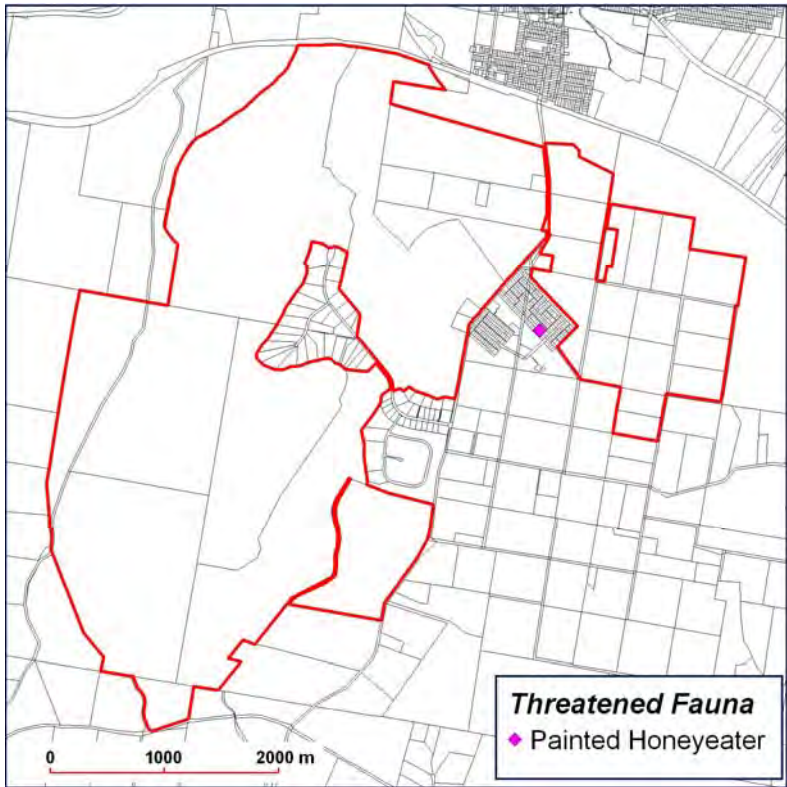
Map:



Notes:

- Absence of Regent Honeyeaters from potential habitat for seemingly long periods does not necessarily reduce the significance of those areas, due to the spasmodic and irregular distribution of flowering Eucalypts and the dependence of this species on continuous supplies of blossom.

Records / Population within Huntlee: Likely irregular visitor.

<i>Grantiella picta</i> Painted Honeyeater	
Status: Vulnerable (TSC Act)	Distribution and Mapping
The Painted Honeyeater is a nomadic species mostly frequenting the western slopes of the Great Dividing Range. It is found across a range of habitats including Boree, Brigalow, Box / Gum woodlands and Box / Ironbark forests that contain its favoured food resource, mistletoe berries. Insects and the nectar of Eucalypts are a smaller component of its diet and it builds a frail cup shaped nest in the drooping branches of woodland trees from spring to autumn. One historical record exists at North Rothbury from 1977 and records of this species elsewhere in the central to lower Hunter Valley are rare. HBOC have recorded this species at Thornton in 1993 and widely spaced records exist from Martindale, (South of Denman 2001 & 2003), Quorrobolong, Broke, Jerry's Plains and White Box camp (HBOC; Atlas of NSW Wildlife data). The Hunter region records for this species are largely western and southerly in distribution and so the North Rothbury record from 1977 is likely to be accidental.	Survey Methods: - Extensive diurnal bird census throughout the winter months. Previous survey effort shown in Table 2.1. Modelling (variables): None shown but may occur across the site where <i>Amyema</i> sp. of mistletoe exist. Map: 
Notes: - A nomadic species that moves widely in response to the availability of fruiting mistletoe.	Records / Population within Huntlee: Probable aberrant record.

Aquila morphnoides

Little Eagle

Status: Vulnerable (TSC Act)

H. morphnoides is a solitary raptor which occurs in woodland and also open habitat, rarely found around dense forest.

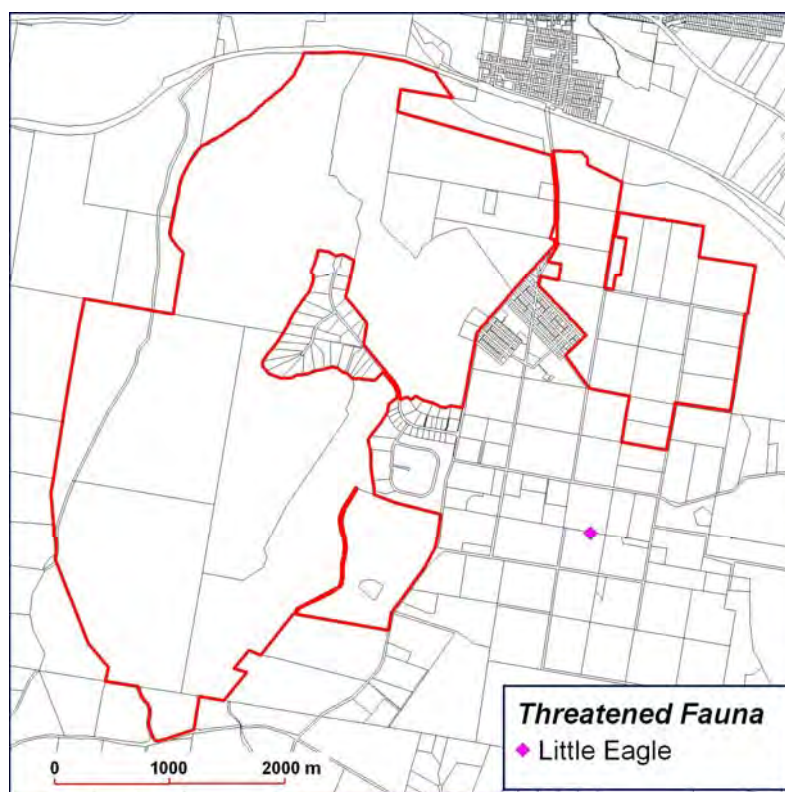
Can be found across most of Australia, but more commonly found near coastal to inland regions in NSW and Victoria. This species is part-migratory to nomadic and dispersive in some areas. Characteristic wind hanging hunting attitude, wings held slightly forward, alulae projected, tail fanned, may drop several stages in this posture, also make vertical stoops, with wings folded, talons stretched forward in final stage of attack (Marchant and Higgins 1993). Display flight also distinctive, series of aerial undulations with or without wing-beats on upswept wings, in light morph, pale belly and underwing flash conspicuously in sunlight, whistling call given loudly and often (Marchant and Higgins 1993).

Distribution and Mapping

Survey Methods:

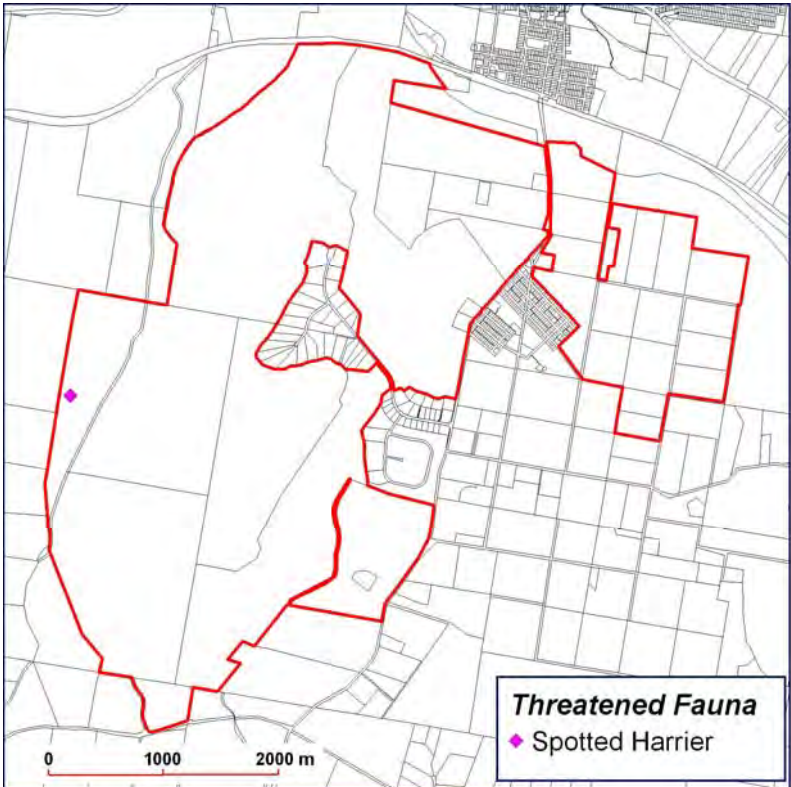
- Extensive diurnal bird census. Previous survey effort shown in Table 2.1.

Map: Actual occurrence - DECC Wildlife Atlas 2010.



Notes:

Records / Population within Huntlee: Irregular visitor?

<i>Circus assimilis</i> Spotted Harrier	
Status: Vulnerable (TSC Act)	Distribution and Mapping
<i>C. assimilis</i> ranges across all of Australia except for Tasmania. Most commonly found inland to near coastal eastern and south eastern Australia. During times of rodent and quail irruptions they will disperse to areas not commonly found. Found in open and wooded country in which it hunts over low vegetation or woodland where hunting at low levels is possible due to vegetation breaks. Usually silent, breeding birds utter piercing squeaks and rapid chatter (Marchant and Higgins 1993). Nest in trees in open remnant woodland, in agricultural areas, often near ripening crop used for hunting (Marchant and Higgins 1993).	Survey Methods: - Extensive diurnal bird census. Previous survey effort shown in Table 2.1. Map: 
Notes:	Records / Population within Huntlee: Irregular visitor?

Petaurus norfolcensis **Squirrel Glider**

Status: Vulnerable (TSC Act)

Distribution and Mapping

Squirrel Gliders occur in Eucalypt forests and woodlands that contain hollow bearing trees for nesting sites. Winter-flowering trees and shrubs constitute an important food resource, which is another important habitat requirement for this species. This species is communal in its social habits and a family group usually roosts together in a bowl-shaped nest lined with leaves.

There have been a number of records of this species within the Huntlee study area in recent times (Atlas of NSW Wildlife data; Conacher Travers 2001) and one individual was observed during nocturnal fauna surveys by RPS at the southern end of the western sector's central ridge. The remains of an individual were found within the study area during extensive flora and fauna surveys (Authors *pers obs.*).

A number of recent records (last 5 years) exist locally, with seven of those records occurring within 5km of the study area (Atlas of NSW Wildlife 2005 & 2007).

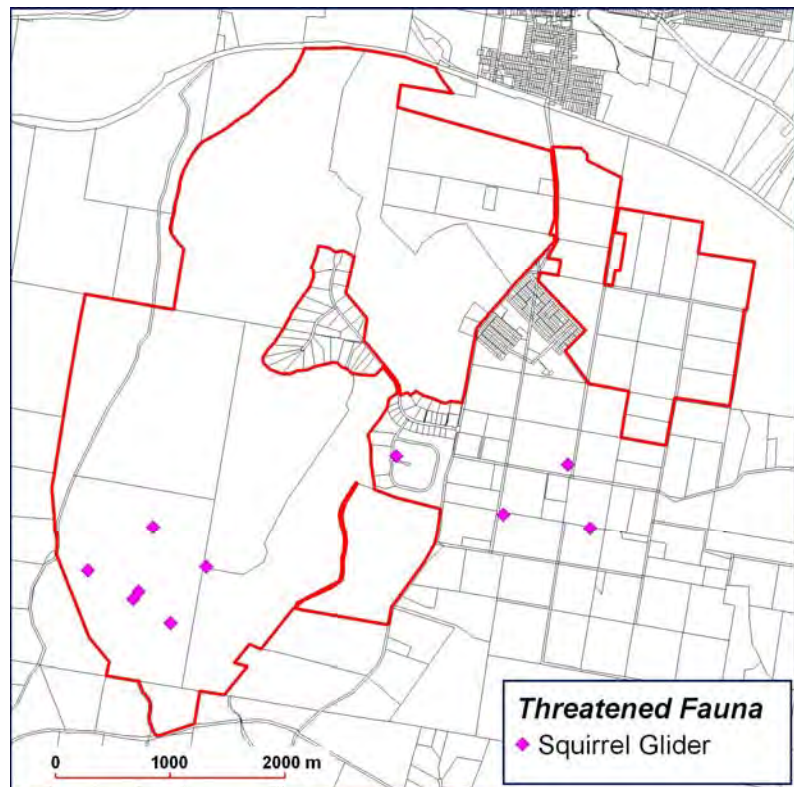
Previous and recent records of this species within fauna surveys infers that a population exhibiting low densities is extant within the study area where hollow-bearing trees offer roosting opportunities.

Survey Methods:

- Hollow bearing trees (potential nesting sites for the species) detailed within the Huntlee study area.
- Arboreal mammal surveys. Previous survey effort shown in Table 2.1.

Modelling (variables): Although not shown, most likely to occur within Central Hunter – Ironbark – Spotted Gum - Grey Box Forest with higher densities of hollow-bearing trees and understorey nectar producing plants.

Map:



Notes:

-The Squirrel Glider is widespread in the Lower Hunter and Central Coast, with populations known from all LGA's including Lake Macquarie, Wyong, Gosford, Port Stephens, Newcastle, Maitland, Singleton and Cessnock (Murray *et al* 2002; Atlas of NSW Wildlife 2005 & 2007).

Records / Population within Huntlee: Uncommon although widely dispersed resident.

Phascolarctos cinereus

Koala

Status: Vulnerable (TSC Act)

Distribution and Mapping

Phascolarctos cinereus (Koala) occurs along the east coast of Australia and extends into Woodland, Mulga and River Red Gum forests west of the Great Dividing Range. The range of the Koala covers all such suitable areas of NSW. In drier forested areas, Koalas are generally observed as individuals in low densities. They are more abundant in coastal woodland and in open forest, where they have been found in densities as high as ten individuals per hectare. They are rare or absent in wet forests in the southern part of their range above 600 m which may be due more to distribution of Eucalypt species than climate, as the Koala is limited to areas where there are acceptable food trees.

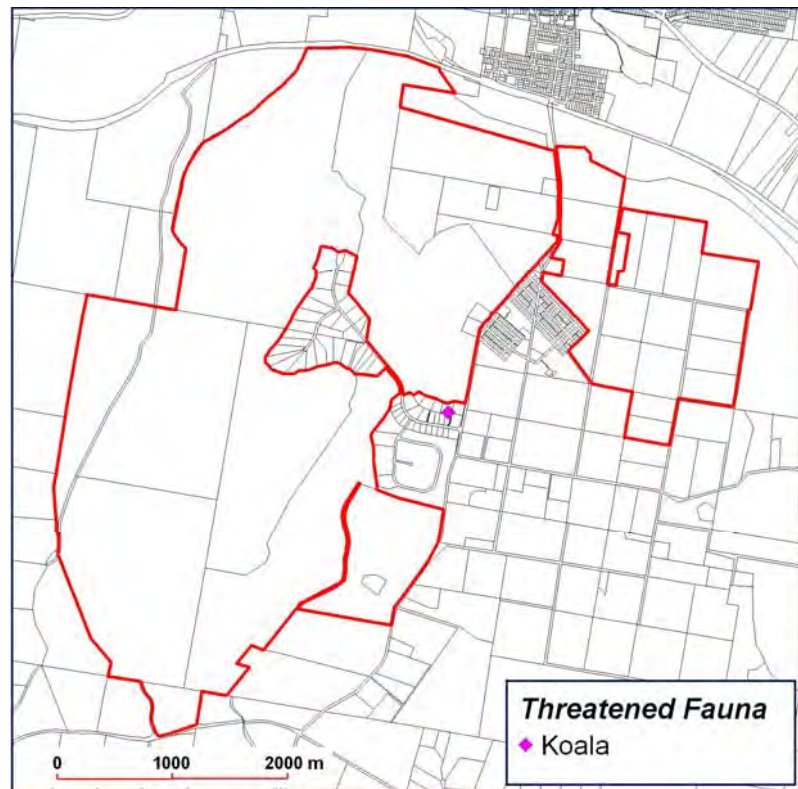
The diet is generally restricted to that of Eucalypt leaves. On occasion, non-Eucalypt foliage is eaten. The foliage of *Eucalyptus camaldulensis* (River Red Gum), *E. microcorys* (Tallowwood), *E. tereticornis* (Forest Red Gum), *E. punctata* (Grey Gum), *E. viminalis* (Ribbon Gum) and *E. robusta* (Swamp Mahogany) are some of the preferred Eucalypt species.

Survey Methods:

Opportunistic sightings during diurnal and nocturnal surveys.

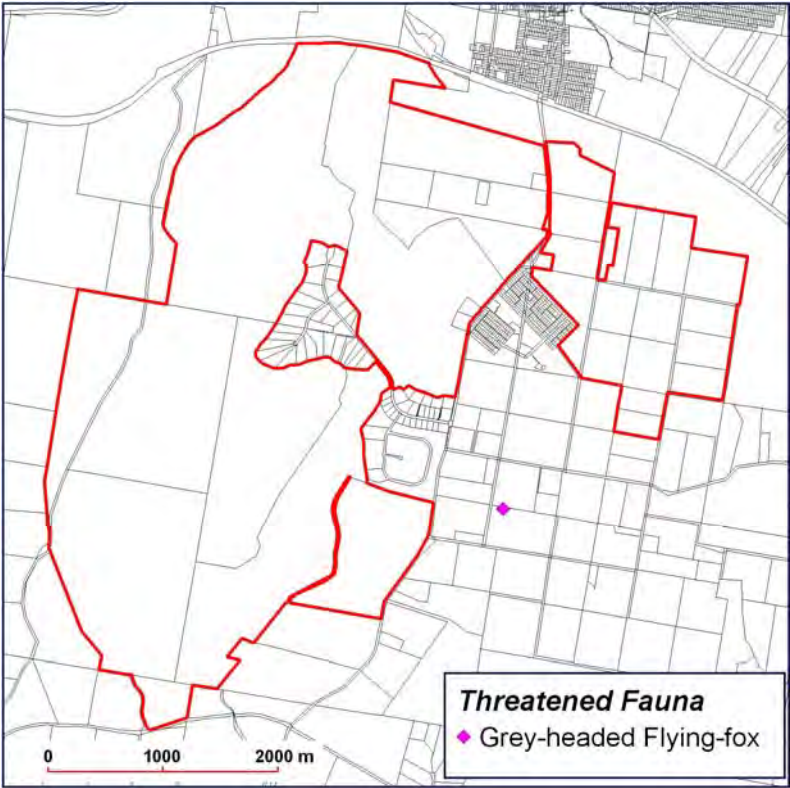
Modelling (variables): None shown.

Map:

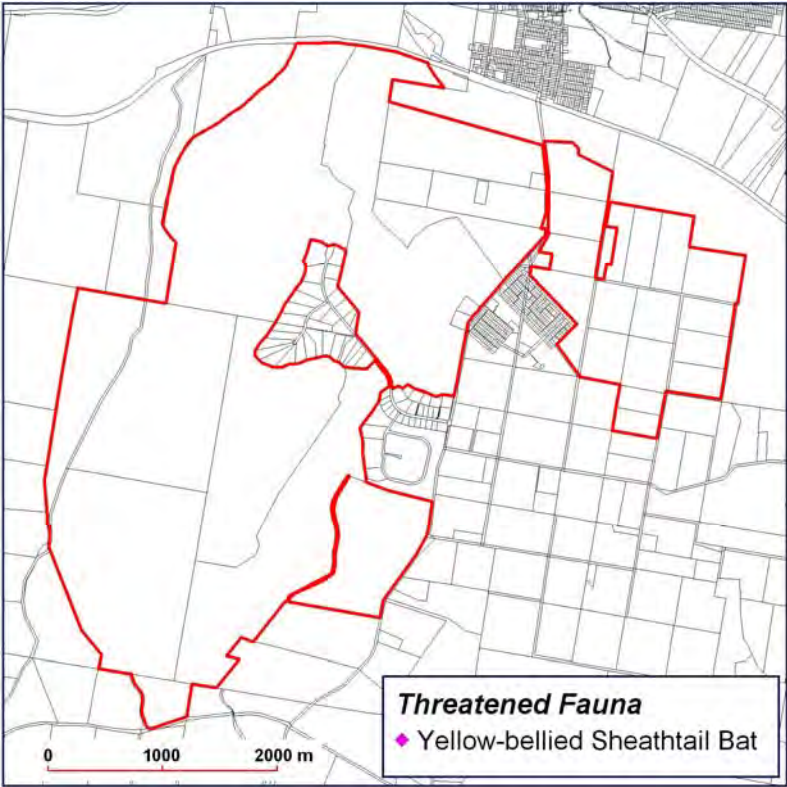


Notes:

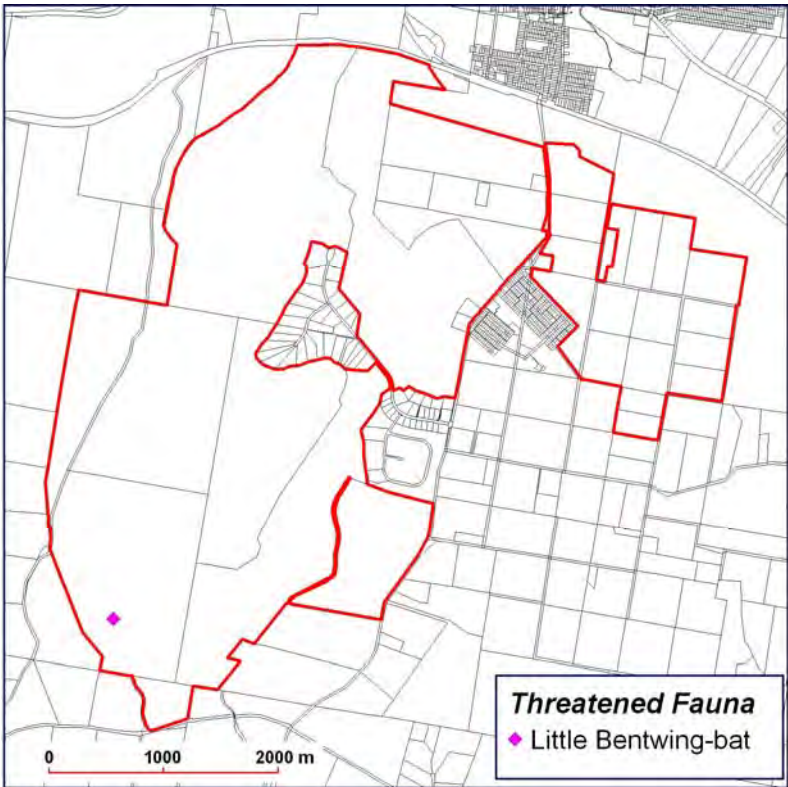
Records / Population within Huntlee: Uncommon.

<i>Pteropus poliocephalus</i> Grey-headed Flying-fox	
Status: Vulnerable (TSC Act 1995)	Distribution and Mapping
Grey-headed Flying Foxes are an extremely mobile species with a nomadic habit. They congregate in large camps in summer and feed on Eucalypt blossom, native fruits from a variety of tree species, mangroves and orchard fruits. They have a nightly feeding range of 20 to 50 km from camps. In winter the adults migrate up to 750km from summer camps (Churchill 1998). Protection of communal camps is of prime importance for the conservation of this species in NSW. Several camps are known from the wider locality including Singleton (20km to the west) and near Millfield (20km to the south). There is one record (Atlas of NSW Wildlife 2005) of this species in the North Rothbury locality from 2004, but this species was not recorded during nocturnal mammal surveys within the Huntlee study area. Suitable habitat occurs on the Huntlee site, for this species, due to the widespread distribution of open forest and woodlands containing nectar-producing trees species. A significant number of records occur from across the Hunter Region and the greater Cessnock area including Aberdare SF, Werakata NP and Pokolbin SF (Atlas of NSW Wildlife 2005 & 2007). Records also exist from the Singleton and Maitland LGAs.	Survey Methods: - Nectar-producing trees (potential foraging resources for the species) are widespread across the Huntlee site. - Nocturnal mammal census. Previous survey effort shown in Table 2-1. Modelling (variables): Although not shown, potential habitat within the Huntlee site is based on the distribution of nectar-producing plant species, which occur widely over the Huntlee study area. Map: 
Notes: - Potential seasonal foraging habitat occurs over much of the Huntlee site. - No suitable camp sites within Huntlee.	Records / Population within Huntlee: Irregular visitor.

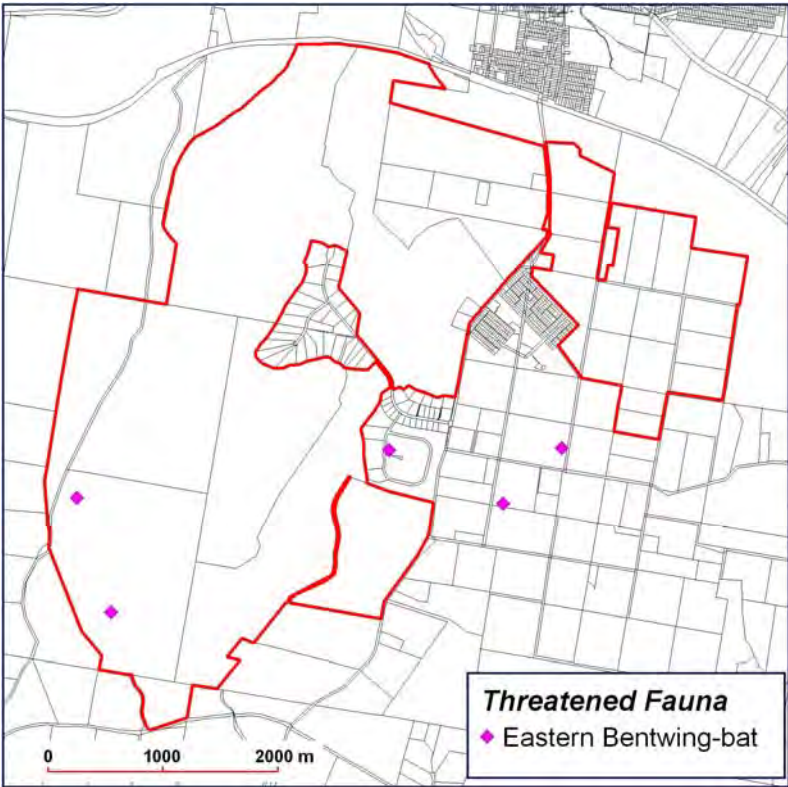
Saccolaimus flaviventris **Yellow-bellied Sheathtail Bat**

Status: Vulnerable (TSC Act) A northern and eastern Australian species, <i>S. flaviventris</i> inhabits most habitats including wooded and open habitats in low densities. It is generally encountered singly, but numbers of individuals have been known to share tree hollow roosting sites. This species is also known to utilise animal burrows for roosting in those areas devoid of trees. There is evidence to suggest that in the southern section of its range there are seasonal north/south movements by this species in response to cool southern winters. This species was recorded at the southern end of the site's central ridge where there are higher numbers of potential roosting hollows available than most other areas of the site. Most records of this species occur further east in the Lower Hunter and in more coastal areas on the central coast (Atlas of NSW Wildlife data 2005) although the frequency of records is not high. The forests and woodlands of Huntlee offer widespread hunting and roosting opportunities for this apparently wide ranging species.	Distribution and Mapping Survey Methods: - Hollow bearing trees (potential roost sites for the species) within the Huntlee study area. - Targeted bat surveys. Previous survey effort shown in Table 2-1. Modelling (variables): Although not shown, potential roosting habitat within the Huntlee study area is based on density of hollows (see Table 3-4). Potential foraging and roosting habitat throughout. Map: 
Notes: - This species is by and large widely distributed, which may account for the relatively low frequency of central Hunter Valley records.	Records / Population within Huntlee: Uncommon visitor?

Miniopterus australis **Little Bentwing-bat**

Status: Vulnerable (TSC Act)	Distribution and Mapping
This species inhabits a wide range of wooded habitats from tropical rainforest through to dry sclerophyll forest occurring along the coastal plains and adjacent ranges from Cape York to the central coast of NSW. It is a sub-canopy hunter with a preference for well-timbered areas but it is also known to hunt in clearings adjacent to forests. It roosts within caves, culverts or similar structures. This species has been recorded within the Huntlee study area during previous fauna surveys (Conacher Travers 2002-2004). This species prefers to roost in caves, horizontal mines and culverts etc. Such habitat is not known to exist within the Huntlee study area (but is possible given past mining operations). In the absence of preferred roost sites, local populations of <i>M. australis</i> may be dependent upon tree hollows for roosting habitat (G. Hoyer pers comm.). Potential supplementary roosting habitat (in the form of tree hollows) exists commonly across the Huntlee study area. The lack of preferred roosting habitat in the Huntlee locality is likely to limit the area's potential to support local populations of this species on a continuous basis. Notwithstanding, tree hollows have been included within habitat assessments as a potential supplementary roosting resource for this species. This species is widespread throughout the coastal and sub-coastal district of the Hunter Valley.	Survey Methods: - Targeted bat surveys. Previous effort shown in Table 2-1. - Hollow bearing trees (potential supplementary roost sites) for the species detailed within the Huntlee study area. Modelling (variables): Although not shown, potential roosting habitat within the Huntlee study area is based on the distribution and density of hollow bearing trees. Potential foraging habitat exists throughout the wooded areas of the site. Map: 
Notes:	Records / Population within Huntlee: Uncommon resident /dispersive nomad?

Miniopterus schreibersii oceanensis **Eastern Bentwing-bat**

Status: Vulnerable (TSC Act)	Distribution and Mapping
This species occurs across the tropical north and down the east coast of Australia where it hunts above the canopy of forested habitats for moths and other flying insects. It uses caves, culverts, stormwater drains and other man-made structures for roosting. This species has been recorded a number of times within the Huntlee study area (Conacher Travers 2002-2004; Atlas of NSW Wildlife data), suggesting that there is a local population that uses the site's forests and woodlands as a hunting area. Man made structures in the Huntlee locality are likely to provide this species with potential roosting habitat, as it does not use tree hollows in lieu of its favoured roosting habitat, which contrasts with the habits of <i>M. australis</i>. Despite the scarcity of recorded roosting sites in the Hunter Region this species is widespread throughout the valley.	Survey Methods: - Targeted bat surveys. Previous survey effort shown in Table 2-1. Modelling (variables): None undertaken. Potential foraging habitat throughout. Map: 
Notes:	Records / Population within Huntlee: Common resident / dispersive nomad?

Mormopterus norfolkensis **East-coast Freetail-bat**

Status: Vulnerable (TSC Act)

Distribution and Mapping

An east coast species, *M. norfolkensis* inhabits open forests and woodlands in NSW and southeast Queensland where it is thought to forage for insects. Open timbered habitats and the interfaces between wooded and cleared habitats are suspected to represent important habitat for this species. Individuals have also been recorded flying low over aquatic habitats and dams and creeks within and adjacent to forested habitats may constitute foraging opportunities for this species.

This species was recorded during targeted bat surveys in the southern section of the western portion of Study Area A.

There have been a number of recent records of this species within the Huntlee site and to the south of the study area (Conacher Travers 2002-2004, Atlas of NSW Wildlife data). *M. norfolkensis* roosts in tree hollows, but it has also been recorded roosting under bark, power pole caps and within huts.

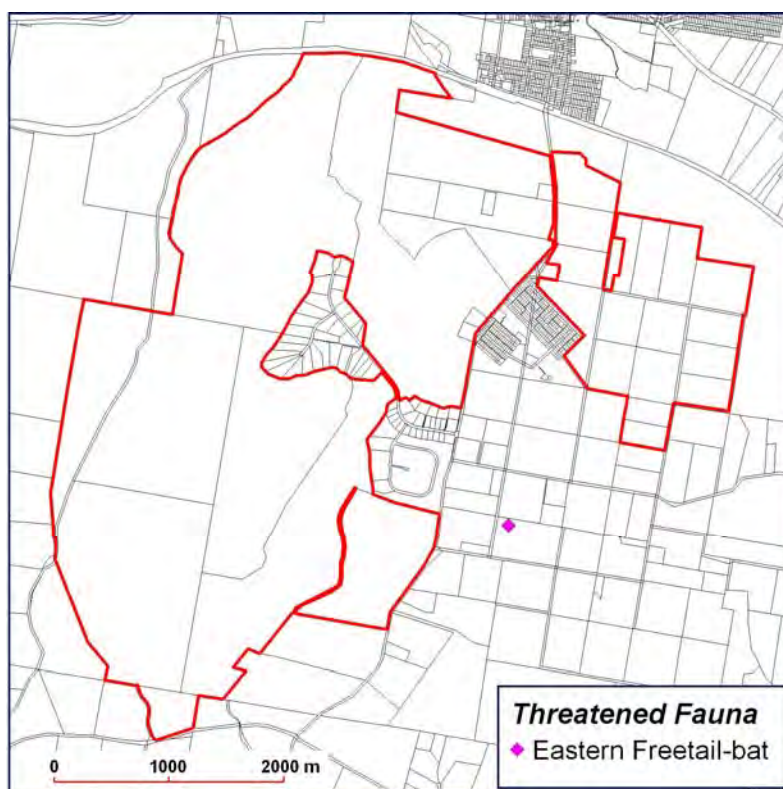
This species is relatively well distributed within the Central to Lower Hunter Valley although the frequency of records is not high. The forests and woodlands of Huntlee offer widespread hunting and roosting opportunities for this species.

Survey Methods:

- Hollow bearing trees (potential roost sites for the species) within the Huntlee study area.
- Targeted bat surveys. Previous survey effort shown in Table 2-1.

Modelling (variables): Although not shown, potential roosting habitat within the Huntlee study area is based on density of hollows (see Table 3-4). Potential foraging and roosting habitat throughout.

Map:

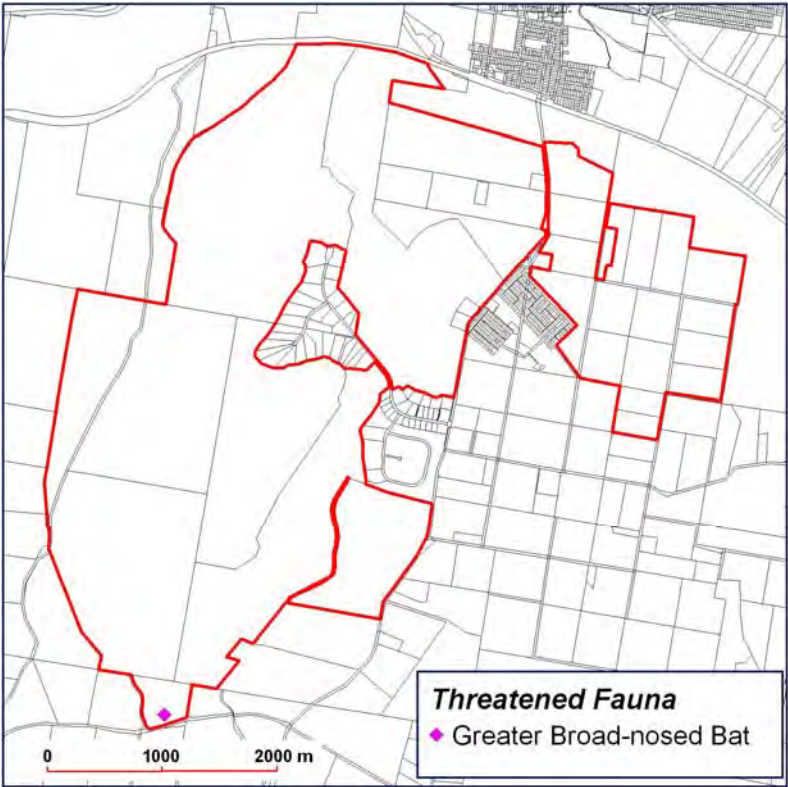


Notes:

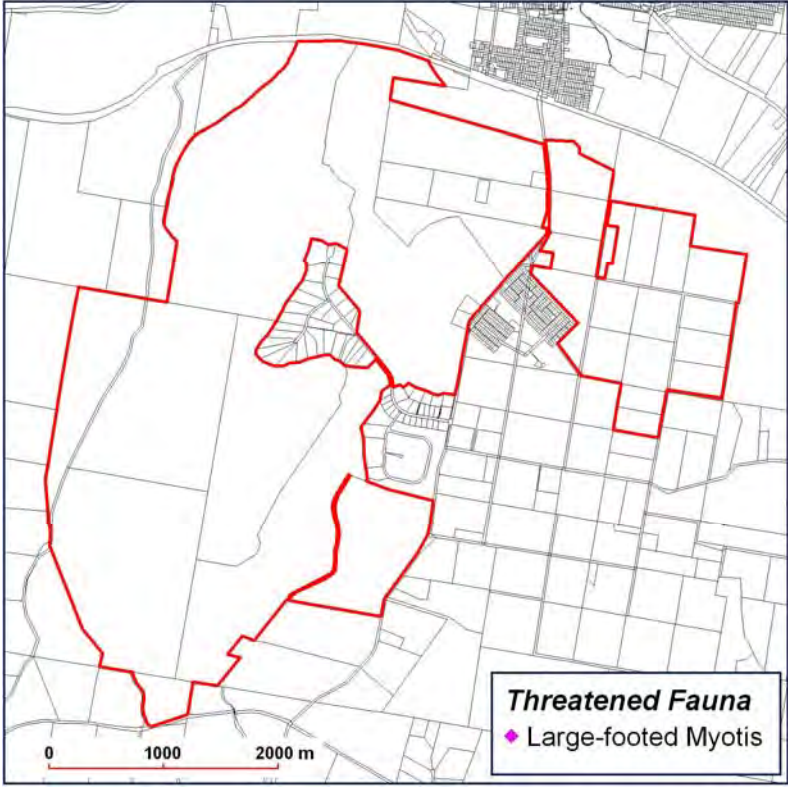
- This species is thought to be largely solitary in its habits, which may account for the relatively low frequency of Hunter Valley records.

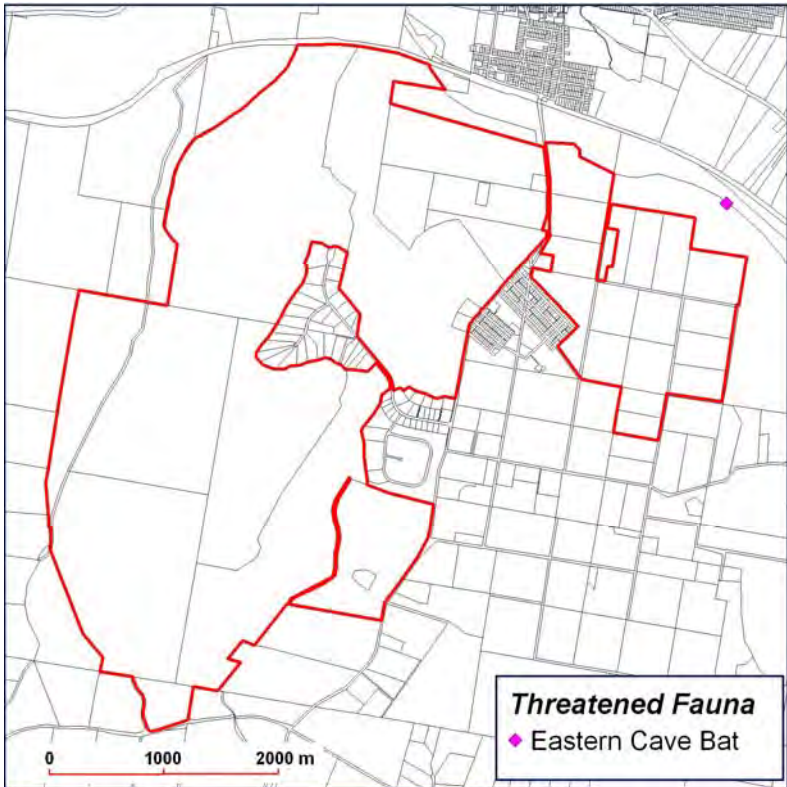
Records / Population within Huntlee: Uncommon resident?

Scoteanax rueppellii Greater Broad-nosed Bat

Status: Vulnerable (TSC Act)	Distribution and Mapping
This species occurs in sparsely wooded areas and clearings (ecotones) within 200km of the Queensland and NSW coast. It is generally restricted to the coast and adjacent ranges although it has been recorded further west in the Tamworth area (Authors <i>pers. obs.</i>). Apparently feeding on other bats, large moths, beetles and some small vertebrates, this slow flying species emerges just after sundown and flies directly at within 3-6 metres of the ground deviating only slightly to catch larger insects. This species roosts in tree hollows. This species has been recorded on the site by Ecotone (2003) along Old North Road. The status of this species in the study area is unclear, although potential foraging and roosting habitat exists throughout the study area. This species is known from scattered localities within the lower Hunter Region.	Survey Methods: - Hollow bearing trees (potential roost sites for the species) detailed across the Huntlee Study Area. - Targeted bat surveys. Previous survey effort shown in Table 2-1. Modelling (variables): Although not shown, potential roosting habitat within the Huntlee study area based on distribution and density of hollows (see Table 3-4). Potential foraging and roosting habitat throughout. Map: 
Notes:	Records / Population within Huntlee: Uncommon resident?

Myotis adversus **Large-footed Myotis**

Status: Vulnerable (TSC Act)	Distribution and Mapping
This species occurs around the northern and eastern coasts of Australia from the Kimberly, east, to the southern corner of South Australia. Its large feet are employed in trawling the surface of ponds, creeks and often large bodies of water for aquatic insects, which make up the bulk of its diet. The species is largely absent from the arid interior of Australia due to its dependence upon water availability and they roost within caves, tree hollows, man-made structures and dense foliage in tropical areas. This species was recorded over water in the south west of the site where a drainage line is reduced to a string of permanent ponds. The site's dams and the slow flowing reaches of Black Creek are likely to represent other potential foraging sites for this species. Most records of this species occur lower in the Hunter Region and there is a higher frequency of records on the central coast and in the Lake Macquarie hinterland. This species is known from scattered localities within the lower Hunter Region.	Survey Methods: - Hollow bearing trees (potential roost sites for the species) within the Huntlee study area. - Targeted bat surveys. Previous survey effort shown in Table 2-1. Modelling (variables): Although not shown, potential foraging habitat within the Huntlee study area is based on the occurrence of permanent and semi-permanent water and roosting habitat is based on the occurrence of hollow-bearing trees. Map: 
Notes: - This species is sometimes recorded as groups of individuals foraging over water and although they are never observed far from water they are not limited to aquatic environments and also take insects on the wing.	Records / Population within Huntlee: Uncommon resident in suitable habitat.

<i>Vespadelus trougtoni</i> Eastern Cave Bat	
Status: Vulnerable (TSC Act)	Distribution and Mapping
<i>Vespadelus trougtoni</i> (Eastern Cave Bat) remains one of the least known members of its genus in Eastern Australia. It is a cave-dweller, known from wet sclerophyll forest and tropical woodlands from the coast and Dividing Range to the drier forests of the semi-arid zone. It has been found roosting in small groups in sandstone overhangs, in mine tunnels and occasionally in buildings. In all situations, the roost sites are frequently in reasonably well-lit areas. Single-sex colonies varying in size from 6 to 50 individuals are more commonly recorded; however a large colony of 500 individuals of equal sex ratio has been recorded in a mine. , <i>V. trougtoni</i> were huddled together and only occupied one-third of a square metre of ceiling. Although it is widely distributed, relatively few records of this species exist, particularly in the southern part of its range where it appears to be localised. The main population stretches from Cape York south to the mid-north coast of NSW. Little is known of its diet and hunting behaviour. Similarly, information on reproductive activities is limited to the noted capture of lactating females in December in the Atherton Tablelands.	Survey Methods: - Targeted bat surveys. Previous survey effort shown in Table 2-1. Modelling (variables): None undertaken. Potential foraging habitat throughout. Map: 
Notes:	Records / Population within Huntlee: Uncommon.

Appendix 2

Vegetation Survey and Mapping Reports

Vegetation survey of “*Sweetwater*”, North Rothbury, mid Hunter Valley, New South Wales.



Final Report

October 2005

Report to:

Harper Somers O'Sullivan
241 Denison Street
Broadmeadow NSW 2292

**Stephen A.J. Bell
& Colin Driscoll**

Eastcoast Flora Survey
PO Box 216
Kotara Fair NSW 2289

Vegetation survey of “*Sweetwater*”, North Rothbury, mid Hunter Valley, New South Wales.

Stephen A.J. Bell
& Colin Driscoll

Eastcoast Flora Survey
PO Box 216
Kotara Fair NSW 2289

October 2005

Abstract

A vegetation survey was undertaken within land near North Rothbury (“Sweetwater”), in the Hunter Valley of New South Wales. This parcel of land occupies approximately 1500 ha of open forest and woodland, and includes part of the former Ayrefield Colliery which currently operates as a railway museum. Aerial photographic interpretation and a detailed ground truthing program were undertaken to produce a vegetation map of the area, showing the distribution of vegetation communities and their variants, following (as far as possible) the terminology of the Lower Hunter and Central Coast Regional Environmental Management Strategy.

During the survey, five vegetation communities were delineated, although one of these (the Central Hunter Ironbark - Spotted Gum – Grey Box Forest) comprised the vast majority of the area. Several communities present are considered to be poorly conserved in the region, and consequently Sweetwater has the potential to play a role in the future protection of these vegetation types. Two vegetation communities (Central Hunter Riparian Forest and Hunter Lowlands Redgum Forest) are presently listed as or included within Endangered Ecological Communities under the terms of the NSW *Threatened Species Conservation Act 1995*, while others are considered regionally significant. Considerable variation in the floristic composition of the Central Hunter Ironbark - Spotted Gum – Grey Box Forest is evident in the area, and discussion is included in this regard. Populations of one Endangered (*Persoonia pauciflora*), two Vulnerable (*Eucalyptus glaucina*, *Eucalyptus parramattensis* subsp. *decadens*) and four rare (*Acacia bulgaensis*, *Eucalyptus fergusonii* subsp. *dorsiventralis*, *Grevillea montana*, *Macrozamia flexuosa*) plant taxa occur within the Sweetwater site, together with several other regionally significant species.

The Sweetwater site is a botanically diverse parcel of land, with over 325 plant taxa currently recorded. A number of species more typically associated with western inland environments are present on the site, many showing disjunct populations. Sweetwater has also been identified by NPWS (2003) as forming part of a regional wildlife corridor linking the site to Werakata National Park, Belford National Park, and Pokolbin State Forest.

Recommendations are made in relation to the need for additional orchid surveys, and for the conservation of plant taxa and vegetation communities within the Sweetwater site.

Note: Front cover shows Spotted Gum *Corymbia maculata* and the undescribed Donkey Orchid *Diuris* sp. aff *dendrobioides* (Hunter Valley). [Photographs © S. Bell]

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1.0 Introduction

1.1 Background

Eastcoast Flora Survey has been requested to undertake a vegetation survey and mapping program of a parcel of land near North Rothbury, in the Hunter Valley. Known as “*Sweetwater*”, the site requires detailed flora survey and mapping to identify any ecological constraints prior to any future potential development. Within the context of surrounding lands, *Sweetwater* supports a large remnant of Hunter Valley floor vegetation, and potentially contains a range of significant flora values.

Previous vegetation studies undertaken in the area have provided a general background to the site, but further clarification and refinement is now required. This is particularly the case given the extent of land clearing that has occurred in the Hunter Valley since European settlement. Within the Hunter Valley floor, at least seven vegetation communities listed on the NSW *Threatened Species Conservation Act 1995* as Endangered Ecological Communities (EEC's) occur, as well as several threatened and rare plant species. There is also the potential for several other taxa or communities of significance to occur in the area.

This report presents the findings of a detailed vegetation survey and mapping program undertaken on behalf of Harper Somers O'Sullivan Pty Ltd, for Hunter Development Brokerage. It provides:

- a review of previous vegetation survey and mapping projects in the area;
- an outline of survey and mapping methodology for assessing the vegetation;
- the results of the survey, and implications for development; and
- information for input into a conservation strategy for the site.

1.2 Location and environmental setting

Sweetwater lies between the Main Northern Railway at North Rothbury and Old North Road to the south, west to Terrace Ridge, and east to Wine Country Drive. A disjunct portion also occurs to the east of Wine Country Drive, within the township of North Rothbury (Figure 1). The study area lies within Cessnock and Singleton local government areas, in the lower Hunter Valley of New South Wales. The wider district comprises a mixture of urban, agricultural, mining, and viticultural land uses, although cleared grazing lands comprise the major activity. Protected public bushland is limited to Belford National Park (formerly Belford State Forest), approximately 5 km to the north-west, and Werakata National Park 10 km to the south-east.

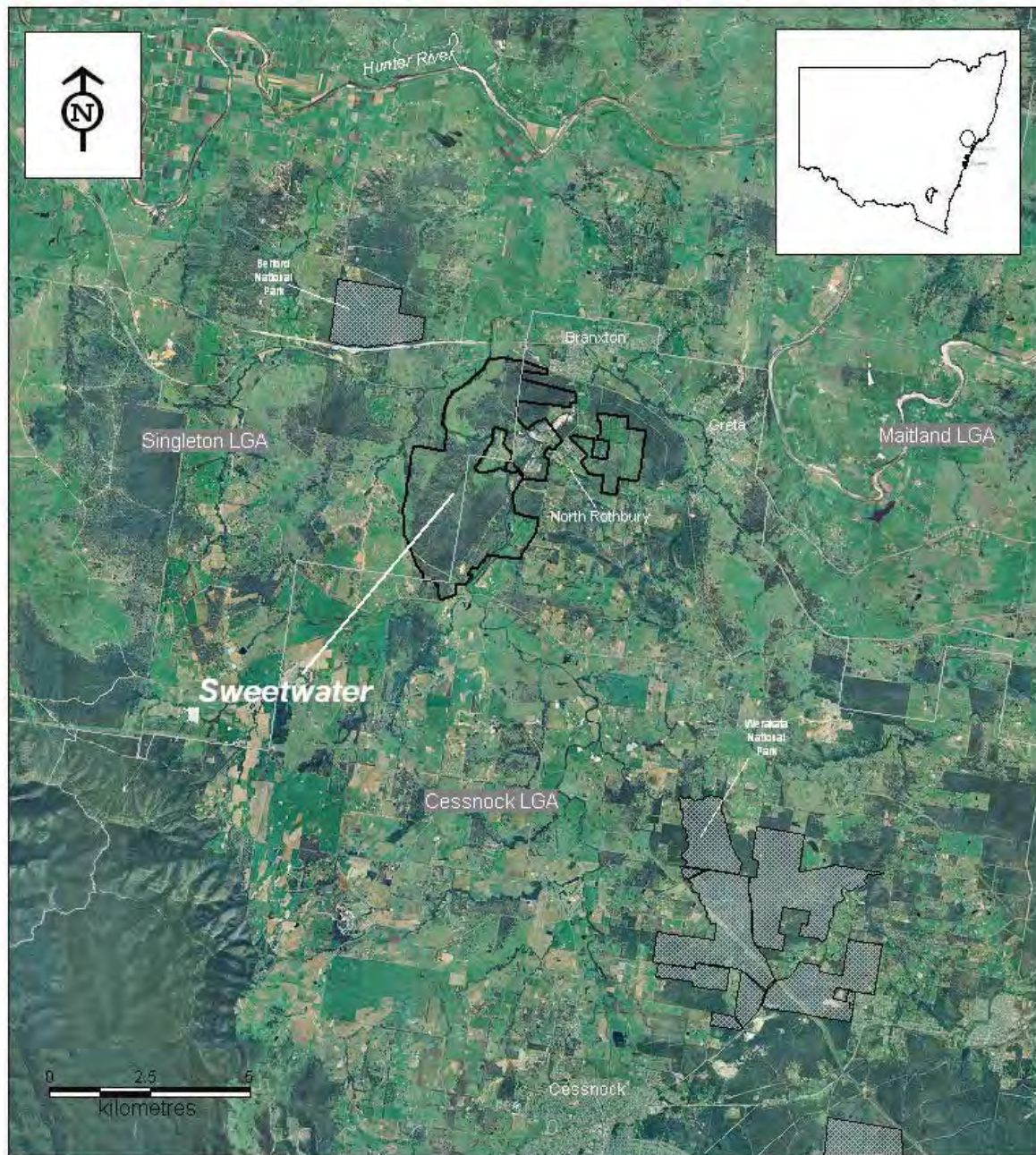


Figure 1 Location of the Sweetwater study area, within the LGA's of Cessnock and Singleton.

In the National context, the lower Hunter Valley lies within the Sydney Basin biogeographical region of Thackway & Cresswell (1995), and parts of the North Coast, Central Coast, South Coast, Central Western Slopes, Central Tablelands and Southern Tablelands botanical divisions of Anderson (1961). The Sydney Basin biogeographical region approximates the Sydney geological Basin, and stretches from around the upper Hunter Valley (Liverpool Range), to Port Stephens on the coast, and south to Batemans Bay on the south coast. The region covers approximately 36 655

km², and is composed of mesozoic sandstones and shales; dissected plateaus; forests, woodlands and heaths; skeletal soils, sands and podzolics (Thackway & Cresswell 1995). The six relevant botanical regions of Anderson (1961) imply that there is considerable botanical diversity throughout the region.

The lower Hunter Valley area falls within a warm temperate climatic zone, with warm wet summers and cool dry winters. Rainfall generally peaks in late Summer and early Autumn, with an annual average of 750 mm per year at Cessnock (17km to the south), 724 mm per year at Singleton (20km to the north-west), and 895 mm at East Maitland (20km to the east). Temperatures range from a daily average low of 4.5° C in July (Cessnock), to a high of 30.7 ° C in January (East Maitland) (Bureau of Meteorology 2005).

Figure 2 illustrates rainfall patterns across the region, showing the study area falling within the 700-800 mm/year rainfall band.

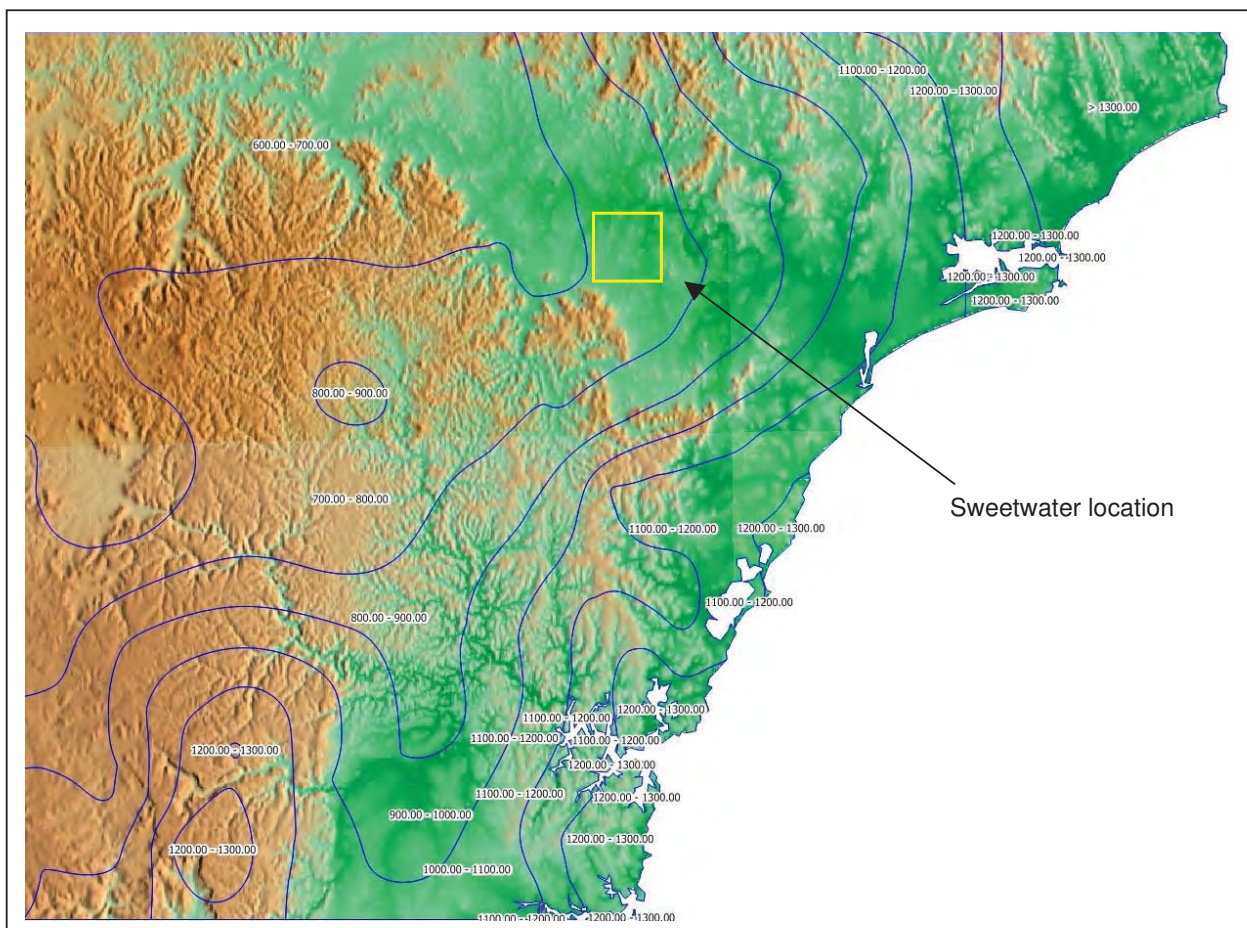


Figure 2 Regional rainfall patterns (100 mm/year bands), showing the Sweetwater locality. (Data sourced from Bureau of Meteorology 2005).

1.3 Previous land use

Sweetwater is centred around the disused Ayrefield No. 3 Colliery (also known as the Rothbury or Branxton Colliery at various times), which mined coal from the Greta Coal Measures in the early 1900's. The 'Rothbury Riots' of 1929-30 occurred within the Ayrefield No. 3 colliery site, where miners clashed with management over the use of non-union labourers and resulted in the death of one miner, and the injury to several others. The Colliery continued operation until it closed in 1974. A railway museum is currently operating from part of this site, and is managed by the Hunter Valley Railway Trust. Surrounding this area, agricultural lands supporting cattle or (more recently) vineyards are present, together with residential areas within the township of North Rothbury.

The bulk of the study area currently supports native vegetation, although light to moderate livestock grazing has occurred across the entire site. It is evident from regrowth timber that some sections of the site had been cleared for grazing purposes several decades previously. During the years when the Ayrefield No. 3 Colliery was active, logging of timber occurred for pit props and other uses. Around the railway museum, large coal waste dumps are present, and there are numerous tracks and trails emanating from the main north-south access road running along the Greta coal seam. In recent years, rural-residential lots have been established in the immediate surrounding lands, such as the Hanwood Estate along Hanwood Road.

1.4 Landforms, geology and soils

The Sweetwater site is mapped by Glen and Beckett (1993) as occurring on Permian conglomerate, sandstone and siltstone, with Quaternary alluvium present along parts of Black Creek in the north (Figure 3). Within the sequence of Permian sediments, the Dalwood Group (oldest), Greta Coal Measures and Maitland Group (youngest) have been recognised (van Heeswijck 2001). The Branxton Formation within the Maitland Group is the most widespread unit in the study area, with older sediments from the Farley Formation (Dalwood Group) occurring in the east. The western boundary supports narrow bands of outcropping Muree Sandstone and Mulbring Siltstone (both Maitland Group). The Greta Coal Measures occur along a fault line in the centre of the study area, which separates the Maitland Group in the west from the Dalwood Group in the east. Table 1 shows the lithostratigraphy of the area.

Soil landscapes in the Sweetwater area have been described and mapped by Kovac (1991) and Kovac & Lawrie (1991) at 1:250 000 scale. These authors map almost the entire study area as supporting the Rothbury landscape, with smaller areas of the Branxton landscape. The Rothbury landscape consists of Permian sandstone, shale, mudstone, siltstone, tuff and coal seams, on

undulating to rolling hills, relief 60-80m, and slopes 6-12%. It supports red podzolic soils on upper slopes and yellow podzolic soils on midslopes. Yellow solodic soils and brown soloths occur on lower slopes, and prairie soils in drainage lines.

Table 1 Lithostratigraphy of the Sweetwater area.

Recent ↕ Older	Quaternary	Quaternary Alluvium	
	Permian	Maitland Group	Mulbring Siltstone Muree Sandstone Branxton Formation
		Greta Coal Measures	
		Dalwood Group	Farley Formation

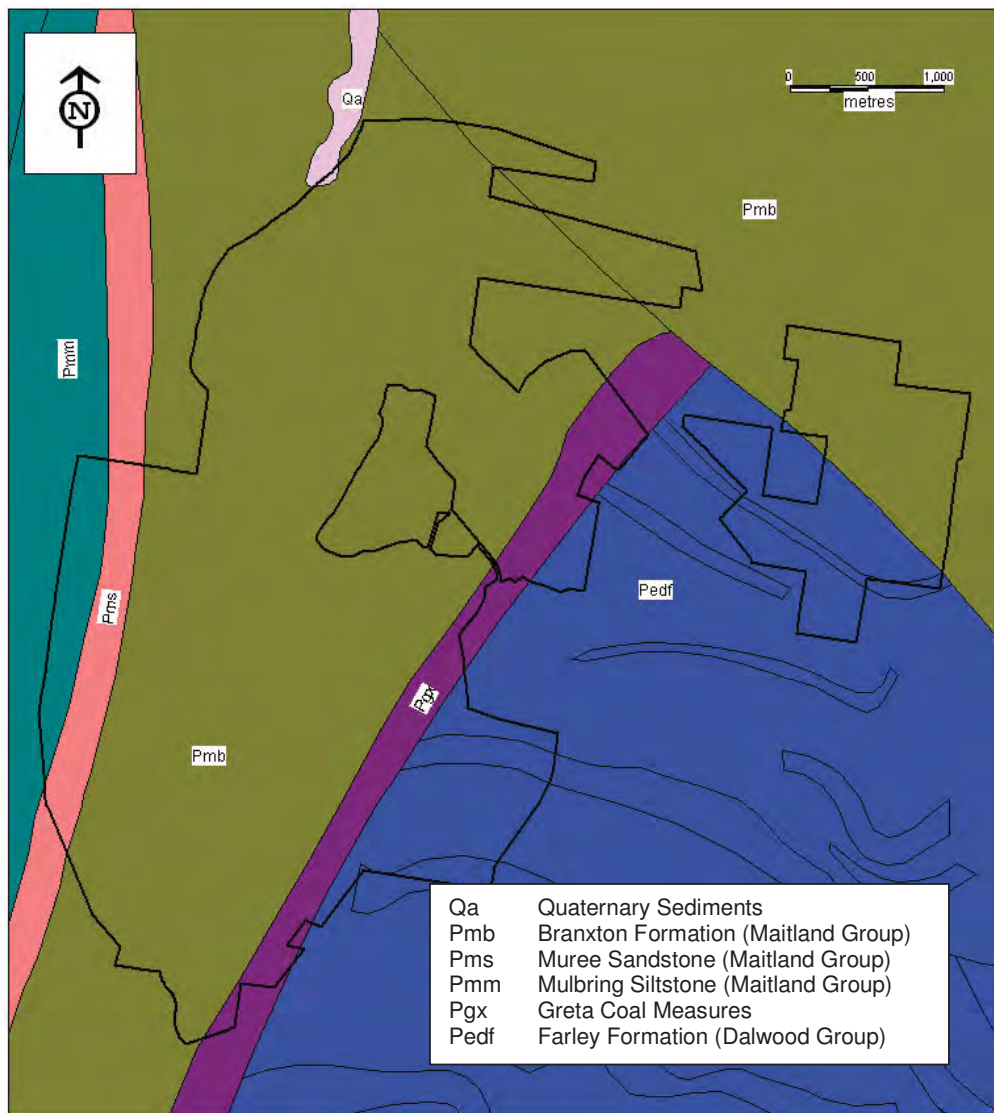


Figure 3 Major geology formations at Sweetwater. (Data sourced from DMR 1999).

The Branxton soil landscape occurs on undulating rises and low hills of Permian sandstone, shale, mudstone, siltstone, tuff and coal seams, with relief 10-40m and slopes to 5%. Yellow podzolic soils occur on midslopes, red podzolic soils on crests, yellow soloths on lower slopes and in drainage lines, and alluvial soils in some creeks.

1.5 Previous botanical studies

1.5.1 Ecotone Ecological Consultants (2003) constraints study:

Ecotone Ecological Consultants (2003) undertook a flora and fauna constraints assessment of the study area, although only two days were spent in the field during June and July 2003. A total of 71 plant species were recorded by Ecotone, with 15 of these comprising exotic species. Four native vegetation communities were identified for the site:

- Forest Red Gum/ Grey Box/ Ironbark Open Forest-Woodland
- Spotted Gum – Ironbark Open Forest
- River Oak – Paperbark Riparian Forest
- Hakea Scrub

The first of these was considered by Ecotone (2003) to closely conform to the Hunter Lowland Redgum Forest EEC, which they indicate occupies the bulk of the forested vegetation. Their Spotted Gum – Ironbark Open Forest is also said to correspond to the Lower Hunter Spotted Gum – Ironbark Forest (now an EEC). On this basis, it appeared that the majority of the study area supported endangered ecological communities.

Ecotone (2003) document two significant plant species (*Persoonia pauciflora* and *Grevillea montana*) as being present in the study area, although the potential for further species is noted.

1.5.2 Peake (2005) remnant vegetation study:

The Hunter Remnant Vegetation Project (HRVP) commenced in 1996 under the auspices of the (then) Hunter Catchment Management Trust and the National Parks and Wildlife Service. It was undertaken following the realisation that remnant vegetation within the Hunter Valley was under considerable threat, and that no comprehensive classification and mapping program of the valley had been completed. The HRVP study area comprised the floor of the Hunter Valley from Branxton to near Wingen and Sandy Hollow, with the northern and southern boundaries being the Barrington

and Wollemi escarpments respectively. Approximately half of the Sweetwater study area occurs within the HRVP area.

Peake (2005) has documented the results of this study, which identified over 35 vegetation communities across 60,700 ha (~19%) of vegetated land, using standard NPWS survey and mapping techniques. Peake (2005) has mapped the western half of the Sweetwater study area as predominantly supporting Central Hunter Ironbark – Spotted Gum – Grey Box Forest, some Lower Hunter Spotted Gum – Ironbark Forest, and riparian areas of Hunter Valley River Oak Forest and Central Hunter Swamp Oak Forest. While still in draft format, the mapping and reports of the HRVP are of immense value to the present study.

1.5.3 NPWS (2000a) regional classification and modeling study:

In a major regional study, NPWS (2000a) undertook a survey, classification and modeling project for the Cessnock, Maitland, Newcastle, Lake Macquarie, Port Stephens, Wyong and Gosford LGA area. Known as the Regional Environmental Management Strategy (REMS), this study attempted to define and model all vegetation within a 563 000 ha area, which included approximately half of the study area. Vegetation communities determined to be present within the site included Lower Hunter Spotted Gum-Ironbark Forest (Unit 17), Hunter Lowlands Redgum Forest (Unit 19), and Central Hunter Riparian Forest (Unit 13). The vast majority of the modeled area is shown to support Unit 17, with Black Creek supporting Unit 13 and some minor creeklines Unit 19.

Hunter Councils subsequently contracted the CSIRO to undertake a review of the methods and results of that study (Nicholls et al. 2002), who concluded that the resulting classification and map was “*regional and not local in its utility*.” The coverage of the plot samples should be regarded as a bare minimum for the region, and this reinforces the fact that the map should only be used at a regional planning scale and not at a site planning scale. At the local scale, great caution should be applied with respect to inferring presence or areal extent of communities within remnants based on interpretation of the vegetation map without on-site inspection to confirm the broad detail implied in the mapping (Nicholls et al. 2002).

Hunter Councils are presently undertaking a revision of the vegetation classification and mapping for the entire Hunter-Central Rivers Catchment Management Area, an area nearly six times the original size.

1.5.4 Williams (1993) Swamp Oak ecology study:

Black Creek was included within the Honours study of Williams (1993), which examined aspects of the distribution and ecology of Swamp Oak (*Casuarina glauca*) in the Hunter Valley. Cluster analysis of site data from eight locations between Greta and Muswellbrook failed to distinguish separate communities, suggesting that the low diversity typical of these stands was consistent throughout the area. Williams (1993) concluded that the disjunct occurrences of Swamp Oak within the Hunter Valley is strongly related to edaphic features of the environment, particularly moderate levels of soil salinity. The entire length of Black Creek, from the New England Highway to near Old North Road was mapped as supporting dense stands of Swamp Oak. While only limited in its application, this study raised some initial speculation about the relationship of these inland stands of Swamp Oak to the more coastal stands in estuarine environments (outside of her study area).

1.5.5 Endangered Ecological Communities

Prior to its legal listing, Lower Hunter Spotted Gum – Ironbark Forest (LHSGIF) has been the subject of some debate in regard to its floristic composition and distributional range. Driscoll and Bell (2004) undertook an initial analysis of open forests dominated or co-dominated by Spotted Gum (*Corymbia maculata*) and various ironbarks, and this work is continuing. The geographical range covered by this project extends from the Hawkesbury River (Gosford LGA), north to near Karuah (Port Stephens LGA), and west to the upper Hunter Valley. Stables and Bell (in prog.) are currently undertaking a similar examination of the distribution of the related Pittwater Spotted Gum Forest EEC within Gosford LGA.

A sizable literature is now available on various aspects of the White Box - Yellow Box – Blakely's Redgum Woodland EEC (eg: Prober & Brown 1994; Prober & Theile 1995; Prober 1996; Prober et al. 1998; Prober & Theile 2004; Prober et al. 2004; Gustafson et al. 2004). Keith (2002) has also undertaken a detailed classification analysis of the vegetation of New South Wales, from which information on several floodplain EEC's has been taken. These include Swamp Oak Floodplain Forest, River Flat Eucalypt Forest on Coastal Floodplains, and Freshwater Wetlands on Coastal Floodplains. Information on the Warkworth Sands Woodland EEC has been compiled in Peake et al. (2002), although the likely occurrence of this EEC on the Sweetwater site is low.

1.6 Significant plant species and EEC's

Few threatened plant species are known from the North Rothbury-Branxton area, however the critically endangered *Persoonia pauciflora* is highly endemic to the locality and previous records

exist for the current study area and surrounding lands (see Weston 1999 and Patrick 1999). The vulnerable *Eucalyptus glaucina* has recently been recorded to the south-east in the vicinity of Mount Molly Morgan (Lucas Grenadier *pers. comm.*), and there are several other records to the south and west of Sweetwater. The rare species *Macrozamia flexuosa* and *Grevillea montana* have been previously recorded from the North Rothbury area (Patrick 1999; Ecotone 2003), but are otherwise widespread in the Cessnock and lower Hunter regions, including conservation reserves (Bell 2001; 2004a). Other threatened and rare plant species known from the vicinity are shown in Table 2.

Table 2 Summary of significant flora from within a 10km radius band from the Sweetwater site. See Briggs & Leigh (1996) for explanation of ROTAP codes.

Species	Status			Location	Source
	EPBC Act	TSC Act	ROTAP		
<i>Persoonia pauciflora</i>	Critically End.	Endangered	2E *	North Rothbury	Weston (1999); Ecotone (2003)
<i>Eucalyptus castrensis</i>	-	Endangered	2V *	Singleton army base	pers. obs.
<i>Eucalyptus fracta</i>	-	Vulnerable	2R- *	Pokolbin SF	NPWS Atlas, pers obs
<i>Eucalyptus glaucina</i>	Vulnerable	Vulnerable	3VCa	south and west	NPWS Atlas
<i>Eucalyptus pumila</i>	Vulnerable	Vulnerable	2VCi	Pokolbin SF	NPWS Atlas
<i>Macrozamia flexuosa</i>	-	-	2K	North Rothbury Werakata NP Tomalpin area	Patrick (1999); Ecotone (2003) Bell (2004a) HSO (2004); Bell (2004)
<i>Eucalyptus fergusonii</i> . subsp <i>dorsiventralis</i>	-	-	2RC-	Tomalpin area	Bell (2004)
<i>Eucalyptus fergusonii</i> . subsp <i>fergusonii</i>	-	-	2RC-	North Rothbury	Patrick (1999)
<i>Grevillea montana</i>	-	-	2KC- **	North Rothbury Singleton army base Werakata NP Tomalpin area	Patrick (1999) pers. obs. Bell (2004a) HSO (2004); Bell (2004)

Note: * = newly described species not included within Briggs & Leigh (1996), but conservation codes recommended by other workers. ** A revision of the ROTAP code to 2RCa for *Grevillea montana* has been suggested in Bell (2001), recognising the large numbers of conserved plants within NPWS estate.

One plant taxa of some conservation interest is the small donkey orchid *Diuris* sp. aff. *dendrobioides* (Hunter Valley). This species is currently undescribed, but is recognised as a distinct entity occupying a restricted zone in the Belford-Branxton locality (see Bishop 1996). Previous records for this taxon exist for the Belford National Park area, and at Stanford Merthyr (Michael Roderick *pers. comm.*).

A number of Endangered Ecological Communities (EEC's), as listed under the NSW *Threatened Species Conservation Act 1995*, may be relevant to the study area, and require consideration in the context of any proposed development. In their regional modeling of vegetation in the lower Hunter and Central Coast, NPWS (2000a) depicted the entire study area as supporting the Lower Hunter Spotted Gum – Ironbark Forest, which has since recently been listed as an EEC. All EEC's potentially present in the area include:

- Lower Hunter Spotted Gum – Ironbark Forest
- Hunter Lowlands Redgum Forest
- Swamp Oak Floodplain Forest
- River Flat Eucalypt Forest on Coastal Floodplains
- White Box – Yellow Box – Blakely's Redgum Woodland
- Warkworth Sands Woodland
- Freshwater Wetlands on Coastal Floodplains;
- Kurri Sands Swamp Woodland.

2.0 Methods

2.1 Survey design

The relatively low relief evident across the study site, and the lack of suitable environmental GIS layers, meant that stratification of plot survey sites was unlikely to produce reliable and achievable results. The overall impression of the site supporting homogeneous grassy forests and woodlands also meant that traditional aerial photographic interpretation alone would not reveal a significant number of photopatterns. Consequently, the survey design for the project followed the following steps:

1. undertake a terrestrial orchid survey across the site, during which time notes would be taken on general trends in the vegetation, allowing for the selection of plot sampling locations to reflect visible, on-ground floristic variation;
2. undertake preliminary vegetation community mapping using hand-held *Garmin* GPS units (positional accuracy 4-7m), walking the boundaries of discernible vegetation communities, while also noting potential plot sampling locations;
3. undertake plot sampling in pre-defined locations, ensuring that all observed variations

noted during earlier field investigations are sampled.

This technique is a departure from the more traditional stratification survey rationale, since in environments that support open grassy forests and woodlands, differences between adjacent vegetation communities or associations tend to be more subtle than in other environments. These subtle differences would mean that considerable variations may potentially remain unsampled using the traditional techniques, and hence a full appreciation of the diversity of vegetation may not be attained. Budgeting for the current project allowed for approximately 60 sample sites to be surveyed.

2.2 Aerial photographic interpretation

As noted above, traditional aerial photographic interpretation using stereoscopic photo pairs was not undertaken due to the relatively homogeneous nature of the site, and the thorough field truthing planned for the project. Instead, orthorectified digital photographs (flown 1998: provided by the Land Information Centre) were interpreted on-screen for visible colour and tone changes, and polygons inspected in the field. Previously cleared and recent regrowth areas were also defined on-screen. Greater emphasis was placed on the field truthing component of the study to delineate community and association boundaries.

2.3 Site selection

The selection of floristic survey sites was driven principally by the need to provide a highly accurate portrayal of the vegetation present. Consequently, study sites were placed in locations representative of observable variations in floristic and structural composition, following extensive field reconnaissance of the entire site. This methodology departs from the more typical approach, where sites are placed proportionally within an environmental stratification (such as soil landscape, elevation etc), as the available resolution for environmental attributes was not considered fine enough to surrogate for floristic variation. In addition, previous experience has shown that more value can be achieved through strategically placed quadrats than those within an environmental stratification.

Positioning of sample sites was also impacted upon by the underscrubbing of vegetation that commenced prior to the completion of sampling. This was particularly problematic in the eastern portion of the study area (east of Wine Country Drive), where extensive areas of vegetation dominated by Spotted Gum (*Corymbia maculata*) and Ironbarks (*Eucalyptus fibrosa* and *Eucalyptus crebra*) were reduced to canopy trees only, meaning that a thorough assessment of the

vegetation could not be completed. Few full floristic survey plots could be undertaken in this area. Large areas in the west of the study area were also impacted upon in this way. In these locations, 'educated guesses' had to be made from the surrounding, undisturbed vegetation to complement interpretations made from standing canopy trees.

2.4 Floristic plot survey

Floristic survey was carried out within the study area primarily between September 2004 and March 2005. This survey period corresponded with the flowering periods of most species present in the area, and adequate rainfall during this time also ensured that opportunistic flowering of grass and herb species occurred.

Survey methodology followed that outlined by Wilson *et al* (1997), which was also identical to that used by NPWS (2000a). It is also consistent with Cessnock Council's D.C.P. No. 56 *Flora and Fauna Survey Guidelines*, and the Lower Hunter and Central Coast Flora and Fauna Survey Guidelines (Murray *et al.* 2001). Within each 0.04 ha survey site, all vascular plant species present were recorded and attributed a cover abundance rating, based on a modified 1-6 Braun-Blanquet scale (see Walker & Hopkins 1990). Physical attributes of the site (vegetation structure, soil type, elevation, slope, aspect, physiographical position, etc) were also recorded, and photographs were taken of the site for later reference. Voucher specimens of unknown or significant taxa were collected for later identification or lodgement with the National Herbarium in Sydney.

During field survey, general reconnaissance was also made over most of the area on foot and in 4WD vehicle, while moving between plots. During such reconnaissance, the distributions of vegetation community types were noted, while searches for significant plant species were also made. Hand-held GPS units were carried at all times, so that search areas could be later transferred to a map.

2.5 Targeted survey

Targeted survey was undertaken across the site for the following significant plant species potentially occurring on the site:

- *Persoonia pauciflora* (EPBC Act Critically Endangered; TSC Act Endangered)
- *Eucalyptus glaucina* (TSC Act Vulnerable)
- *Grevillea parviflora* subsp. *parviflora* (EPBC Act Vulnerable; TSC Act Vulnerable)
- *Rutidosis heterogama* (EPBC Act Vulnerable; TSC Act Vulnerable)

- *Grevillea montana* (ROTAP)
- *Macrozamia flexuosa* (ROTAP)
- *Diuris* sp aff *dendrobioides* (Hunter Valley) (Undescribed, but highly endemic)

The authors were familiar with all but the *Diuris* prior to the survey, from previous projects undertaken elsewhere in the region. At all times while in the field, hand-held GPS units were carried to trace searched areas, with walked tracks downloaded to the computer at the completion of each day. Maps showing survey effort for significant species could then be prepared, and were beneficial in highlighting unsearched areas during the course of fieldwork. Cropper (1993) and Keith (2000) indicate that the detection of rare or threatened plant species is often best achieved through targeted, random traverses.

2.6 Data analysis and vegetation classification

Cluster analysis was performed on collected data using the *PATN* Statistical Analysis Package (Belbin 1989), following methodology undertaken in similar works (eg: Keith & Bedward 1999; Griffith, Wilson & Maryott-Brown 2000; NPWS 2000a). Belbin (1991) provides detailed discussion on how ecological data is analysed using this program.

Delineation of vegetation communities was planned to be undertaken as finely as possible (preferably at the 0.7 level of dissimilarity or better), although reference to field notes collected during field activities formed an important part of the analysis. At all times, familiarity with the field situation guided the classification process. Most vegetation classifications carried out using *PATN* clustering techniques delineate vegetation communities at the 0.6 to 0.8 dissimilarity levels wherever possible, although this is dependant on the size and quality of the dataset, and the field knowledge of the interpreter.

A number of data analyses were undertaken, both on the *Sweetwater* dataset and on a wider regional dataset maintained by *Eastcoast Flora Survey*, principally to answer the following two questions:

1. How many vegetation communities and/or associations are present within the study area ?
2. Does any vegetation present within the study area equate to the:
 - Lower Hunter Spotted Gum – Ironbark Forest EEC ?
 - Hunter Lowlands Redgum Forest EEC ?

- Swamp Oak Floodplain Forest EEC ?
- River Flat Eucalypt Forest on Coastal Floodplains EEC ?
- White Box – Yellow Box – Blakely's Redgum Woodland EEC ?
- Warkworth Sands Woodland EEC ?
- Freshwater Wetlands on Coastal Floodplains EEC ?
- Kurri Sands Swamp Woodland EEC ?

Subsets of the regional database were created to answer some of these questions, such as amalgamating all survey plots in the region where Spotted Gum (*Corymbia maculata*) formed an important canopy component. Such manipulation of data has been previously undertaken on a number of occasions to assist in defining particularly vegetation groups (eg: Anderson & Douglas 2001; Keith & Holman 2003; Connolly 2003; Bell 2004).

Each dataset was cleaned (taxonomic review and exclusion of weed species) prior to analysis. Lists of diagnostic plant species were generated for all communities discernible within the study area, using the *Fidel* program. This program was originally developed for work on the South Coast of New South Wales (Keith & Bedward 1999), and extracts relevant data from each group in the PATN analysis, and identifies which species (termed 'diagnostic species') characterise one community (or PATN group) from another. User defined rules can be specified to determine the level of sensitivity of diagnostic species. In some cases, a species can be dominant both in terms of its frequency of occurrence and its abundance, while in others it may occur sporadically or not at all. Recent examples of the use of this program include the vegetation classifications of Western Sydney (NPWS 2000b) and the Lower Hunter and Central Coast REMS region (NPWS 2000a), and in Gosford LGA (Bell 2004).

2.7 Vegetation mapping

The mapping of vegetation communities and associations across the study area was a two-stage process. For the first stage, on-screen interpretation and digitising of orthorectified digital aerial photographs was undertaken to prepare a base layer of extant vegetation, together with recent regrowth areas (~<10 years old), water bodies, trails etc. Discernible vegetation polygons were also tentatively digitised pending the results of further field investigations.

For the second stage, and given the subtle intergrading nature of the vegetation communities present on the site, considerable effort was placed on walking the boundaries of all vegetation associations with hand-held GPS units, guided generally by the dominance of canopy tree species but with regard to understorey composition. As an example, where Spotted Gum *Corymbia*

maculata was present, the boundary marking the edge of this species distribution was walked until the study area limit was reached, or it returned to its original starting position. Notes were also made during this process if other types of vegetation could be discernible within the walked polygon, such as a stand of Bulloak *Allocasuarina luehmannii*, and these were later returned to and perimeters walked. Small cleared areas and trails were ignored during this process, and were included as a continuation of the polygon under investigation. Downloaded tracks from the GPS units were then converted to polygons in the GIS, with each polygon essentially representing a discernible 'unit' of vegetation on the ground. Although a time-consuming and often tedious process, this method of vegetation mapping is considerably more accurate than relying solely on remote interpretation from aerial photographs, and is particularly suitable to grassy open forests and woodlands.

As a third stage in the mapping process, the extant vegetation layer produced from the digital aerial photographic interpretation in stage one was intersected with the preliminary vegetation polygons in stage two, to produce a base vegetation map. This base map effectively consisted of walked community or association boundaries, but excluded cleared areas, trails, water bodies etc. At this point, the results of the classification of plot data (see Section 2.6) directed where the final community and association boundaries would lie, as in some cases mapped polygons may be shown to not significantly differ in floristic composition, and would be subsequently absorbed by other polygons. Descriptions of vegetation units finally determined followed, wherever possible, the regional nomenclature of NPWS (2000a). In cases where new units were discernible, additional sub-units were created within the regional framework.

3.0 Results

3.1 Survey effort

3.1.1 Threatened species searches

A combined total of 380 km of dedicated searches and random meanders were undertaken across the Sweetwater site by two observers. This level of investigation is rarely undertaken across such large expanses of land, however the survey design adopted for the project allowed such an effort to be completed. Figure 5 indicates the extent of investigation.



Figure 5 Extent of targeted survey effort, Sweetwater.

3.1.2 Floristic plot survey

Sixty-two full floristic survey plots were completed over the course of the survey (Figure 6). Plots were located in areas recognised in the field as representing differing vegetation types, and replicated in other similar areas as often as possible. In comparison to several other classification and mapping studies completed in the region over recent years, the survey effort undertaken across the Sweetwater area greatly exceeds past studies.



Figure 6 Location of floristic study plots (solid circles), Sweetwater.

3.2 Overall floristic diversity

A total in excess of 325 plant taxa has been recorded within the study area (Appendix 1), including sixty-three weed species. Three threatened species (*Eucalyptus glaucina*, *Eucalyptus parramattensis* subsp. *decadens* & *Persoonia pauciflora*) and four rare species (*Acacia bulgaensis*, *Grevillea montana*, *Macrozamia flexuosa*, *Eucalyptus fergusonii*) are present within the area, in addition to several other species considered of conservation significance (Table 3). Figure 7 shows the location of rare and threatened species within Sweetwater, and Section 4.2 discusses significant taxa in further detail. One taxa (*Diuris* sp. aff. *dendrobioides* Hunter Valley) present awaits formal description and recognition.

Table 3 Significant plant taxa, Sweetwater.

Species	Significance	Occurrence at Sweetwater
<i>Persoonia pauciflora</i>	EPBC Critically End.; TSC Endangered	a few locations in the east
<i>Eucalyptus glaucina</i>	EPBC Vulnerable; TSC Vulnerable	principally in the west
<i>Eucalyptus parramattensis</i> subsp. <i>decadens</i>	EPBC Vulnerable; TSC Vulnerable	single plant in small creekline in the west
<i>Acacia bulgaensis</i>	ROTAP; range extension east	one location of two individuals
<i>Eucalyptus fergusonii</i>	ROTAP; unusual habitat	few trees on central ridge
<i>Grevillea montana</i>	ROTAP; potential northern limit	several locations
<i>Macrozamia flexuosa</i>	ROTAP	several locations
<i>Diuris</i> sp. aff. <i>dendrobioides</i> (HV)	undescribed, restricted endemic	within Grey Box forest in the west
<i>Allocasuarina verticillata</i>	range extension; disjunct occurrence	central ridge in the west
<i>Angophora subvelutina</i>	uncommon, few records	two locations along old mine road
<i>Callitris endlicheri</i>	easterly limit; disjunct location	several plants near the old mine road
<i>Crotalaria mitchellii</i> ssp. <i>mitchellii</i>	potential southern limit	sandy alluvium near Black Creek
<i>Eucalyptus microcarpa</i>	range extension: disjunct occurrence	single location in south near Old North Rd
<i>Geijera salicifolia</i> var. <i>latifolia</i>	unusual habitat; potential western limit	single location on central ridgeline in west
<i>Gompholobium inconspicuum</i>	northerly extension of range	across the study area
<i>Hibbertia polyantha</i> ms *	undescribed	scattered
<i>Maireana microphylla</i>	eastern limit	a few plants on Terrace Ridge
<i>Perotis rara</i>	uncommon; southern limit	sandy alluvium near Black Creek
<i>Sarcostemma brunonianum</i>	range extension; disjunct occurrence	single location in east

Note: * a distinct taxon currently undescribed, and the subject of research by the Adelaide Herbarium.

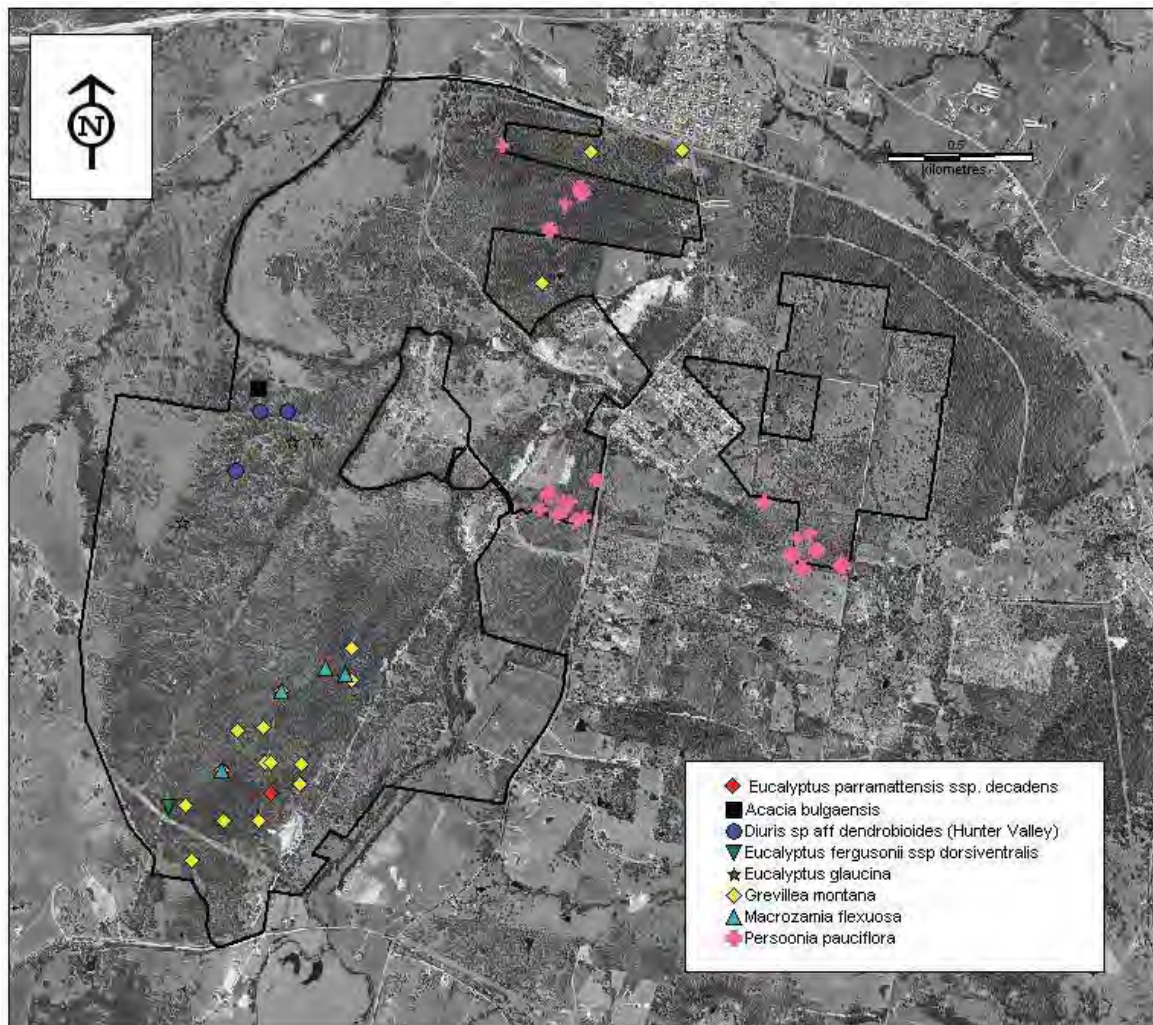


Figure 7 Location of significant plant taxa, Sweetwater.

Note that few records are shown in Figure 7 for *Eucalyptus glaucina* due to the difficulty in confidently differentiating this species from *Eucalyptus tereticornis*, with which it forms hybrid swarms.

3.3 Data analysis and delineated plant communities

A number of classification analyses were undertaken on the Sweetwater plot survey data, both as its own entity, and within wider regional datasets maintained by *Eastcoast Flora Survey*. The latter analyses allowed for the testing of the Sweetwater data in respect to Endangered Ecological Communities with which some elements of the vegetation bear some resemblance. Given that NPWS (2000a) mapped the majority of the area as Lower Hunter Spotted Gum – Ironbark Forest, and Ecotone (2003) indicated that it more closely resembled Hunter Lowland Redgum Forest (both of which are listed EEC's), it was considered important to clarify where the Sweetwater vegetation fits into the regional perspective. All data analyses utilised plot survey data collected by a single observer (with the exception of 11 sites from southern Gosford/ Pittwater) to reduce the error associated with multiple observers. All datasets underwent a taxonomic review prior to analysis to ensure consistency in plant naming between the various datasets.

3.3.1 Sweetwater

The sixty-two floristic survey plots undertaken at Sweetwater were subjected to cluster analysis using the Bray Curtis association measure, the agglomerative hierarchical fusion strategy using the flexible UPGMA technique, and with a Beta value of -0.1 . The full site dendrogram is reproduced in Figure 8.

Two major groups of sites are evident in the dendrogram, splitting at 1.1081 dissimilarity. By far the largest represents all of the grassy open forests, woodlands and scrubs typical of the mid-Hunter Valley. The second group comprises only three sites, and represents regrowth areas of riparian Swamp Oak (*Casuarina glauca*) forest. Such areas have been heavily invaded by Swamp Oak following previous clearing, and in many areas support monocultures of the species. Within the first group, six sub-clusters of sites can be recognised at the 0.6750 level of dissimilarity, which are here treated as distinct vegetation communities. Several variations within each of these sub-clusters are also evident, and are treated as associations within each community. Note that two additional vegetation communities have also been delineated based on field reconnaissance and mapping, but were not sampled using standard plots due to the large weed presence within each of them.

Table 4 summarises the vegetation communities and associations delineated for Sweetwater, classified within the framework of NPWS (2000a). Brief summaries of each community follow.

Table 4 Vegetation communities and associations present at Sweetwater.

REMS Unit	REMS Community	Sweetwater Association
3	Hunter Valley Dry Rainforest	3 <i>Backhousia myrtifolia</i> Gallery Rainforest
13	Central Hunter Riparian Forest	13a <i>Casuarina glauca</i> Riparian Forest (regrowth) 13b <i>Melaleuca decora</i> Floodplain Woodland 13c <i>Allocasuarina luehmannii</i> Floodplain Low Forest 13d <i>Melaleuca nodosa</i> Floodplain Scrub
14	Wollombi Redgum - River Oak Woodland	14a <i>C. cunninghamiana</i> – <i>C. glauca</i> Riparian Forest 14b <i>A. floribunda</i> Dune Forest (greatly disturbed) 14c <i>E. amplifolia</i> Depression Forest
18	Central Hunter Ironbark – Spotted Gum – Grey Box Forest	18a <i>Allocasuarina luehmannii</i> Low Forest 18b <i>E. molucana</i> Open Forest 18c <i>E. crebra</i> – <i>C. maculata</i> Open Forest 18d <i>C. maculata</i> – <i>Callitris endlicheri</i> Open Forest 18e <i>E. crebra</i> – <i>E. tereticornis</i> Open Forest 18f <i>E. eugenioides</i> Open Forest 18g <i>C. maculata</i> – <i>E. punctata</i> – <i>E. crebra</i> Open Forest 18h <i>E. fibrosa</i> – <i>C. maculata</i> Open Forest 18i <i>Angophora floribunda</i> Open Forest (regrowth) 18j <i>C. maculata</i> – <i>Allocasuarina torulosa</i> Open Forest 18k <i>Allocasuarina luehmannii</i> – <i>E. moluccana</i> Forest 18l <i>C. maculata</i> – <i>E. fibrosa</i> - <i>Melaleuca nodosa</i> Scrub-Forest 18m <i>C. maculata</i> – <i>E. crebra</i> – <i>Melaleuca nodosa</i> Scrub-Forest 18n <i>E. crebra</i> Grassy Open Forest 18o <i>E. glaucina</i> Grassy Forest 18p <i>E. albens</i> Grassy Forest
19	Hunter Lowlands Redgum Forest	19 <i>E. tereticornis</i> – <i>E. punctata</i> – <i>M. linariifolia</i> Riparian Forest
40a	<i>Phragmites</i> Rushland	40a <i>Phragmites</i> Rushland (old dams)

Unit 3: Hunter Valley Dry Rainforest

A small strip of vegetation adjacent to a tributary of Black Creek supports remnant dry rainforest dominated by *Backhousia myrtifolia*, together with emergent canopy species of *Eucalyptus amplifolia*, *Casuarina cunninghamiana* and *Angophora floribunda*. This area is heavily invaded by weed species in the understorey, particularly *Tradescantia albiflora*, *Cestrum parqui*, and *Cardiospermum grandiflorum*. However, some native species are present at low abundances, including *Adiantum aethiopicum*, *Pyrrosia rupestris*, *Plectranthus parvifolius*, *Clerodendrum tomentosum*, *Caraytia clematidea* and *Asplenium flabellifolium*. This remnant rainforest occurs between the tributary and a small rocky cliffline, which has protected the area from fire and heavy grazing.

Unit 13: Central Hunter Riparian Forest

The majority of areas mapped as Central Hunter Riparian Forest now support vigorous stands of the invasive *Casuarina glauca*. Although a native species which was probably present in the original vegetation, this species rapidly colonises disturbed areas following clearing.

Characteristically, monotypic stands of *Casuarina glauca* (+/- remnant emergent eucalypts) occur over a very sparse shrub layer of *Bursaria spinosa* and *Nicotiana* spp., and a dense ground layer of *Microlaena stipoides* var. *stipoides*, *Paspalidium albobillosum*, *Austrostipa ramosissima*, and *Cheilanthes distans*.

On the old floodplain sediments of Black Creek, three different associations occur which most closely fall within the Central Hunter Riparian Forest described by NPWS (2000a). The largest of these is a low forest or woodland dominated by *Melaleuca decora*. Prior to survey, this area had been recently underscrubbed and hence understorey composition was transitional. Despite this, grasses such as *Microlaena stipoides* var. *stipoides*, *Cynodon dactylon*, and *Aristida vagans*, together with *Cheilanthes sieberi* subsp. *sieberi* and various *Lomandra* spp. dominate. Other areas support monotypic stands of *Allocasuarina luehmannii* with little understorey, or dense low thickets of *Melaleuca nodosa*.

Unit 14: Wollombi Redgum – River Oak Woodland

Black Creek and its major tributaries are dominated by narrow bands of River Oak (*Casuarina cunninghamiana*) for much of its length. This community is heavily disturbed with an abundance of weed species, particularly *Cestrum parqui*, *Tradescantia albiflora*, *Macfaydena unguis-cati*, and *Cardiospermum grandiflorum*. *Casuarina glauca* is also becoming dominant in places where the original canopy has been removed. Some resilient native species do remain, such as *Lomandra longifolia* along high-energy banks, but the long term prospects for this vegetation are very poor. In many places, exotic vines extend to the upper canopy, and are gradually killing off individual River Oak specimens.

Two other variants of Wollombi Redgum – River Oak Woodland have been identified. The first of these is a heavily degraded yet very interesting area of *Angophora floribunda* growing on small sandy dunes and rises associated with the old Black Creek floodplain. Currently, this area supports many weeds in the understorey, together with native species such as *Pteridium esculentum*, *Hibbertia obtusifolia*, *Perotis rara*, *Cymbopogon refractus*, *Crotalaria mitchellii* subsp. *mitchellii*, *Microlaena stipoides* var. *stipoides*, *Eragrostis brownii*, *Cheilanthes sieberi* subsp. *sieberi*, *Glycine clandestina*, *Tricoryne elatior*, and *Lomandra multiflora* subsp. *multiflora*. This association has some immediate similarities to the Warkworth Sands Woodland EEC (see Peake et al. 2003), yet species such as *Banksia integrifolia* and *Melaleuca thymifolia* appear to be absent. The long history of disturbance on the Black Creek site makes a direct comparison of the two areas difficult, and the relationships will probably never be known. At present, the area supports a few scattered mature *Angophora floribunda* with several regrowth specimens.

The second variant recognised occurs adjacent to Black Creek at a single location, where *Eucalyptus amplifolia* dominates the canopy in a small drainage depression. Associated canopy species include *Eucalyptus tereticornis* and *Eucalyptus eugenioides*. This site has been grazed in the past, and had been underscrubbed prior to survey. The understorey present at the time of survey comprised a dense grass layer of *Imperata cylindrica* var. *major*, *Cynodon dactylon* and *Microlaena stipoides* var. *stipoides*, and a number of herb species.

Unit 18: Central Hunter Ironbark – Spotted Gum – Grey Box Forest

Central Hunter Ironbark – Spotted Gum – Grey Box Forest is by far the most widespread vegetation community within the study area, however the survey effort undertaken within this area has enabled a complex interaction of associations to be delineated. In general terms, this community is characterised by an open forest of *Eucalyptus crebra*, *Corymbia maculata*, and/or *Eucalyptus moluccana*, over a grassy understorey where *Aristida vagans*, *Cymbopogon refractus*, *Aristida ramosa*, *Eragrostis brownii* and *Microlaena stipoides* var. *stipoides* are prominent. Sixteen associations broadly fitting within the Central Hunter Ironbark – Spotted Gum – Grey Box Forest have been delineated and mapped:

- Bulloak Low Forest (18a) – monotypic stands of *Allocasuarina luehmannii* with a very sparse understorey of a few grasses and *Cheilanthes sieberi* subsp. *sieberi*.
- Grey Box Open Forest (18b) – a grassy open forest dominated by *Eucalyptus moluccana*, with occasional *Eucalyptus tereticornis* or *Eucalyptus glaucina*. A sub-canopy of *Melaleuca decora* may be present in undisturbed areas, although recently cleared areas support several grasses and herbs.
- Narrow-leaf Ironbark – Spotted Gum Open Forest (18c) – a shrubby open forest clearly dominated by varying combinations of *Eucalyptus crebra* and *Corymbia maculata*, with the occasional *Eucalyptus moluccana* in some areas. In places, a dense shrub layer of *Bursaria spinosa* occurs, possibly resulting from the long history of grazing.
- Spotted Gum – White Cypress Pine Open Forest (18d) – a few small areas in the central parts of the study area support an open forest with a sub-canopy of *Callitris endlicheri* within the wider Spotted Gum-dominated vegetation. This species is fire sensitive, and the presence of these areas suggests a long period free of intense fire.

- Narrow-leaf Ironbark – Forest Redgum Open Forest (18e) – an open forest with varying combinations of *Eucalyptus crebra* and *Eucalyptus tereticornis*, over a grassy understorey of *Aristida vagans*, *Aristida ramosa* and several herb species.
- Thin-leaf Stringybark Open Forest (18f) – present in three separate areas within the study area, this association is characterised by almost monotypic stands of *Eucalyptus eugenioides* over a grassy understorey, generally on lower slopes in close proximity to creeklines or floodplains.
- Spotted Gum – Grey Gum – Narrow-leaf Ironbark Open Forest (18g) – although Grey Gum (*Eucalyptus punctata*) occurs sporadically in many areas throughout the study area, in some it becomes co-dominant with *Corymbia maculata* and/or *Eucalyptus crebra*. Little floristic difference was evident between sites located on a rocky ridgeline in the west, and those of a broader lower slope/ drainage depression site, where *Melaleuca decora* was also present.
- Broad-leaf Ironbark – Spotted Gum Open Forest (18h) – sizeable areas in the eastern half of the study area support an open forest dominated by *Eucalyptus fibrosa* and *Corymbia maculata*. Understorey vegetation is often, but not always, comprised of *Daviesia ulicifolia* and/ or *Melaleuca nodosa*, over a grassy ground layer of *Aristida vagans*, *Cymbopogon refractus* and *Aristida ramosa*. While superficially similar to the Lower Hunter Spotted Gum – Ironbark Forest of NPWS (2000a), there are important floristic differences in the ground layer vegetation (see further analysis in Section 3.3.2).
- Rough-barked Apple Open Forest (18i) – a few small areas support an open forest of *Angophora floribunda* over a grassy understorey. These areas most likely represent previously cleared areas which have regenerated from remnant trees. Little floristic differences were evident between sites in these areas and those within other variations, but it has been retained as a separate map unit due to its distinctive canopy component.
- Spotted Gum – Forest Oak Open Forest (18j) – one area within the wider *Corymbia maculata* – dominated vegetation supports often dense stands of *Allocasuarina torulosa*. While the single plot located here did not differ significantly from other similar vegetation, the area has been retained as a distinct map unit due to its potential importance as a food source to threatened fauna (Glossy Black Cockatoo).

- Bulloak – Grey Box Forest (18k) – a single area of possibly previously disturbed Grey Box Open Forest now supports a dense sub-canopy of *Allocasuarina luehmannii*, although the remainder of the understorey differs little from the Grey Box Open Forest.
- Spotted Gum – Broad-leaf Ironbark – Melaleuca Scrub-Forest (18l) – within the more widespread Broad-leaf Ironbark – Spotted Gum Forest, a tall shrub layer or mid-canopy of *Melaleuca nodosa* occurs, which is reminiscent of the Lower Hunter Spotted Gum – Ironbark Forests around Cessnock.
- Spotted Gum – Narrow-leaf Ironbark – Melaleuca Scrub-Forest (18m) – as in unit 18l, localised stands of *Melaleuca nodosa* distinguish this type from the more widespread Spotted Gum – Narrow-leaf Ironbark Forest.
- Narrow-leaf Ironbark Grassy Forest (18n) – a widespread vegetation type where almost monotypic stands of *Eucalyptus crebra* occur over a predominantly grassy understorey. Much of this area has been grazed, maintaining the grass and herb layer.
- Slaty Red Gum Grassy Forest (18o) – a few small locations on the western ridgeline support regrowth stands of *Eucalyptus glaucina* over a grassy understorey. These areas have been moderately well grazed and support little or no shrub layer.
- White Box Grassy Forest (18p) – also on the western ridgeline, a few small pockets of *Eucalyptus albens* occur in previous grazing lands, with occasional shrubs such as *Maireana microphylla*.

Unit 19: Hunter Lowlands Redgum Forest

Within the study area, only a single drainage line adjacent to Wine Country Drive currently supports undisturbed vegetation representative of the Hunter Lowlands Redgum Forest. Other drainage lines in the eastern portion, although in poor condition, possibly originally supported a similar vegetation type. The dominance of *Eucalyptus tereticornis* with *Eucalyptus punctata* (and/or *Eucalyptus punctata* X *canaliculata*), together with the presence of *Melaleuca linariifolia* as a sub-canopy delineate this community. In places, *Casuarina glauca* may also occur, and this species is likely to have invaded following previous clearing.

Unit 40a: Phragmites Rushland

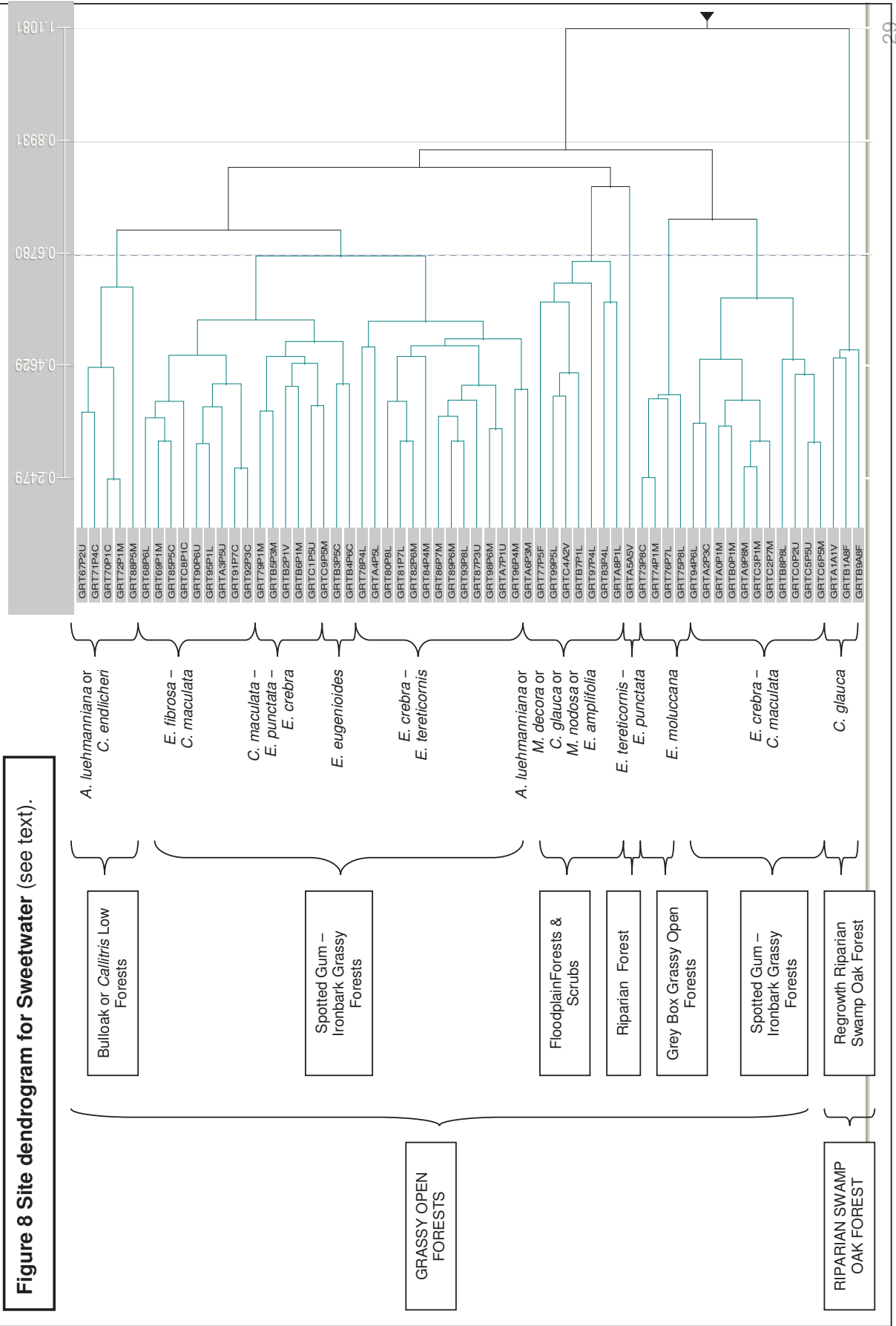
A small number of man-made dams and water bodies currently support stands of *Phragmites australis*, which equates to the community of the same name delineated by NPWS (2000a). Other dams support aquatic vegetation such as *Nymphoides germinata* and the introduced *Nymphaea caerulea* var. *zanzibarensis*, as well some stands of *Typha orientalis*.

3.3.2 Lower Hunter Spotted Gum – Ironbark Forest (LHSGIF)

Following on from the work presented in Driscoll and Bell (2004), the opportunity was taken to extend the regional analysis of Spotted Gum (*Corymbia maculata*) communities with incorporation of the Sweetwater data. Our experience in other projects has highlighted the need for a more thorough analysis of vegetation data in order to ascertain the identity of certain vegetation communities, particularly where Endangered Ecological Communities are involved. In doing this, more weight is applied to the science behind delineation of vegetation communities, and in effect advances understanding of regional vegetation patterns. Consequently, an additional 34 survey plots were added to the existing dataset to examine floristic similarities across nearly 200 survey sites. Evidently, data analyses indicated that the Spotted Gum – Ironbark vegetation present on the Sweetwater site aligns closer with vegetation elsewhere in the mid to upper Hunter Valley, than it does to the Lower Hunter Spotted Gum – Ironbark Forest around Cessnock. The following text details how this conclusion has been reached.

Cluster analysis using the Bray Curtis association measure, agglomerative hierarchical fusion strategy using the flexible UPGMA technique, and with a Beta value of –0.1 was undertaken on nearly 200 floristic survey sites. Figure 9 shows the resulting abbreviated dendrogram of sites, with all but one of the Sweetwater plots falling within the Central Hunter Spotted Gum – Grey Box – Ironbark Forest. Delineation of communities was undertaken at 0.7827 dissimilarity, where 14 groups of plots were recognisable.

Examining the dendrogram in further detail, the first major split occurs at ~ 1.24 dissimilarity, which separates the near-coastal, higher rainfall plots (top 6 clades) from the dryer, more inland ones (bottom 8 clades). Within the bottom clade, a further split occurs at ~ 1.12 distinguishing the lower Hunter Valley sites (top 6 clades) from the mid and upper Hunter Valley sites (bottom 2 clades). It is within this lower clade where 33 of the 34 Sweetwater plots fell, clearly distant from sites around Cessnock representing the Lower Hunter Spotted Gum – Ironbark Forest EEC. The one outstanding Sweetwater site grouped within the Upper Hunter Spotted Gum – Ironbark Forest.



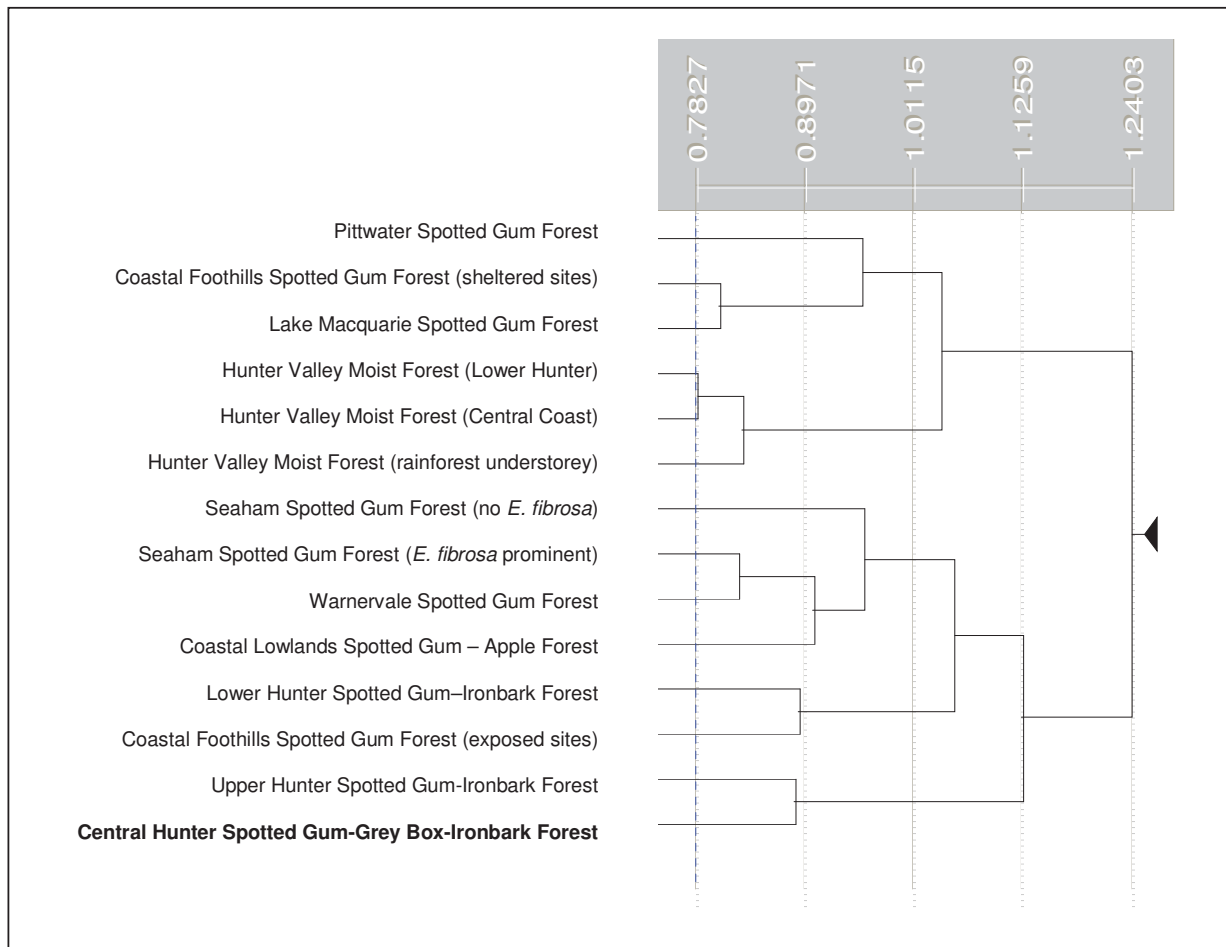


Figure 9 Abbreviated dendrogram (0.7827 dissimilarity) of 192 regional survey plots supporting Spotted Gum *Corymbia maculata* as a dominant or co-dominant species. Survey plots from Sweetwater are contained within the bottom clade, well distant from sites located immediately around Cessnock and in the Lower Hunter Spotted Gum – Ironbark Forest clade. Levels of dissimilarity are shown across the top axis.

Fidel analysis of the Spotted Gum data clearly distinguished between what we here refer to as Lower Hunter Spotted Gum – Ironbark Forest and Central Hunter Spotted Gum – Grey Box – Ironbark Forest. Cut-off points were set at 50% and a cover abundance of 2 or higher. Table 5 summarises the main diagnostic species for these two communities based on the available regional data. It is evident that distinguishing the two communities relies more on the ground layer vegetation than it does the canopy, particularly the herb and grass layer. There are no positively diagnostic shrub species present within the CHISGGBF, but a more diverse herb and grass layer.

Table 5 Constant, positively diagnostic and unique plant species for Lower Hunter Spotted Gum – Ironbark Forest (LHSGIF) and Central Hunter Ironbark - Spotted Gum – Grey Box Forest (CHISGGBF), as defined in the regional data analysis. ‘Constant’ = species consistently occurring across all community groups; ‘Positive’ = diagnostic species for that community; ‘Unique’ = species recorded only in that community within the dataset. Species are listed in decreasing order of importance.

Stratum	Stratum	Species	LHSGIF	CHISGGBF
Constant	Canopy	<i>Corymbia maculata</i>	✓	✓
	Shrub	-		
	Ground	<i>Entolasia stricta</i>	✓	
		<i>Cheilanthes sieberi sieberi</i>	✓	
		<i>Aristida vagans</i>	✓	
		<i>Lomandra multiflora</i>		✓
		<i>Microlaena stipoides stipoides</i>		✓
		<i>Aristida vagans</i>		✓
		<i>Pratia purpurascens</i>		✓
		<i>Entolasia stricta</i>		✓
		<i>Glycine clandestina</i>		✓
Positive	Canopy	<i>Eucalyptus fibrosa</i>	✓	
		<i>Eucalyptus crebra</i>		✓
	Shrub	<i>Persoonia linearis</i>	✓	
		<i>Grevillea montana</i>	✓	
		<i>Daviesia ulicifolia ulicifolia</i>	✓	
		<i>Melaleuca nodosa</i>	✓	
		<i>Acacia ulicifolia</i>	✓	
		<i>Grevillea parvifolia parvifolia</i>	✓	
		<i>Lissanthe strigosa</i>	✓	
	Ground	<i>Eragrostis brownii</i>	✓	✓
		<i>Phyllanthus hirtellus</i>	✓	
		<i>Pomax umbellata</i>	✓	✓
		<i>Lepidosperma laterale</i>	✓	
		<i>Joycea pallida</i>	✓	
		<i>Lomandra cylindrica</i>	✓	
		<i>Cassytha glabella f. glabella</i>	✓	
		<i>Anisopogon avenaceus</i>	✓	
		<i>Dianella revoluta revoluta</i>	✓	✓
		<i>Aristida ramosa</i>		✓
		<i>Cheilanthes sieberi sieberi</i>		✓
		<i>Cymbopogon refractus</i>		✓
		<i>Laxmannia gracilis</i>		✓
		<i>Oxalis perennans</i>		✓
		<i>Vernonia cinerea cinerea</i>		✓
		<i>Goodenia rotundifolia</i>		✓
		<i>Lomandra filiformis coriacea</i>		✓

		<i>Opercularia diphylla</i>	✓	
		<i>Fimbristylis dichotoma</i>	✓	
		<i>Glycine tabacina</i>	✓	
		<i>Paspalidium distans</i>	✓	
Unique	Canopy	<i>Corymbia eximia</i>	✓	
		<i>Eucalyptus punctata</i> X <i>canaliculata</i>	✓	
		<i>Angophora bakeri</i>	✓	
		<i>Allocasuarina luehmannia</i>		✓
		<i>Allocasuarina verticillata</i>		✓
		<i>Eucalyptus glaucina</i>		✓
	Shrub	<i>Astrotricha obovata</i>	✓	
		<i>Leptospermum parvifolium</i>	✓	
		<i>Isopogon anemonifolius</i>	✓	
		<i>Dillwynia trichopoda</i>	✓	
		<i>Acacia buxifolia</i>	✓	
		<i>Acacia kulnurensis</i>	✓	
		<i>Brachyloma daphnoides</i>	✓	
		<i>Melichrus procumbens</i>	✓	
		<i>Styphelia triflora</i>	✓	
		<i>Styphelia tubiflora</i>	✓	
		<i>Calytrix tetragona</i>		✓
	Ground	<i>Drosera peltata</i>	✓	
		<i>Gompholobium uncinatum</i>	✓	
		<i>Platysace ericoides</i>	✓	
		<i>Gompholobium minus</i>	✓	
		<i>Hibbertia linearis</i>	✓	
		<i>Linum marginatum</i>	✓	
		<i>Oxylobium pultenae</i>	✓	
		<i>Chrysocephalum semipapposum</i>	✓	
		<i>Genoplesium fimbriatum</i>	✓	
		<i>Laxmannia compacta</i>	✓	
		<i>Lepidosperma viscidum</i>	✓	
		<i>Microtis parviflora</i>	✓	
		<i>Oxalis chnoodes</i>	✓	
		<i>Paspalidium crinatum</i>	✓	
		<i>Thelymitra malvina</i>	✓	
		<i>Zornia dyctiocarpa dyctiocarpa</i>		✓
		<i>Chamaesyce</i> sp A		✓
		<i>Hibbertia riparia</i>		✓
		<i>Marsdenia viridiflora</i>		✓
		<i>Digitaria diffusa</i>		✓
		<i>Einadia trigonos</i> subsp. <i>leiocarpa</i>		✓
		<i>Hypoxis hygrometrica</i> var. <i>villosisepala</i>		✓
		<i>Lotus australis</i>		✓

Importantly, the presence of *Eucalyptus fibrosa* in the canopy is not a presumption that a particular community is Lower Hunter Spotted Gum – Ironbark Forest. Indeed, this species occurs across a wide range of habitats in the region, and within the fourteen Spotted Gum communities defined for the region in this analysis, this species occurs in seven of them. In order to demonstrate this aspect further, 57 sites were extracted from the regional dataset of Spotted Gum – Ironbark vegetation, where *Eucalyptus fibrosa* and *Corymbia maculata* co-occur. Cluster analysis was undertaken on this new dataset, again using the Bray Curtis association measure, agglomerative hierarchical fusion strategy using the flexible UPGMA technique, and with a Beta value of -0.1 . Five groups of sites are discernible at the 0.7148 dissimilarity level, with sites from the Cessnock area clearly distinct from all others (0.9735 dissimilarity). Sites from Sweetwater form a distinct clade within the Wallaroo-Beresfield sub-group (Figure 10).

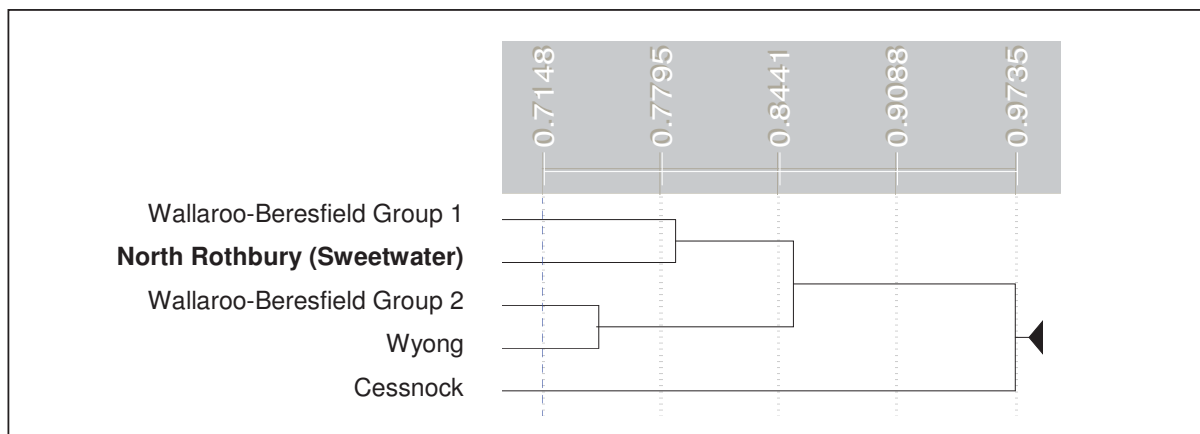


Figure 10 Abbreviated dendrogram (0.7148 dissimilarity) of 57 regional survey plots supporting Spotted Gum *Corymbia maculata* and Broad-leaf Ironbark *Eucalyptus fibrosa* as co-occurring species. Survey plots from Sweetwater are contained within the second top clade, well distant from sites located immediately around Cessnock. Levels of dissimilarity are shown across the top axis.

Floristic similarities and differences between what is here defined as Lower Hunter Spotted Gum – Ironbark Forest (LHSGIF – in the Cessnock area) and Central Hunter Ironbark – Spotted Gum – Grey Box Forest (CHISGGBF – in the Greta/ North Rothbury area) have been examined through a Fidel analysis of sites identified in the regional Spotted Gum analysis. Cut-off points of 50% plot frequency and cover abundances of greater than 2 were employed. All species occurring in less than 10% of plots were excluded. Appendix 2 shows the full species lists generated for each community, and a summary of the main diagnostic features is as follows:

- Species constantly occurring at high cover abundances (> 2) and frequency ($> 50\%$) of plots for both LHSGIF and CHISGGBF include *Corymbia maculata*, *Pomax umbellata*,

Eragrostis brownii, *Aristida vagans*, *Entolasia stricta*, *Dianella revoluta* var. *revoluta*, and *Cheilanthes sieberi* subsp. *sieberi*.

- LHS GIF is characterised in the canopy by *Corymbia maculata* and *Eucalyptus fibrosa*, together with a range of other unique species occurring less frequently. CHISGGBF is characterised by *Corymbia maculata* and *Eucalyptus crebra*, with other unique species including *Allocasuarina luehmannii* and *Eucalyptus tereticornis*. While *Eucalyptus fibrosa* also occurs in the CHISGGBF, *Eucalyptus crebra* has not been recorded in the LHS GIF.
- LHS GIF is characterised by a diverse and well-developed shrub layer, including high abundances and frequencies of *Persoonia linearis*, *Grevillea montana*, *Melaleuca nodosa*, *Daviesia ulicifolia* subsp. *ulicifolia*, *Lissanthe strigosa*, *Leptospermum parvifolium*, *Grevillea parvifolia* subsp. *parvifolia*, and *Acacia ulicifolia*. In contrast, CHISGGBF supports a poorly developed shrub layer, and contains the three unique species *Acacia parvipinnula*, *Indigofera australis* and *Cassinia arcuata*. Other species when present occur at significantly lower abundances.
- Important herb species within the LHS GIF include high frequencies of *Phyllanthus hirtellus*, and a range of less common but unique species such as *Platysace ericoides*, *Gompholobium uncinatum*, *Oxylobium pultenae* and *Drosera peltata*. CHISGGBF supports a more diverse herb layer, including high frequencies of *Vernonia cinerea* var. *cinerea*, *Laxmannia gracilis*, *Goodenia rotundifolia*, *Oxalis perennans*, *Hibbertia diffusa*, *Solanum prinophyllum*, and *Opercularia diphylla*, in addition to a range of less common but unique species.
- Both LHS GIF and CHISGGBF share high abundances and frequencies of the grasses *Eragrostis brownii*, *Entolasia stricta* and *Aristida vagans*, although the latter is more abundant in the CHISGGBF. Other important grass species in the LHS GIF include the uniquely occurring *Joycea pallida* and *Anisopogon avenaceus*. In contrast, grass species are far more prevalent in the CHISGGBF, with positively diagnostic species such as *Aristida ramosa*, *Cymbopogon refractus*, *Microlaena stipoides* var. *stipoides*, and *Paspalidium distans* occurring at greater frequencies, together with several other unique species.
- LHS GIF supports higher frequencies of *Lepidosperma laterale*, together with the unique *Lomandra cylindrica* and *Dianella prunina*. CHISGGBF supports high frequencies of

Lomandra multiflora subsp. *multiflora* and *Lomandra filiformis* subsp. *coriacea*, and the unique *Gahnia aspera*.

- LHSGIF supports the unique *Macrozamia reducta*, and higher frequencies of *Cassytha glabella* forma *glabella*, while CHISGGBF supports the unique *Cheilanthes distans* and higher frequencies of *Glycine clandestina*.

Evidently, the preceding data analyses have indicated that the Spotted Gum – Ironbark vegetation present on the Sweetwater site aligns closer with vegetation elsewhere in the mid to upper Hunter Valley, than it does to the Lower Hunter Spotted Gum – Ironbark Forest around Cessnock.

3.3.3 Hunter Lowlands Redgum Forest (HLRF)

A separate data analysis was also undertaken to ascertain whether or not the vegetation present at Sweetwater, referred to by Ecotone (2003) as comprising the Hunter Lowlands Redgum Forest EEC, did in fact differ from other sites supporting redgum eucalypts elsewhere in the region. To accomplish this, a new dataset of survey sites was prepared where one or more of the following redgum species were present:

- *Eucalyptus tereticornis*
- *Eucalyptus glaucina*
- *Eucalyptus amplifolia* subsp. *amplifolia*
- *Eucalyptus blakelyi*

Twelve of the 90 sites so amalgamated also contained *Eucalyptus punctata*, two had *Eucalyptus canaliculata*, and a further two supported *Eucalyptus punctata* x *canaliculata* hybrids. All three of these species are commonly referred to as Grey Gums, and *Eucalyptus punctata* is noted in the final determination for HLRF as being a co-dominant with *Eucalyptus tereticornis*. The analysis concentrated on sites supporting one or more of the four redgum species listed above, within the Hunter Valley – Central Coast – lower North Coast region.

After several analyses (with and without weeds, Kulczynski vs Bray-Curtis association measure), it was evident that while a few groups of sites remained consistent from analysis to analysis, there was a large group of sites where site mobility was high. Several groups of sites could be defined across the region, however it was not possible to define a group of sites that might represent the Hunter Lowland Redgum Forest. In his remnant vegetation study, Peake (2005) also found that

further survey and analysis was required to better define this community in the region. Figure 11 shows an abbreviated dendrogram of the redgum analysis, with communities defined at the 0.8 level of dissimilarity.

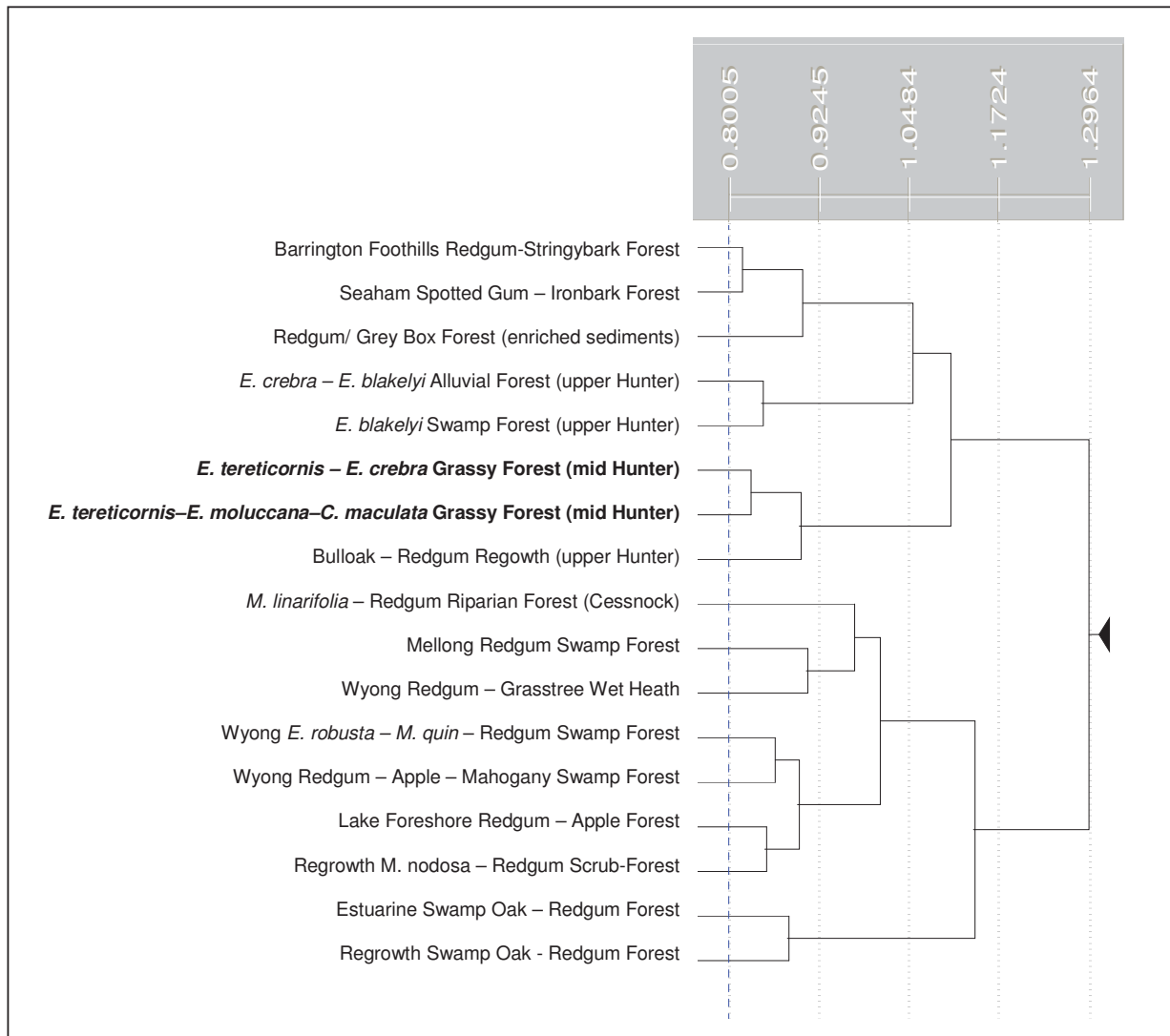


Figure 11 Abbreviated dendrogram (0.8005 dissimilarity) of 90 regional survey plots supporting redgums *Eucalyptus tereticornis*, *Eucalyptus blakelyi*, *Eucalyptus amplifolia*, *Eucalyptus glaucina*. Survey plots from Sweetwater occurred principally within the sixth and seventh clade from the top. Levels of dissimilarity are shown across the top axis.

3.3.4 Swamp Oak Floodplain Forest (SOFF)

An additional data analysis was carried out on all available data supporting *Casuarina glauca*, principally to address the potential occurrence of the Swamp Oak Floodplain Forest EEC. This

analysis examined 41 survey sites within the region, including six from the Sweetwater site, and all weeds were excluded. Figure 12 shows the resulting abbreviated dendrogram, illustrating the distinction between the estuarine swamp forests and sedgeland fringing coastal lagoons and estuaries, from all other sites (the first split in the dendrogram, at 1.1344 dissimilarity). The next division in the dendrogram occurs at 1.0864 dissimilarity, which separates all regrowth Swamp Oak sites from the Hunter Valley, including five of the Sweetwater sites. The sixth Sweetwater site occurs in a thicket of *Melaleuca nodosa* on the Black Creek floodplain, with emergent *Casuarina glauca*, and has consequently grouped within the third cluster from the top.

Given the evidence of this analysis, the Sweetwater study area is considered not to support the Swamp Oak Floodplain Forest EEC.

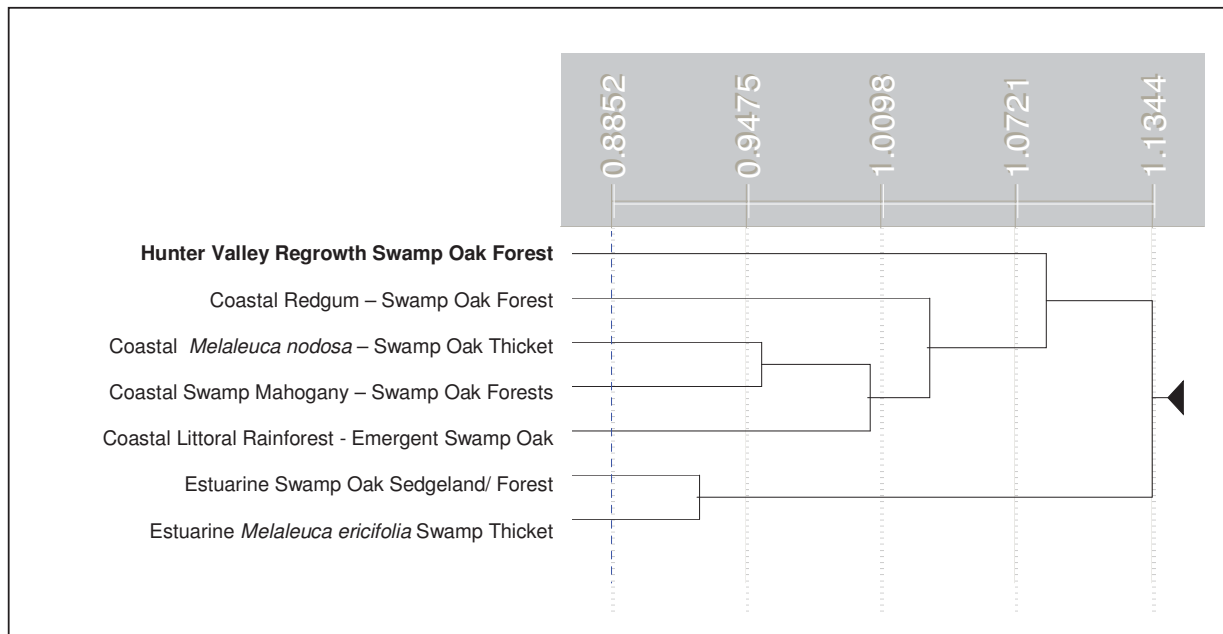


Figure 12 Abbreviated dendrogram (0.8852 dissimilarity) of 41 regional survey plots supporting Swamp Oak *Casuarina glauca*. Survey plots from Sweetwater are contained within the top clade, well distant from sites comprising the Estuarine Swamp Oak Forest (the SOOF EEC). Levels of dissimilarity are shown across the top axis.

3.3.5 River Flat Eucalypt Forest on Coastal Floodplains (RFEFCF)

The recently listed RFEFCF EEC aims to protect all floodplain vegetation occurring on periodically inundated alluvial flats, drainage lines and river terraces. For the Hunter Valley, the final determination specifically nominates the Central Hunter Riparian Forest and Wollombi Redgum-River Oak Woodland as forming a part of this EEC. Both of these communities, including variations within them, are present on the Sweetwater site and hence the EEC is present there.

3.3.6 White Box – Yellow Box – Blakely's Redgum Woodland (WBYBBRW)

A few small stands of White Box (*Eucalyptus albens*) have been mapped for the western ridgeline at Sweetwater. These stands occur in a highly modified and moderately grazed landscape, and appear to represent a disjunct occurrence of the species for this part of the Hunter Valley. The cluster analysis undertaken on the Sweetwater dataset (see Section 3.3.1) did not significantly differentiate the single plot sampled from this area, suggesting that the understorey composition is similar to the other grassy forests at Sweetwater. We have no available EEC plot data from which to analyse and compare the single plot undertaken, however it would appear that significant floristic differences are evident. The final determination for the White Box – Yellow Box – Blakely's Redgum EEC lists a number of plant species that are not present within the Sweetwater site. Peake (2005) considers his Upper Hunter White Box – Ironbark Grassy Woodland to fall within the WBYBBRW EEC, and this represents the only occurrence of the EEC within the Hunter Valley. He describes this vegetation for the Muswellbrook to Wingen area of the Upper Hunter Valley, a distance of some 50 km from Rothbury.

3.3.7 Warkworth Sands Woodland (WSW)

Highly degraded remnants of a woodland or forest dominated by *Angophora floribunda*, and occurring on low sandy dunes adjacent to Black Creek occur within the study area (unit 14b). While there is little floristic diversity in these remnant stands to analyse (no plots could be undertaken due to their highly degraded nature), the geomorphological conditions and the few native species present suggest a vegetation with some affinities to the Warkworth Sands Woodland. Peake et al. (2002) report that the WSW EEC comprises *Angophora floribunda*, *Banksia integrifolia*, *Acacia filicifolia*, *Pteridium esculentum* and *Imperata cylindrica* var. *major*, together with a range of other less abundant species. Peake (2005) also describes a variant of the Warkworth Sands Woodland occurring in the Singleton Military Area, where *Eucalyptus punctata* occurs, and *Banksia integrifolia* is absent. At Sweetwater, scattered and regrowing *Angophora floribunda* occur over *Pteridium esculentum*, *Hibbertia obtusifolia* and several grasses and weeds. The highly degraded nature of the site ensures that the true identity of the community will remain unknown.

Another potential identity for this vegetation at Sweetwater may be the similar low sandy rises present in the Cessnock area, which are possibly related to the sandy alluvial deposits associated with the Kurri Sands Swamp Woodland EEC. This vegetation is again dominated by *Angophora floribunda* and *Pteridium esculentum*, and has been identified in the Tomalpin and Abermain areas of Cessnock (Bell 2004c; Driscoll & Bell 2004; Bell 2004d).

3.3.8 Freshwater Wetlands on Coastal Floodplains (FWCF)

Freshwater Wetlands on Coastal Floodplains support some vegetation that also colonises old, disused farm dams and the like. The final determination for this EEC identified the Freshwater Wetland Complex of NPWS (2000a) as included within the FWCF, but none of this community occurs on the Sweetwater site. Several species listed in the final determination are present within the many disused farm and colliery dams, however such occurrences are not included within the EEC.

3.3.9 Kurri Sands Swamp Woodland (KSSW)

Kurri Sands Swamp Woodland occurs principally in the Cessnock to Kurri area of the lower Hunter Valley, on sandy substrates. It supports an open woodland or forest structure, over a heathy understorey of plant species largely from the Proteaceae, Fabaceae and Myrtaceae plant families. No vegetation present within the Sweetwater site qualifies as this vegetation community.

3.4 Vegetation mapping

Mapping of floristic vegetation communities was heavily based on field reconnaissance, but also considered the results of the cluster analysis. As such, there is a high degree of accuracy within the final map, as all polygons have been visited. Patterns in vegetation distribution throughout Sweetwater are provided as Figure 13, where all floristic variations observable in the field have been mapped and placed within the NPWS (2000a) classification. A second map (Figure 14) was also prepared which shows the vegetation distribution using the broad NPWS (2000a) units. This map was developed by merging all mapped variations into the parent map unit, and provides a considerably more simplistic view of the vegetation present. The main difference between this latter map and the original model produced through the REMS project (NPWS 2000a) is that map unit 17 (Lower Hunter Spotted Gum – Ironbark Forest) has now been replaced by map unit 18 (Central Hunter Ironbark – Spotted Gum – Grey Box Forest).

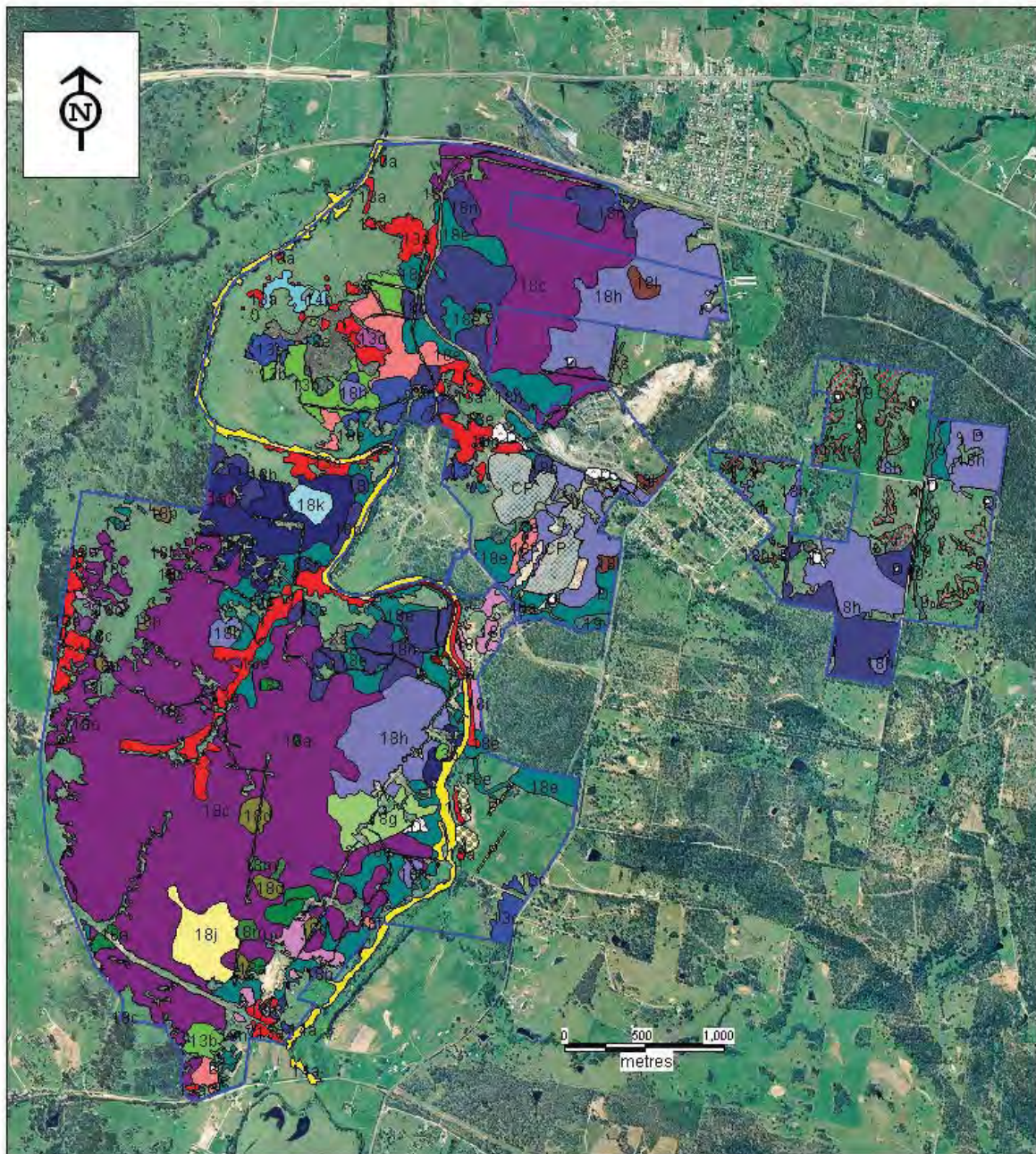


Figure 13 Vegetation map of the Sweetwater site, showing all floristic variations present. See text for details.

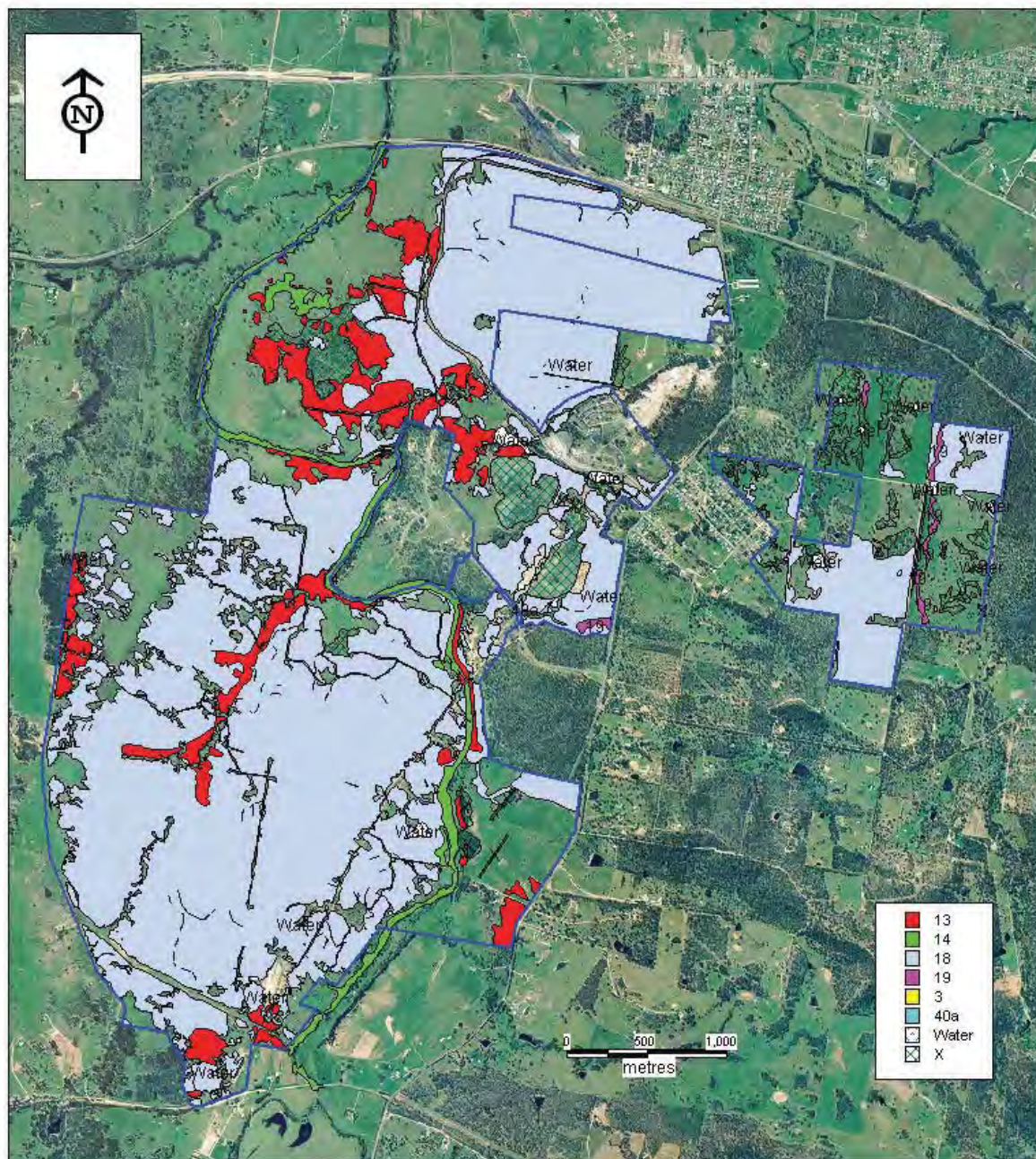


Figure 14 Vegetation map of the Sweetwater site, based on the NPWS (2000) classification. See text for details.

4.0 Discussion and Conservation Significance

4.1 *The Sweetwater flora*

The native vegetation of Sweetwater includes a range of vegetation communities and flora species that are generally poorly reserved throughout the lower Hunter Valley. Of particular interest is the number of plant species occurring which are more typical of western inland locations, and which occur as disjunct populations at Sweetwater. Survey and analysis undertaken for the current study has identified over three hundred and twenty-five plant taxa and six vegetation communities, the latter comprised of several sub-communities or associations. One endangered (*Persoonia pauciflora*), two vulnerable (*Eucalyptus glaucina*, *Eucalyptus parramattensis* subsp. *decadens*) and four rare (*Acacia bulgaensis*, *Eucalyptus fergusonii*, *Grevillea montana*, *Macrozamia flexuosa*) plant species are present on the site. In addition, the site supports suitable habitat for the undescribed *Diuris* sp aff. *dendrobioides* (Hunter Valley), and two locations supporting the species were located. Two Endangered Ecological Communities (Hunter Lowlands Redgum Forest, River-Flat Eucalypt Forest on Coastal Floodplains), as listed on the *Threatened Species Conservation Act 1995*, are present on the site.

The Sweetwater site also plays an important role in wildlife corridors in the mid-lower Hunter Region. In their regional corridor mapping, NPWS (2003, and see Scotts & Drielsma 2003) have identified two regional corridors (the Allandale and Sweetwater corridors) merging within the study area. The Allandale corridor links to Werakata National Park in the south-east, while the Sweetwater corridor links with Belford National Park to the north and Pokolbin State Forest in the south-west. In addition, two sub-regional corridors have been identified, the Rothbury Creek corridor running to the south, and the Branxton corridor running between the townships of Branxton and North Rothbury. Figure 15 shows these mapped corridors.

Corridors mapped by NPWS (2003) are broad in nature and, in general, have not been assessed on the ground for their suitability to facilitate the movement of plant pollinators and propagules and other fauna migrations. In addition, some sections of designated corridors require the co-operation of many landholders to either retain remnant vegetation that may occur on their properties, or to revegetate vital linkage areas. Consequently, any development proposed for the land at Sweetwater will need to address the issue of wildlife corridors previously identified in the area by NPWS (2003), including on-ground inspection of corridor proposals and collaboration with affected neighbours.

As mentioned, Sweetwater currently supports a number of plant taxa that more typically occur further inland, and which exist in the North Rothbury area as outliers or as remnants of their natural distribution prior to European settlement. Such species would include *Allocasuarina luehmannii*, *Allocasuarina verticillata*, *Brachychiton populneus*, *Callitris endlicheri*, *Canthium buxifolium*, *Chenopodium carinatum*, *Dodonaea truncatiales*, *Einadia nutans* subsp. *linifolia*, *Eucalyptus albens*, *Eucalyptus microcarpa*, *Maireana microphylla*, *Marsdenia viridiflora* subsp. *viridiflora*, *Myoporum montanum*, *Notelaea microcarpa* var. *microcarpa*, *Nyssanthus diffusa*, and *Sarcostemma brunonianum*.



Figure 15 Location of wildlife corridors (including corridor names) mapped by NPWS (2003).

4.2 Comparison with previous projects

Classification and mapping of the vegetation within Sweetwater has allowed direct comparisons to be made with the classification and modeling undertaken during the LHCCREMS project (NPWS 2000a), as well as that completed by the Hunter Catchment Management Trust (now the Hunter-Central Rivers CMA) (Peake 2005). In general, the finer scale of investigation allowable in the current study has greatly improved upon the LHCCREMS framework for the Cessnock LGA, while it has also confirmed or clarified the mapping of Peake (2005) for the Singleton LGA area.

Table 6 presents a comparison of the two existing classifications with that reported in the current work. As can be seen, the classification of Peake (2005) closely mirrors that reported here for Sweetwater, while both can be broadly included in the six broad NPWS (2000a) units.

In regard to the mapping outputs, the following points summarise the refinements:

- in the LHCCREMS mapping, Lower Hunter Spotted Gum – Ironbark Forest occupies virtually all of the Cessnock LGA portion of the site (Singleton LGA was not included within the LHCCREMS project). Data analysis for the current project has shown that this community can more accurately be depicted as Central Hunter Ironbark – Spotted Gum– Grey Box Forest, and conforms generally to the mapping of Peake (2005) for this area;
- a number of floristic variations are discernible in the field within the Central Hunter Ironbark – Spotted Gum– Grey Box Forest, and these could not be identified during the LHCCREMS project. Some of these have been noted in Peake (2005);
- the distribution of Hunter Lowlands Redgum Forest throughout most of the area as shown in the LHCCREMS mapping, while not spatially correct, does approximate the ground situation reasonably well.

The main consequences of this revised mapping for Sweetwater are that the large expanses of what was formally mapped as the Lower Hunter Spotted Gum – Ironbark Forest EEC cannot be supported by the current data. However, the Central Hunter Ironbark - Spotted Gum - Grey Box Forest, its replacement, is considered a regionally significant vegetation community with very poor reservation in formal conservation reserves (Peake 2005).

4.3 Threatened & Rare taxa

During the course of current and previous survey work, several species of conservation significance have been recorded for Sweetwater. In total, one endangered (*Persoonia pauciflora*), two vulnerable (*Eucalyptus glaucina*, *Eucalyptus parramattensis* subsp. *decadens*), four rare (*Acacia bulgaensis*, *Eucalyptus fergusonii* subsp. *dorsiventralis*, *Grevillea montana*, *Macrozamia*

flexuosa) and several species of regional significance (see Table 7) were detected. Regional significance is based on the listing of species maintained by the Rare Plants Subcommittee of the Hunter Region Botanic Gardens (Bell, Peake, Tame, Simpson & Curran in prep.). In addition, one undescribed and potential new taxa (*Diuris* sp aff *dendrobioides* Hunter Valley) was recorded, and additional surveys targeting this species are recommended for subsequent flowering seasons, as many orchid species do not flower consistently from year-to-year. Specimens of all significant species have been lodged at the National Herbarium, Sydney.

4.3.1 Undescribed Species

***Diuris* sp. aff. *dendrobioides* (Hunter Valley).**

Diuris sp. aff. *dendrobioides* (Hunter Valley) is a terrestrial Donkey Orchid restricted to the lower Hunter Valley (Figure 16). Bishop (1996) describes this taxon as a distinct entity occupying a restricted zone in the Belford-Branxton locality. Previous records for this taxon exist for the Belford National Park area (L. Copeland, pers. comm.) and in the vicinity of Stanford Merthyr within Kurri Sand Swamp Woodland (M. Roderick, pers. comm.). This species is currently not listed as threatened in New South Wales, however given its very restricted range and the extent of fragmentation to its habitat, it certainly qualifies for listing.



Figure 16 *Diuris* sp aff *dendrobioides*
(Hunter Valley) at Sweetwater

Table 6 A comparison of vegetation classifications for Sweetwater, the Hunter Valley remnant vegetation project (Peake 2005), and the LHCCREMS (NPWS 2000a).

Sweetwater (current classification)		Peake (2005)		NPWS (2000a)	
3	<i>Backhousia myrtifolia</i> Gallery Rainforest	1	Lower Hunter Dry Rainforest	3	Hunter Valley Dry Rainforest
13a	<i>Casuarina glauca</i> Riparian Forest (regrowth)	28	Central Hunter Swamp Oak Forest	13	Central Hunter Riparian Forest
13b	<i>Melaleuca decora</i> Floodplain Woodland	17	Central Hunter Paperbark Soaks Woodland		
13c	<i>Allocasuarina luehmianii</i> Floodplain Low Forest	32	Central Hunter Bullock Forest Regeneration		
13d	<i>Melaleuca nodosa</i> Floodplain Scrub	24	(?) Hunter Lowland Red Gum Forest (variant)		
14a	<i>C. cunninghamiana</i> – <i>C. glauca</i> Riparian Forest	30	Hunter Valley River Oak Forest	14	Wollombi Redgum - River Oak Woodland
14b	<i>A. floribunda</i> Dune Forest (greatly disturbed)	14	(?) Warkworth Sands Woodland (variant)		
14c	<i>E. amplifolia</i> Depression Forest	22	Wollombi Alluvial Redgum – Apple Forest (variant)		
18a	<i>Allocasuarina luehmianii</i> Low Forest	32	Central Hunter Bullock Forest Regeneration	18	Central Hunter Ironbark–Spotted Gum–Grey Box Forest
18b	<i>E. moluccana</i> Open Forest	27	Central Hunter Ironbark – Spotted Gum – Grey Box Forest		
18c	<i>E. crebra</i> – <i>C. maculata</i> Open Forest	27	Central Hunter Ironbark – Spotted Gum – Grey Box Forest		
18d	<i>C. maculata</i> – <i>Callitris endlicheri</i> Open Forest	27	Central Hunter Ironbark – Spotted Gum – Grey Box Forest		
18e	<i>E. crebra</i> – <i>E. tereticornis</i> Open Forest	27	Central Hunter Ironbark – Spotted Gum – Grey Box Forest		
18f	<i>E. eugenoides</i> Open Forest	22	(?) Wollombi Alluvial Redgum – Apple Forest (variant)		
18g	<i>C. maculata</i> – <i>E. punctata</i> – <i>E. crebra</i> Open Forest	27	Central Hunter Ironbark – Spotted Gum – Grey Box Forest		
18h	<i>E. fibrosa</i> – <i>C. maculata</i> Open Forest	27	Central Hunter Ironbark – Spotted Gum – Grey Box Forest		
18i	<i>Angophora floribunda</i> Open Forest (regrowth)	n/a			
18j	<i>C. maculata</i> – <i>Allocasuarina torulosa</i> Open Forest	27	Central Hunter Ironbark – Spotted Gum – Grey Box Forest		
18k	<i>Allocasuarina luehmianii</i> – <i>E. moluccana</i> Forest	27	Central Hunter Ironbark – Spotted Gum – Grey Box Forest		
18l	<i>C. maculata</i> – <i>E. fibrosa</i> - <i>Melaleuca nodosa</i> Scrub-Forest	27	Central Hunter Ironbark – Spotted Gum – Grey Box Forest		
18m	<i>C. maculata</i> – <i>E. crebra</i> – <i>Melaleuca nodosa</i> Scrub-Forest	27	Central Hunter Ironbark – Spotted Gum – Grey Box Forest		
18n	<i>E. crebra</i> Grassy Open Forest	27	Central Hunter Ironbark – Spotted Gum – Grey Box Forest		
18o	<i>E. glauca</i> Grassy Forest	27	Central Hunter Ironbark – Spotted Gum – Grey Box Forest		
18p	<i>E. albens</i> Grassy Forest	27	Central Hunter Ironbark – Spotted Gum – Grey Box Forest		
19	<i>E. tereticornis</i> – <i>E. punctata</i> – <i>M. linearifolia</i> Riparian Forest	24	Hunter Lowland Red Gum Forest	19	Hunter Lowlands Redgum Forest
40a	<i>Phragmites</i> Rushland (old dams)	n/a		40a	<i>Phragmites</i> Rushland

While this species was targeted during field surveys, an underscrubbing program running concurrently meant that considerable areas of potential habitat could not be surveyed in time. Never-the-less, two locations were recorded supporting the species, centred around the open forest of Grey Box (*Eucalyptus moluccana*) in the west. However, it is recommended that further targeted surveys for this taxon be undertaken in the 2005-2006 flowering season (early September).

4.3.2 Endangered Species

Persoonia pauciflora P.H. Weston.

Persoonia pauciflora (Figure 17) is a highly endemic species known only from the North Rothbury area (Weston 1999). It is currently listed as Critically Endangered on the Commonwealth *Environmental Protection and Biodiversity Conservation Act 1999* and Endangered (Schedule 1) on the NSW *Threatened Species Conservation Act 1995*, and is subject to a number of threats including land clearing and agricultural activities. There are currently no known populations within secure conservation reserves, and the total known population (of about 250 plants) occurs within a radius of 2 km of North Rothbury. Weston (1999) described the habitat for this species as dry sclerophyll forest dominated by *Eucalyptus fibrosa*, *Eucalyptus moluccana*, *Eucalyptus punctata* and *Corymbia maculata*, over a grassy understorey. Further studies on the ecology of this species are in progress (G. Patrick, pers. comm.).



Figure 17 *Persoonia pauciflora* at Sweetwater.

The bulk of the population of *Persoonia pauciflora* is centred adjacent to the Sweetwater site along Tuckers Lane. However, a small number of plants are present within the study area, mostly

occurring as single individuals or small, loose groups. All plants occur within the Central Hunter Ironbark – Spotted Gum – Grey Box Forest.

4.3.3 Vulnerable Species

***Eucalyptus glaucina* Blakely**

Hill (2002) describes *Eucalyptus glaucina* as a tree to 30 m in height, locally frequent but sporadic in grassy woodland on deep moderately fertile and well-watered soils near Casino and from Taree to Broke. This species is currently listed as Vulnerable on both the Commonwealth *Environmental Protection and Biodiversity Conservation Act 1999* and NSW *Threatened Species Conservation Act 1995*, and is also listed as 3VCa by Briggs & Leigh (1996). Populations of *Eucalyptus glaucina* are known from Selection Flat Flora Reserve on the NSW North Coast, where presumably more than 1000 individuals occur (Briggs & Leigh 1996), and also in part of Werakata National Park (Bell 2004a). In his survey of State Forests, Binns (1996) did not record *Eucalyptus glaucina* from anywhere within the Morisset forestry district, but suggested that if it did occur it would most likely be on the lower slopes or valley flats of Pokolbin State Forest. During studies undertaken at the Hunter Employment Zone near Cessnock, this species was considered by Ken Hill (National Herbarium of NSW) to occur within hybrid swarms with *Eucalyptus tereticornis* (see Bell 2004a).



Figure 18 *Eucalyptus glaucina* regrowth at Sweetwater.

A number of individuals and small populations of *Eucalyptus glaucina* were recorded in the western parts of the study area, often but not always occurring with *Eucalyptus tereticornis* or *Eucalyptus moluccana*. It is apparent that within the study area considerable hybridisation is occurring, which is indicated by the strongly glaucous juvenile leaves and branchlets, which progressively lose this character trait as trees mature. Regrowth throughout the areas of the study area underscrubbed during the survey period enabled a good indication of where populations of *Eucalyptus glaucina* may be found (see Figure 18).

As with most other occurrences of this species in the Hunter Valley, all sites have been grazed in the past, leaving an open grassy understorey with only scattered shrubs. As in the population of *Eucalyptus glaucina* near Mt Tomalpin (Bell 2004c), it would be a very difficult task to provide accurate population counts of the species without examining every tree, supported by genetic studies.

Eucalyptus parramattensis* subsp. *decadens L.A.S. Johnson & Blaxell

Eucalyptus parramattensis subsp. *decadens* is a small tree to 15m in height, occurring in dry sclerophyll woodland on sandy soils in low, often wet, sites, from Tomago to Kurri Kurri (Hill 2002). It is currently listed as Vulnerable on both the Commonwealth *Environmental Protection and Biodiversity Conservation Act 1999* and NSW *Threatened Species Conservation Act 1995*, and is also listed as 2V by Briggs & Leigh (1996). Conserved populations occur within Werakata National Park near Cessnock (Bell 2004a), with the Tomago populations present within Crown Reserve but subject to water extraction activities by Hunter Water (Bell & Fallding 2002).

A single, healthy individual of *Eucalyptus parramattensis* subsp. *decadens* was discovered by Allan Richardson of HSO in the southern part of the study area, in a small drainage line associated with sandstone bedrock material, and surrounded by Central Hunter Ironbark – Spotted Gum – Grey Box Forest (see Figure 19). This find is considered to be very significant, as the specimen occurs well north (at least 10km) of the currently accepted distributional range of this taxon, and is also present in currently undocumented habitat for the species. The main populations of this taxon occur in the Cessnock-Kurri region to the south, and also on the Tomago Sandbeds to the east in Port Stephens Shire. At both of these locations, *Eucalyptus parramattensis* subsp. *decadens* occurs on deep sand or clay substrates, generally well above any bedrock material. The single specimen recorded for the Sweetwater site may represent a vestige of what may have occurred prior to European settlement, which may have been a small disjunct population at the northern limit of the main population.



Figure 19 *Eucalyptus parramattensis* subsp. *decadens* at Sweetwater

4.3.4 Rare Species

Acacia bulgaensis Tind. & S.J. Davies

Tindale, Kodala & Davies (1992) described *Acacia bulgaensis* as common in the vicinity of Bulga, Milbrodale and Broke on the edge of the sandstone escarpment south of Singleton. Subsequent to this work, extensive survey of the adjacent Yengo NP has revealed substantial populations of this species (Bell, Vollmer & Gellie 1993; Maryott-Brown & Wilks 1993), which suggests a revision of the ROTAP code of 2RC- applied by Briggs & Leigh (1996) can be made. Indeed, Maryott-Brown & Wilks (1993) state that all sites visited during their survey had large population levels (greater than 1000 plants). Bell (1998a) also reports the species for the north-eastern section of Wollemi NP, where it adjoins Yengo NP, while Binns (1996) notes this species as common in a portion of Pokolbin SF excluded from logging.

At Sweetwater, *Acacia bulgaensis* is represented by two individuals in the west, within open grassy forest of *Eucalyptus tereticornis*, *Eucalyptus moluccana* and *Eucalyptus crebra*. It is highly disjunct

from other known populations (25-30km to the south-west & west), and occurs on a different geological substrate material (Permian sediments vs Narrabeen Sandstones elsewhere).

Eucalyptus fergusonii* subsp. *dorsiventralis L. Johnson & K. Hill

Eucalyptus fergusonii subsp. *dorsiventralis* is an ironbark tree to 25m in height, growing in dry sclerophyll forest on sandstone ridges, in the Wollombi Valley and the Wollemi Wilderness (Hill 2002). This species is currently listed by Briggs & Leigh (1996) with a conservation risk code of 2RC-, indicating a rare species with a geographical distribution of less than 100km, and with unknown population sizes in conservation reserves. The species is known from Wollemi National Park (Briggs & Leigh 1996; Bell 1998a), Yengo National Park (Bell, Vollmer & Gellie 1993; Maryott-Brown & Wilks 1993), and Watagans National Park (Bell 2002), Pokolbin and Yango State Forests (Bell 1995; Binns 1996), and in the north-western sections of Heaton State Forest (Bell 2000). Bell (2001) has suggested that the increase in records of this species from throughout the Hunter region warrants downgrading of the conservation risk code to 2RCa (adequately conserved).

At Sweetwater, a small population of *Eucalyptus fergusonii* subsp. *dorsiventralis* was recorded along the rocky ridgeline in the south-west of the site, within Central Hunter Ironbark - Spotted Gum – Grey Box Forest. Note that the distinction between the two subspecies of this species (*fergusonii* and *dorsiventralis*) can be subtle in some areas, and it is likely that the two may be merged in the future (K. Hill, pers. comm.). Records of both subspecies exist for the general Rothbury locality.

Grevillea montana R. Br.

Currently listed as a rare species by Briggs & Leigh (1996), with a conservation code of 2KC-, *Grevillea montana* is restricted to the southern rim of the Hunter Valley from Sandy Hollow to Kurri Kurri (Olde & Marriott 1994; Makinson 2002). In recent years, survey work in national parks (eg: Wollemi NP, Yengo NP, Werakata NP) and other semi-protected areas (eg: HEZ 7(b) lands, Myambat Logistics Company, Singleton Military Area) has revealed substantial populations which suggest the revision of this code to 2RCa (Bell 2001).

Grevillea montana occurs in a few key areas at Sweetwater, although it does not grow as prolifically as in some areas around Cessnock (eg Werakata NP, Bell 2004a). Areas in which the species is common in the understorey are on the northern, western and eastern ridgelines. The Sweetwater populations potentially occur at their northern limit of distribution in the North Rothbury area, although a disjunct population has been reported at Rosebrook Ridge near Maitland (Hill 2003).

***Macrozamia flexuosa* C. Moore**

Macrozamia flexuosa is a rare species currently listed with a conservation code of 2K (Briggs & Leigh 1996), and occurs generally from Bulahdelah to Lake Macquarie (Hill 1998). This species is currently known from Glenrock SRA (Bell 1998b), Lake Macquarie SRA and Pulbah Island NR (Bell 1998c), Werakata National Park (Bell 2004a), and Karuah and Wallaroo Nature Reserves (Bell 2002b). Additional populations exist in numerous other semi-protected areas in the region (eg: HEZ 7(b) lands).

A small number of locations of this species occur within Sweetwater, where it occurs in the Central Hunter Ironbark - Spotted Gum - Forest. Its occurrence at Sweetwater most likely represents its north-western distributional limit, as the availability of suitable habitat diminishes rapidly in lands to the north.

Other threatened or rare species potentially present

With continuing survey, it is considered reasonable that some additional threatened or rare species may occur within Sweetwater. For example, *Rutidosia heterogama* (Vulnerable) has been recently discovered in a number of locations on the Central Coast and lower Hunter Valley, particularly around Cessnock. Bell and Driscoll (2004) have documented the known populations of this species in the region, and although targeted during the current surveys, no specimens could be located.

4.3.5 Regionally significant species

A small number of additional taxa are present within Sweetwater that are considered to be regionally significant in the Hunter Valley (Bell *et al* in prep.). These taxa are summarised in Table 7. None of these species are legally protected, nor require addressing under threatened species legislation. However, all contribute to the diversity of vegetation present within the study area, and also allude to the vegetation present in the wider locality prior to European settlement.

4.4 Significant vegetation types

Much of the vegetation within Sweetwater supports vegetation of conservation significance, either through the presence of Endangered Ecological Communities or other communities considered to hold regional significance. These latter communities are considered important due to their general rarity, or their lack of adequate reservation in formal conservation reserves.

Table 7 Regionally significant taxa (excluding listed threatened, rare or undescribed species).

Species	Regional significance	Occurrence at Sweetwater
<i>Allocasuarina verticillata</i>	range extension; disjunct occurrence	western portions
<i>Angophora subvelutina</i>	uncommon, few regional records	two locations along old mine road
<i>Callitris endlicheri</i>	disjunct easterly occurrence	few locations in the south-west
<i>Crotalaria mitchellii</i> subsp. <i>mitcheilii</i>	southern distributional limit	sandy areas along Black Creek
<i>Eucalyptus albens</i>	easterly occurrence	western ridgeline
<i>Eucalyptus microcarpa</i>	disjunct occurrence	extreme south of the area
<i>Geijera salicifolia</i> var. <i>latifolia</i>	westerly distributional limit	single occurrence in west
<i>Gompholobium inconspicuum</i>	northerly extension of range	across the study area
<i>Hibbertia polyantha</i> ms	undescribed	scattered
<i>Maireana microphylla</i>	disjunct easterly occurrence	few locations in the west
<i>Notelaea microcarpa</i> var. <i>microcarpa</i>	disjunct easterly occurrence	few locations
<i>Perotis rara</i>	southern distributional limit	sandy areas along Black Creek
<i>Sarcostemma brunonianum</i>	disjunct eastern occurrence	single location in the east

LHCCRBCS (2003) have assessed the conservation status of vegetation communities within the lower Hunter Valley and Central Coast, based on the classification and mapping of NPWS (2000a). They identified a number of vegetation communities that would qualify for listing on the Commonwealth EPBC Act, the NSW TSC Act, or that should be considered of regional significance. LHCCRBCS (2003) list the following communities of significance relevant to Sweetwater (see Table 4 in Section 4.2):

- Central Hunter Ironbark – Spotted gum – Grey Box Forest (Commonwealth, Regional)
- Hunter Lowlands Redgum Forest (Commonwealth, State)
- Wollombi Redgum – River Oak Forest (Commonwealth, Regional)
- Hunter Valley Dry Rainforest (Commonwealth, Regional)
- Central Hunter Riparian Forest (Commonwealth, Regional)
- Phragmites Rushland (Regional)

Following a similar assessment process, Peake (2005) has also assessed the conservation significance of his 35 vegetation communities occurring on the Hunter Valley floor. He identifies the

following vegetation communities considered equivalent to vegetation at Sweetwater (see Table 4 in Section 4.2) as meeting the criteria for listing on the EPBC Act:

- Lower Hunter Dry Rainforest
- Central Hunter Paperbark Soaks Woodland
- Wollombi Alluvial Redgum-Apple Forest
- Hunter Lowland Redgum Forest
- Central Hunter Ironbark – Spotted Gum – Grey Box Forest
- Hunter Valley River Oak Forest
- Central Hunter Bull Oak Forest Regeneration

Both the LHCCREMS (2003) and Peake (2005) assessments indicate that virtually all of the remnant vegetation present at Sweetwater qualifies for listing on the EPBC Act as an endangered or vulnerable community, which would also translate to endangered ecological communities on the NSW TSC Act. At present, only the Hunter Lowlands Redgum Forest EEC and River Flat Eucalypt Forest on Coastal Floodplains EEC are present on the site; however, all other communities should be regarded as regionally significant.

4.4.1 Endangered Ecological Communities

Potentially, seven Endangered Ecological Communities occur within the Sweetwater study area. However, as has been demonstrated in Section 3.3, only two of these are present (see Figure 20):

- Hunter Lowlands Redgum Forest EEC
Unit 19: *E. tereticornis* – *E. punctata* – *M. linariifolia* Riparian Forest
- River Flat Eucalypt Forest on Coastal Floodplains EEC
Unit 13a: *Casuarina glauca* Riparian Forest (regrowth)
Unit 13b: *Melaleuca decora* Floodplain Woodland
Unit 13c: *Allocasuarina luehmannii* Floodplain Low Forest
Unit 13d: *Melaleuca nodosa* Floodplain Scrub
Unit 14a: *C. cunninghamiana* – *C. glauca* Riparian Forest
Unit 14b: *A. floribunda* Dune Forest (greatly disturbed)
Unit 14c: *E. amplifolia* Depression Forest

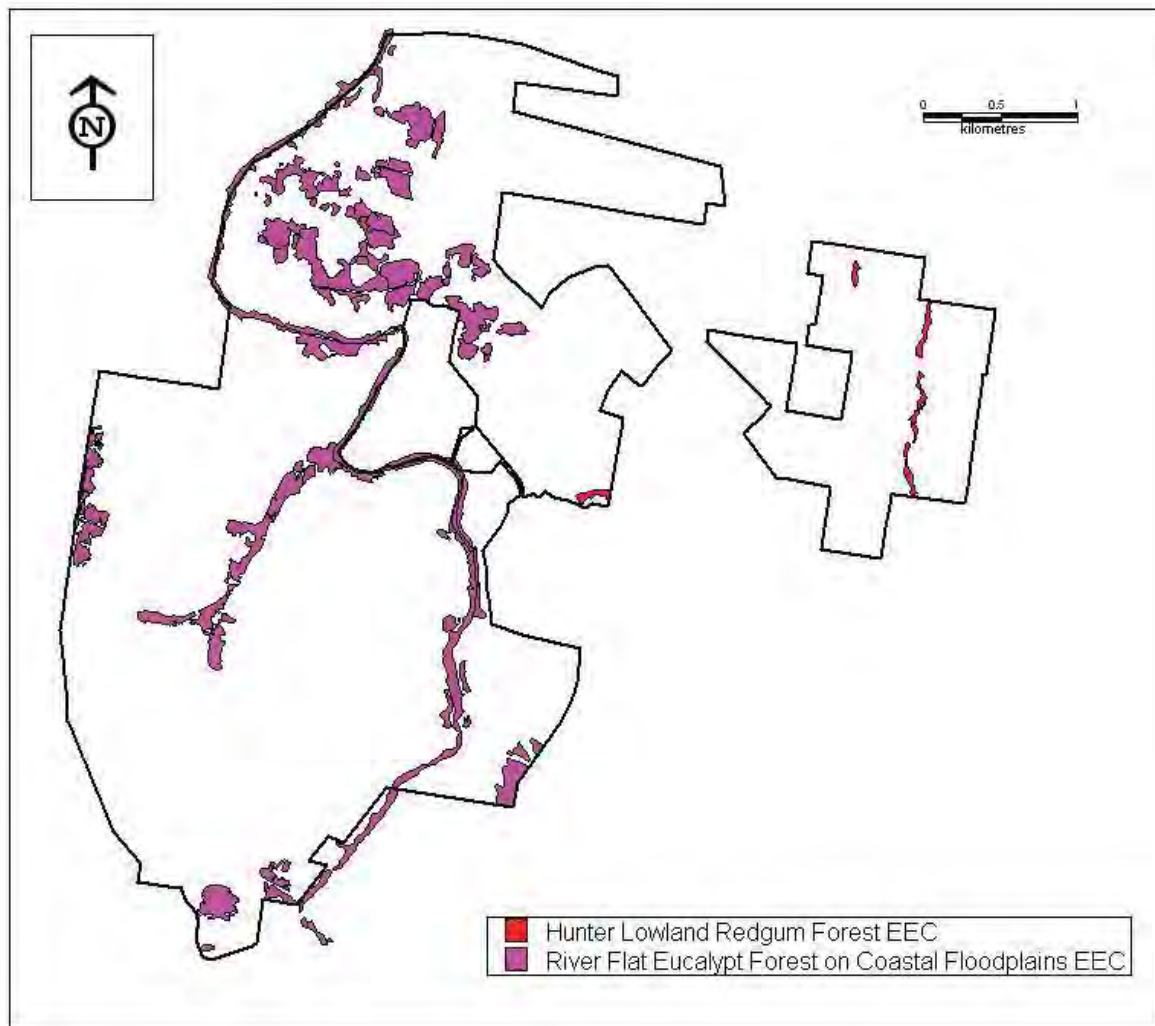


Figure 20 Distribution of Endangered Ecological Communities at Sweetwater.

Hunter Lowlands Redgum Forest

Hunter Lowlands Redgum Forest was originally identified as a regionally significant vegetation community by NPWS (2000a), and is now listed as an Endangered Ecological Community under the NSW *TSC Act 1995*. Within Sweetwater, only a few creeklines in the east support this vegetation type. This finding is in contrast to the conclusion reached by Ecotone Ecological Consultants (2003), who suggested that nearly all of the Sweetwater area supported this community. As far as is known, Werakata National Park (with 12ha, including recent additions) represents the only formal conservation reserve protecting examples of this vegetation type in the region (Bell 2004a; 2004c). However, other areas such as the HEZ 7(b) lands near Mt Tomalpin also conserve a further 70 ha of this community.

Within the region, there is considerable variation within the Hunter Lowlands Redgum Forest, much of it related to soil drainage and disturbance history (pers. obs.). Areas suffering from frequent fires and light-to-moderate grazing tend to support a higher component of grass species, while in other areas shrubs such as *Bursaria spinosa* and *Melaleuca nodosa* are prevalent. In poorly drained depressions where runoff forms small billabongs and ponds, *Melaleuca linariifolia* thickets occur offering specialised fauna habitat.

River Flat Eucalypt Forest on Coastal Floodplains

The recent listing of the River Flat Eucalypt Forest on Coastal Floodplains EEC is an attempt to protect all vegetation present on the major river systems in eastern New South Wales. As a consequence, there is a considerable amount of floristic variation evident across this large area. In the final determination to list this community, vegetation identified in the regional mapping study of NPWS (2000) is specified as being included within the EEC. In this case, the Central Hunter Riparian Forest (map unit 13), Wollombi Redgum – River Oak Woodland (map unit 14) and Redgum Rough-barked Apple Swamp Forest (map unit 38) of NPWS (2000) form part of this community in the lower Hunter Valley. At Sweetwater, sub-units of both units 13 and 14 are present and have been mapped, and are therefore included in this determination.

4.4.2 Regionally Significant Communities

In his major Hunter Valley remnant vegetation study, Peake (2005) identified a number of vegetation communities which meet the criteria for listing as endangered or vulnerable communities under the *EPBC Act 1999*. Until such time as those communities are assessed, nominated and listed, those that currently remain unlisted should be regarded as regionally significant. As the level of detail undertaken in classifying the vegetation at Sweetwater is greater than elsewhere in the region, it is imperative that all recognised variants within broader units be included as regionally significant, at least until certain forms can be shown to be more widespread. Consequently, in terms of the current work, such regionally significant communities would include (see also Figure 21):

- Hunter Valley Dry Rainforest
Unit 3: *Backhousia myrtifolia* Gallery Rainforest
- Central Hunter Ironbark – Spotted Gum – Grey Box Forest
Unit 18a: *Allocasuarina luehmannii* Low Forest
Unit 18b: *E. molucana* Open Forest

- Unit 18c: *E. crebra* – *C. maculata* Open Forest
- Unit 18d: *C. maculata* – *Callitris endlicheri* Open Forest
- Unit 18e: *E. crebra* – *E. tereticornis* Open Forest
- Unit 18g: *C. maculata* – *E. punctata* – *E. crebra* Open Forest
- Unit 18h: *E. fibrosa* – *C. maculata* Open Forest
- Unit 18j: *C. maculata* – *Allocasuarina torulosa* Open Forest
- Unit 18k: *Allocasuarina luehmannii* – *E. moluccana* Forest
- Unit 18l: *C. maculata* – *E. fibrosa* - *Melaleuca nodosa* Scrub-Forest
- Unit 18m: *C. maculata* – *E. crebra* – *Melaleuca nodosa* Scrub-Forest
- Unit 18n: *E. crebra* Grassy Open Forest
- Unit 18o: *E. glaucina* Grassy Forest
- Unit 18p: *E. albens* Grassy Forest

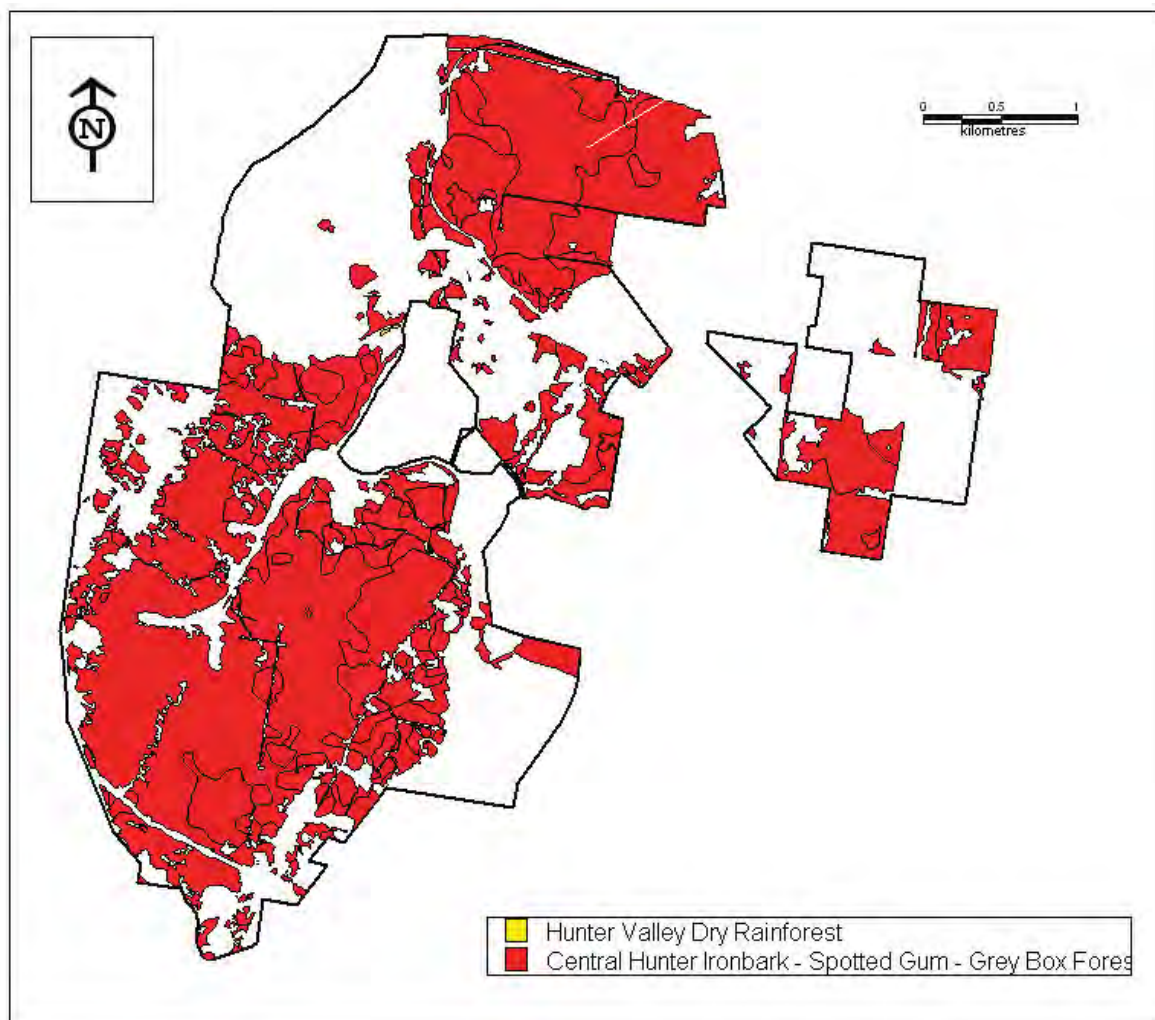


Figure 21 Distribution of regionally significant vegetation communities at Sweetwater, excluding EEC's.

Hunter Valley Dry Rainforest

The single occurrence of Hunter Valley Dry Rainforest within the study area is perhaps a good indication of the vegetation prior to European settlement. A number of rainforest plant species are present scattered along the banks of Black Creek, but only in one location does a distinct, closed low forest of *Backhousia myrtifolia* occur. Peake (2005) has identified Lower Hunter Dry Rainforest for the northern rim of the Hunter Valley floor, which although essentially equivalent to the Hunter Dry Rainforest defined by NPWS (2000a), does support several different species. NPWS (2000a) have mapped a total of 1326 ha of Hunter Valley Dry Rainforest extant in the region, while Peake (2005) indicates 25 ha extant. Connolly (2003) undertook a review of rainforest vegetation within the Hunter to southern Sydney regions and concluded that there was a distinct dry rainforest community within the lower Hunter Valley.

Note that the Lower Hunter Dry Rainforest vegetation community identified by Peake (2005) is stated by him to be restricted to the northern rim of the Hunter Valley floor, yet still equivalent to the Hunter Valley Dry Rainforest of NPWS (2000a). Peake's (2005) assessment of this community as regionally significant may or may not directly translate to the Hunter Valley Dry Rainforest (Unit 3) identified at Sweetwater. An alternate view may be that the Hunter Valley Dry Rainforest at Sweetwater is equivalent to the variant of Wollombi Redgum - River Oak Woodland (Unit 14) identified by NPWS (2000a), which supports stands of *Backhousia myrtifolia* on sheltered creek banks. The level of weed invasion at the Sweetwater site has prevented further clarification of this issue.

Central Hunter Ironbark – Spotted Gum – Grey Box Forest

Central Hunter Ironbark – Spotted Gum – Grey Box Forest was formerly widespread in the Hunter Valley, but has been heavily impacted upon by agricultural and mining activities. Indeed, Peake (2005) has estimated a pre-1750 distribution of 47000 ha for the Hunter Valley floor, which has been reduced by 60% to now occupy only 18000 ha, very little of which is in secure conservation reserve. Within Sweetwater, several variants of this community have been delineated and mapped, and until such time that these variants have been mapped elsewhere in the region, all should be regarded as regionally significant.

4.5 Management issues

Numerous trails and tracks are evident throughout the Sweetwater site, and rationalisation of these should be undertaken to assist in the control of rubbish dumping, firewood collection, arson and weed dispersal. Trail bike riding is also a common occurrence, which promotes erosion to fire

trails. Weed invasion is particularly problematic along Black Creek, where dense infestations of *Cestrum parqui*, *Tradescantia albiflora*, *Macfaydena unguis-cati*, and *Cardiospermum grandiflorum* are prevalent in the River Oak forests. However, it is unlikely that such weeds will be completely eradicated, as upstream influences are likely to maintain the presence of weed species.

5.0 Recommendations

Considering the extent and distribution of vegetation communities and significant plant species present within Sweetwater, and the levels of underscrubbing recently undertaken, it is recommended that:

- some areas of the site be set aside for conservation, particularly in view of the fact that much of it supports vegetation of at least regional conservation significance, and which has also been identified within existing key regional wildlife corridors;
- targeted seasonal surveys be undertaken in suitable habitat for *Diuris* sp aff *dendrobioides* (Hunter Valley) and other terrestrial orchid species;
- all individuals of *Persoonia pauciflora* present within the study area be protected within a buffering conservation area, to recognise the ecological importance of this narrow endemic;
- implementation of a weed management and bushland restoration program along Black Creek, which now forms part of a listed Endangered Ecological Community;
- investigations be undertaken into establishing ecological trade-offs or offset packages, to compensate for the loss of biodiversity that may potentially occur following development;

6.0 Acknowledgements

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Appendix 1 Species list for Sweetwater

Plant taxa recorded from the study area between September 2004 and March 2005. Species marked “*” represent non-endemic taxa, and includes weed species and native species not endemic to the local area. Significant taxa are noted.

Family	Genus & Species	Status
CLASS FILICOPSIDA (Ferns)		
ADIANTACEAE	<i>Adiantum aethiopicum</i> <i>Adiantum hispidulum</i> <i>Cheilanthes austrotenuifolia</i> <i>Cheilanthes distans</i> <i>Cheilanthes sieberi</i> subsp. <i>sieberi</i>	
ASPLENIACEAE	<i>Asplenium flabellifolium</i>	
CYATHEACEAE	<i>Cyathea australis</i> *	Non-endemic
DENNSTAEDTIACEAE	<i>Pteridium esculentum</i>	
DICKSONIACEAE	<i>Calochlaena dubia</i>	
POLYPODIACEAE	<i>Pyrrosia rupestris</i>	
CLASS CYCADOPSIDA (Cycads)		
ZAMIACEAE	<i>Macrozamia flexuosa</i>	ROTAP
CLASS CONIFEROPSIDA (Conifers)		
CUPRESSACEAE	<i>Callitris endlicheri</i> <i>Juniperus</i> sp * <i>Pinus elliotii</i> *	Disjunct eastern occurrence Non-endemic Non-endemic
CLASS MAGNOLIOPSIDA (Flowering Plants) Subclass Magnoliidae (Dicotyledons)		
ACANTHACEAE	<i>Brunoniella australis</i> <i>Brunoniella pumilio</i> <i>Pseuderanthemum variabile</i>	
AMARANTHACEAE	<i>Gomphrena celosioides</i> * <i>Nyssanthus diffusa</i>	Non-endemic
APIACEAE	<i>Platysace ericoides</i>	
ASCLEPIADACEAE	<i>Gomphocarpus fruticosus</i> * <i>Marsdenia viridiflora</i> subsp. <i>viridiflora</i> <i>Sarcostemma brunonianum</i> <i>Tweedia coerulea</i> *	Non-endemic Disjunct, eastern range extension Non-endemic
ASPARAGACEAE	<i>Myrsiphyllum asparagoides</i> *	Non-endemic

	<i>Protasparagus aethiopicus</i> *	Non-endemic
ASTERACEAE	<i>Ambrosia tenuifolia</i> *	Non-endemic
	<i>Aster subulatus</i> *	Non-endemic
	<i>Bidens pilosa</i> *	Non-endemic
	<i>Brachyscome multifida</i> var. <i>multifida</i>	
	<i>Calotis dentex</i>	
	<i>Calotis lappulacea</i>	
	<i>Cassinia aculeata</i>	
	<i>Cassinia arcuata</i>	
	<i>Cassinia quinquefaria</i>	
	<i>Cassinia uncata</i>	
	<i>Chrysocephalum apiculatum</i>	
	<i>Cirsium vulgare</i> *	Non-endemic
	<i>Conyza</i> spp. *	Non-endemic
	<i>Conyza sumatrensis</i> *	Non-endemic
	<i>Epaltes australis</i>	
	<i>Gamochaeta spicata</i> *	Non-endemic
	<i>Glossogyne tannensis</i>	
	<i>Hypochaeris glabra</i> *	Non-endemic
	<i>Hypochaeris microcephala</i> var. <i>albiflora</i> *	Non-endemic
	<i>Lagenifera stipitata</i>	
	<i>Olearia elliptica</i>	
	<i>Ozothamnus diosmifolius</i>	
	<i>Schkuhria pinnata</i> *	Non-endemic
	<i>Senecio madagascariensis</i> *	Non-endemic
	<i>Sigesbeckia australiensis</i>	
	<i>Sigesbeckia orientalis</i> subsp. <i>orientalis</i>	
	<i>Solenogyne bellioides</i>	
	<i>Sonchus oleraceus</i> *	Non-endemic
	<i>Tagetes minuta</i> *	Non-endemic
	<i>Taraxacum officinale</i> *	Non-endemic
	<i>Vernonia cinerea</i> var. <i>cinerea</i>	
	<i>Vittadinia cuneata</i> var. <i>cuneata</i>	
	<i>Vittadinia sulcata</i>	
BIGNONIACEAE	<i>Jacaranda mimosifolia</i> *	Non-endemic
	<i>Macfaydena unguis-cati</i> *	Non-endemic
BRASSICACEAE	<i>Lepidium bonariense</i> *	Non-endemic
	<i>Sisymbrium orientale</i> *	Non-endemic
CACTACEAE	<i>Opuntia aurantiaca</i> *	Non-endemic
	<i>Opuntia stricta</i> var. <i>stricta</i> *	Non-endemic
CAMPANULACEAE	<i>Wahlenbergia communis</i>	
	<i>Wahlenbergia gracilis</i>	
	<i>Wahlenbergia stricta</i> subsp. <i>stricta</i>	
CAPRIFOLIACEAE	<i>Lonicera japonica</i> *	Non-endemic
CASUARINACEAE	<i>Allocasuarina littoralis</i>	
	<i>Allocasuarina luehmannii</i>	
	<i>Allocasuarina torulosa</i>	
	<i>Allocasuarina verticillata</i>	Disjunct eastern occurrence
	<i>Casuarina cunninghamiana</i> subsp. <i>cunninghamiana</i>	
	<i>Casuarina glauca</i>	
CELASTRACEAE	<i>Maytenus silvestris</i>	
CHENOPODIACEAE	<i>Chenopodium carinatum</i>	
	<i>Einadia hastata</i>	
	<i>Einadia nutans</i> ssp. <i>linifolia</i>	
	<i>Einadia trigonos</i> subsp. <i>leiocarpa</i>	
	<i>Maireana microphylla</i>	Eastern distributional limit

	<i>Notelaea microcarpa</i> var. <i>microcarpa</i>	disjunct easterly occurrence
	<i>Notelaea ovata</i>	
	<i>Olea europaea</i> subsp. <i>cuspidata</i> *	Non-endemic
ONAGRACEAE	<i>Ludwigia peploides</i> subsp. <i>montevidensis</i> *	Non-endemic
	<i>Oenothera stricta</i> subsp. <i>stricta</i> *	Non-endemic
OXALIDACEAE	<i>Oxalis chnoodes</i>	
	<i>Oxalis perennans</i>	
PITTOSPORACEAE	<i>Billardiera scandens</i>	
	<i>Bursaria longisepala</i>	
	<i>Bursaria spinosa</i>	
	<i>Pittosporum undulatum</i>	
PLANTAGINACEAE	<i>Plantago debilis</i>	
	<i>Plantago gaudichaudii</i>	
	<i>Plantago lanceolata</i> *	Non-endemic
POLYGALACEAE	<i>Polygala japonica</i>	
POLYGONACEAE	<i>Persicaria decipiens</i>	
PROTEACEAE	<i>Grevillea montana</i>	ROTAP
	<i>Grevillea robusta</i> *	Non-endemic
	<i>Hakea sericea</i>	
	<i>Persoonia linearis</i>	
	<i>Persoonia pauciflora</i>	Endangered (TSC Act)
RANUNCULACEAE	<i>Clematis glycinoides</i>	
	<i>Ranunculus lappaceus</i>	
ROSACEAE	<i>Rubus ulmifolius</i> *	Non-endemic
RUBIACEAE	<i>Asperula conferta</i>	
	<i>Canthium buxifolium</i>	
	<i>Opercularia aspera</i>	
	<i>Opercularia diphylla</i>	
	<i>Pomax umbellata</i>	
	<i>Richardia humistrata</i> *	Non-endemic
	<i>Richardia stellaris</i> *	Non-endemic
RUTACEAE	<i>Geijera salicifolia</i> var. <i>latifolia</i>	Western distributional limit
SANTALACEAE	<i>Exocarpos strictus</i>	
SAPINDACEAE	<i>Cardiospermum grandiflorum</i> *	Non-endemic
	<i>Dodonaea viscosa</i> subsp. <i>cuneata</i>	
	<i>Dodonaea truncatiales</i>	
SCROPHULARIACEAE	<i>Veronica plebeia</i>	
SOLANACEAE	<i>Cestrum parqui</i> *	Non-endemic
	<i>Lycium ferocissimum</i> *	Non-endemic
	<i>Nicotiana suaveolens</i>	
	<i>Nicotiana debneyi</i> subsp. <i>debneyi</i>	
	<i>Solanum mauritanum</i> *	Non-endemic
	<i>Solanum nigrum</i> *	Non-endemic
	<i>Solanum prinophyllum</i>	
	<i>Solanum pungetium</i>	
STACKHOUSIACEAE	<i>Stackhousia viminea</i>	
STERCULIACEAE	<i>Brachychiton populneus</i>	
THYMELAEACEAE	<i>Pimelea linifolia</i> subsp. <i>linifolia</i>	

VERBENACEAE	<i>Clerodendrum tomentosum</i>	
	<i>Lantana camara</i> *	Non-endemic
	<i>Verbena bonariensis</i> *	Non-endemic

VITACEAE	<i>Cayratia clematidea</i>	
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CLASS MAGNOLIOPSIDA (Flowering Plants)

Subclass Liliidae (Monocotyledons)

ANTHERICACEAE	<i>Arthropodium milleflorum</i>	
	<i>Arthropodium minus</i>	
	<i>Caesia parviflora</i> var. <i>parviflora</i>	
	<i>Laxmannia gracilis</i>	
	<i>Tricoryne elatior</i>	
COMMELINACEAE	<i>Commelina cyanea</i>	
	<i>Murdannia graminea</i>	
	<i>Tradescantia albiflora</i> *	Non-endemic
CYPERACEAE	<i>Baumea juncea</i>	
	<i>Carex inversa</i>	
	<i>Cyperus aggregatus</i> *	Non-endemic
	<i>Cyperus eragrostis</i> *	Non-endemic
	<i>Cyperus gracilis</i>	
	<i>Elaeocharis equisetina</i>	
	<i>Elaeocharis sphacelata</i>	
	<i>Fimbristylis dichotoma</i>	
	<i>Gahnia aspera</i>	
	<i>Lepidosperma laterale</i>	
HAEMODORACEAE	<i>Haemodorum planifolium</i>	
HYPOXIDACEAE	<i>Hypoxis hygrometrica</i> var. <i>hygrometrica</i>	
	<i>Hypoxis hygrometrica</i> var. <i>villosisepala</i>	
IRIDACEAE	<i>Patersonia sericea</i>	
JUNCACEAE	<i>Juncus acutus</i> *	Non-endemic
	<i>Juncus continuus</i>	
	<i>Juncus usitatus</i>	
LOMANDRACEAE	<i>Lomandra confertifolia</i> subsp. <i>pallida</i>	
	<i>Lomandra confertifolia</i> subsp. <i>rubiginosa</i>	
	<i>Lomandra filiformis</i> subsp. <i>coriacea</i>	
	<i>Lomandra filiformis</i> subsp. <i>filiformis</i>	
	<i>Lomandra glauca</i>	
	<i>Lomandra longifolia</i>	
	<i>Lomandra multiflora</i> subsp. <i>multiflora</i>	
ORCHIDACEAE	<i>Caladenia alba</i>	
	<i>Caladenia catenata</i>	
	<i>Dendrobium linguiforme</i>	
	<i>Dipodium punctatum</i>	
	<i>Diuris</i> spp. aff <i>dendrobioides</i> (Hunter Valley)	undescribed
	<i>Diuris sulphurea</i>	
	<i>Pterostylis bicolor</i>	
	<i>Pterostylis curta</i>	
PHORMIACEAE	<i>Dianella caerulea</i> var. <i>assera</i>	
	<i>Dianella caerulea</i> var. <i>caerulea</i>	
	<i>Dianella longifolia</i> var. <i>longifolia</i>	
	<i>Dianella revoluta</i> var. <i>revoluta</i>	
	<i>Dianella tasmanica</i>	

POACEAE	<i>Aristida ramosa</i>	
	<i>Aristida vagans</i>	
	<i>Aristida warburgii</i>	
	<i>Austrodanthonia caespitosa</i>	
	<i>Austrodanthonia fulva</i>	
	<i>Austrodanthonia setacea</i>	
	<i>Austrostipa ramosissima</i>	
	<i>Austrostipa verticillata</i>	
	<i>Axonopus fissifolius</i> *	Non-endemic
	<i>Bothriochloa decipiens</i>	
	<i>Chloris truncata</i>	
	<i>Cymbopogon refractus</i>	
	<i>Cynodon dactylon</i>	
	<i>Dichelachne micrantha</i>	
	<i>Digitaria diffusa</i>	
	<i>Digitaria ramularis</i>	
	<i>Echinopogon caespitosus</i> var. <i>caespitosus</i>	
	<i>Echinopogon ovatus</i>	
	<i>Ehrharta erecta</i> *	Non-endemic
	<i>Enteropogon acicularis</i>	
	<i>Entolasia stricta</i>	
	<i>Eragrostis brownii</i>	
	<i>Eragrostis leptostachya</i>	
	<i>Imperata cylindrica</i> var. <i>major</i>	
	<i>Melinis repens</i> *	Non-endemic
	<i>Microlaena stipoides</i> var. <i>stipoides</i>	
	<i>Notodanthonia longifolia</i>	
	<i>Oplismenus aemulus</i>	
	<i>Oplismenus imbecillis</i>	
	<i>Panicum effusum</i>	
	<i>Panicum maximum</i> var. <i>maximum</i> *	Non-endemic
	<i>Panicum simile</i>	
	<i>Paspalidium albobillosum</i>	
	<i>Paspalidium distans</i>	
	<i>Paspalum urvillei</i> *	Non-endemic
	<i>Perotis rara</i>	Southern distributional limit
	<i>Phragmites australis</i>	
	<i>Poa labillardierei</i> var. <i>labillardierei</i>	
	<i>Setaria gracilis</i> *	Non-endemic
	<i>Sporobolus africanus</i> *	Non-endemic
	<i>Themeda australis</i>	
TYPHACEAE	<i>Typha orientalis</i>	
XANTHORRHOEACEAE	<i>Xanthorrhoea media</i>	
TOTAL PLANT TAXA	328	

Appendix 2 Diagnostic species list - Cessnock vs Greta Spotted Gum – Ironbark Forests

The table below presents the results of a FIDEL analysis (at 50% group sites and C/A of 2 or more) between the Cessnock group of plots (designated here Lower Hunter Spotted Gum Ironbark Forest), and the Sweetwater plots (Central Hunter Spotted Gum – Grey Box - Ironbark Forest), based on the regional spotted gum analysis framework. All species occurring in <10% in either group have been omitted from table. Shaded species represent the core of the diagnostic species list for each community.

Life Form	Species	LHSGIF Group			CHSGGBIF Group		
		C/A	Freq.	Fidelity class	C/A	Freq.	Fidelity class
1 Trees	Corymacu	2	100.00%	constant	3	100.00%	constant
	Eucafibr	2	66.67%	positive	4	31.43%	negative
	Syncglol	1	41.67%	unique	0	0.00%	absent
	Eucaaggl	3	33.33%	unique	0	0.00%	absent
	Coryxim	3	25.00%	unique	0	0.00%	absent
	Eucapuca	3	16.67%	unique	0	0.00%	absent
	Corygumm	3	16.67%	unique	0	0.00%	absent
	Angoflor	4	16.67%	unique	0	0.00%	absent
	Meladeco	1	16.67%	uninformative	2	14.29%	uninformative
	Eucacreb	0	0.00%	negative	3	65.71%	unique
	Allolueh	0	0.00%	absent	2	28.57%	unique
	Eucapunc	0	0.00%	absent	3	25.71%	unique
	Allotoru	0	0.00%	absent	1	14.29%	unique
	Eucatere	0	0.00%	absent	3	11.43%	unique
2 Shrubs	Persline	2	83.33%	positive	1	40.00%	negative
	Grevmont	2	66.67%	positive	2	31.43%	negative
	Melanodo	4	58.33%	positive	6	11.43%	negative
	Daviulic	3	58.33%	positive	1	68.57%	negative
	Astrobov	2	58.33%	unique	0	0.00%	absent
	Lissstri	2	50.00%	positive	1	60.00%	negative
	Leptparv	2	50.00%	unique	0	0.00%	absent
	Grevparp	2	50.00%	unique	0	0.00%	absent
	Acaculic	2	50.00%	unique	0	0.00%	absent
	Lepttrin	2	41.67%	unique	0	0.00%	absent
	Monoscop	1	33.33%	unique	0	0.00%	absent
	Dillreto	2	33.33%	unique	0	0.00%	absent
	Isopanem	1	25.00%	unique	0	0.00%	absent
	Acaclonf	1	25.00%	unique	0	0.00%	absent
	Acacirri	1	25.00%	unique	0	0.00%	absent
	Rapavari	1	16.67%	unique	0	0.00%	absent
	Melathym	2	16.67%	unique	0	0.00%	absent
	Leptpolc	4	16.67%	unique	0	0.00%	absent
	Dillsptr	2	16.67%	unique	0	0.00%	absent
	Davisqua	4	16.67%	unique	0	0.00%	absent
	Burslong	2	16.67%	unique	0	0.00%	absent
	Bossobco	1	16.67%	unique	0	0.00%	absent
	Bankspio	3	16.67%	unique	0	0.00%	absent

	Acacalni	1	16.67% unique	0	0.00% absent
	Meliurce	1	50.00% uninformative	1	34.29% uninformative
	Hakeseri	1	50.00% uninformative	1	31.43% uninformative
	Podollic	1	41.67% uninformative	1	2.86% uninformative
	Jackscop	3	33.33% uninformative	2	31.43% uninformative
	Dendvite	1	33.33% uninformative	1	20.00% uninformative
	Bursspin	1	25.00% uninformative	1	42.86% uninformative
	Acacelon	2	25.00% uninformative	1	37.14% uninformative
	Pimelino	1	16.67% uninformative	2	5.71% uninformative
	Ozotdios	1	16.67% uninformative	1	14.29% uninformative
	Maytsilv	1	16.67% uninformative	1	22.86% uninformative
	Breyoblo	1	16.67% uninformative	1	34.29% uninformative
	Acacfala	1	16.67% uninformative	1	37.14% uninformative
	Acacbrow	1	16.67% uninformative	1	8.57% uninformative
	Pultspin	1	8.33% uninformative	2	34.29% uninformative
	Acacparv	0	0.00% absent	1	51.43% unique
	Indiaust	0	0.00% absent	1	25.71% unique
	Cassarcu	0	0.00% absent	1	25.71% unique
3 Herbs	Pomaumbe	2	91.67% constant	2	88.57% constant
	Phylhirt	2	91.67% positive	2	25.71% negative
	Plateric	2	33.33% unique	0	0.00% absent
	Gompunci	2	33.33% unique	0	0.00% absent
	Drospelt	2	33.33% unique	0	0.00% absent
	Oxylpult	2	16.67% unique	0	0.00% absent
	Linumarg	1	16.67% unique	0	0.00% absent
	Hibblin	2	16.67% unique	0	0.00% absent
	Gonotetr	2	16.67% unique	0	0.00% absent
	Gompminu	2	16.67% unique	0	0.00% absent
	Hibbpedu	2	41.67% uninformative	1	42.86% uninformative
	Verocinc	2	33.33% negative	2	85.71% positive
	Goodrotu	2	33.33% negative	2	74.29% positive
	Laxmgrac	1	16.67% negative	2	82.86% positive
	Pseuvari	2	25.00% uninformative	2	17.14% uninformative
	Chorparv	1	25.00% uninformative	1	11.43% uninformative
	Pratpurp	2	16.67% negative	2	80.00% negative
	Gaesparp	1	16.67% uninformative	1	20.00% uninformative
	Tricelat	1	8.33% uninformative	1	14.29% uninformative
	Poramicr	2	8.33% uninformative	1	11.43% uninformative
	Lagestip	2	8.33% uninformative	2	11.43% uninformative
	Brueaust	1	8.33% uninformative	2	31.43% uninformative
	Oxalpere	1	8.33% negative	2	85.71% positive
	Hibbdiff	0	0.00% absent	1	88.57% unique
	Solaprin	0	0.00% absent	1	57.14% unique
	Operdiph	0	0.00% absent	2	48.57% unique
	Chryapic	0	0.00% absent	1	48.57% unique
	Dichrepe	0	0.00% absent	2	31.43% unique
	Phylvirg	0	0.00% absent	1	31.43% unique
	Stacvimi	0	0.00% absent	2	28.57% unique
	Eremdebi	0	0.00% absent	2	28.57% unique
	Veropleb	0	0.00% absent	1	25.71% unique
	Calolapp	0	0.00% absent	2	22.86% unique

	Commcyan	0	0.00% absent	1	22.86% unique
	Wahlcomm	0	0.00% absent	1	20.00% unique
	Glostann	0	0.00% absent	1	20.00% unique
	Desmvari	0	0.00% absent	2	14.29% unique
	Zorndycd	0	0.00% absent	1	14.29% unique
	Murdgram	0	0.00% absent	2	11.43% unique
4 Grasses	Eragbrow	2	91.67% constant	2	71.43% constant
	Entostri	2	91.67% constant	2	71.43% constant
	Arisvaga	2	66.67% constant	3	85.71% constant
	Joycpall	2	75.00% unique	0	0.00% absent
	Anisaven	2	50.00% unique	0	0.00% absent
	Themaust	3	41.67% uninformative	2	22.86% uninformative
	Panisimi	2	33.33% uninformative	1	8.57% uninformative
	Impecylm	2	33.33% uninformative	1	2.86% uninformative
	Dicemicr	3	16.67% uninformative	1	14.29% uninformative
	Digiramu	1	16.67% uninformative	1	31.43% uninformative
	Austsetc	2	8.33% uninformative	2	22.86% uninformative
	Arisramo	2	33.33% negative	3	94.29% positive
	Cymbrefr	2	16.67% negative	2	91.43% positive
	Micrstis	2	33.33% negative	2	88.57% positive
	Pasidist	2	8.33% negative	2	54.29% positive
	Panieffu	0	0.00% absent	2	20.00% unique
	Echicaea	0	0.00% absent	2	11.43% unique
	Cynodact	0	0.00% absent	2	14.29% unique
	Chlotrun	0	0.00% absent	1	14.29% unique
5 Sedges	Dianrevr	2	50.00% constant	2	77.14% constant
	Lepilate	2	83.33% positive	2	45.71% negative
	Lomacyli	2	66.67% unique	0	0.00% absent
	Dianprun	1	25.00% unique	0	0.00% absent
	Xantglag	2	16.67% unique	0	0.00% absent
	Diancaeu	1	16.67% unique	0	0.00% absent
	Lomafilf	2	33.33% uninformative	2	28.57% uninformative
	Pateseri	2	16.67% uninformative	1	2.86% uninformative
	Lomalong	3	16.67% uninformative	1	8.57% uninformative
	Lomaglau	2	16.67% uninformative	2	5.71% uninformative
	Lomaconp	3	16.67% uninformative	2	42.86% uninformative
	Fimblich	1	8.33% uninformative	2	48.57% uninformative
	Lomamulm	1	25.00% negative	2	88.57% positive
	Lomafilc	2	25.00% negative	2	62.86% positive
	Gahnaspe	0	0.00% absent	1	14.29% unique
6 Ferns	Cheisies	2	75.00% constant	2	100.00% constant
	Cheiaust	1	8.33% uninformative	1	25.71% uninformative
	Cheidist	0	0.00% absent	2	11.43% unique
7 Cycads	Macrflex	1	66.67% uninformative	1	5.71% uninformative
	Macreddu	2	41.67% unique	0	0.00% absent
8 Vines	Cassglag	2	58.33% positive	1	2.86% negative
	Hardviol	1	50.00% uninformative	1	17.14% uninformative
	Glycclan	1	50.00% negative	2	60.00% positive
	Billscan	1	33.33% uninformative	1	2.86% uninformative
	Glyctaba	2	8.33% uninformative	2	48.57% uninformative

Appendix 3 Supplementary Report of Extension Study Area

Vegetation survey of “*Sweetwater*”, North Rothbury, mid Hunter Valley, New South Wales.

Supplementary Report of Expanded Study Area

30 September 2005

Report to:

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1.0 Background

Detailed vegetation survey and mapping of 1500ha of land within the North Rothbury vicinity ("Sweetwater") has previously identified five vegetation communities (two of which are included within listed Endangered Ecological Communities on the *TSC Act 1995*), one endangered species (Schedule 1 of the *TSC Act 1995*), two vulnerable species (Schedule 2 of the *TSC Act 1995*) and four nationally rare species (see Bell & Driscoll 2005). Subsequent to the completion of that study, additional investigation areas have now been identified which significantly expand the Sweetwater study area to approximately 3750ha.

While negotiations with the current land owners within this revised study area are in progress, a brief study of the additional lands has been requested in order to highlight potentially significant areas prior to detailed study. This report (and the associated mapping) documents the results of this rapid assessment.

2.0 The Expanded Study Area

Figure 1 shows the original ('core') and expanded study area boundaries. Although large portions of the expanded area are cleared, important remnants of vegetation may still be present.

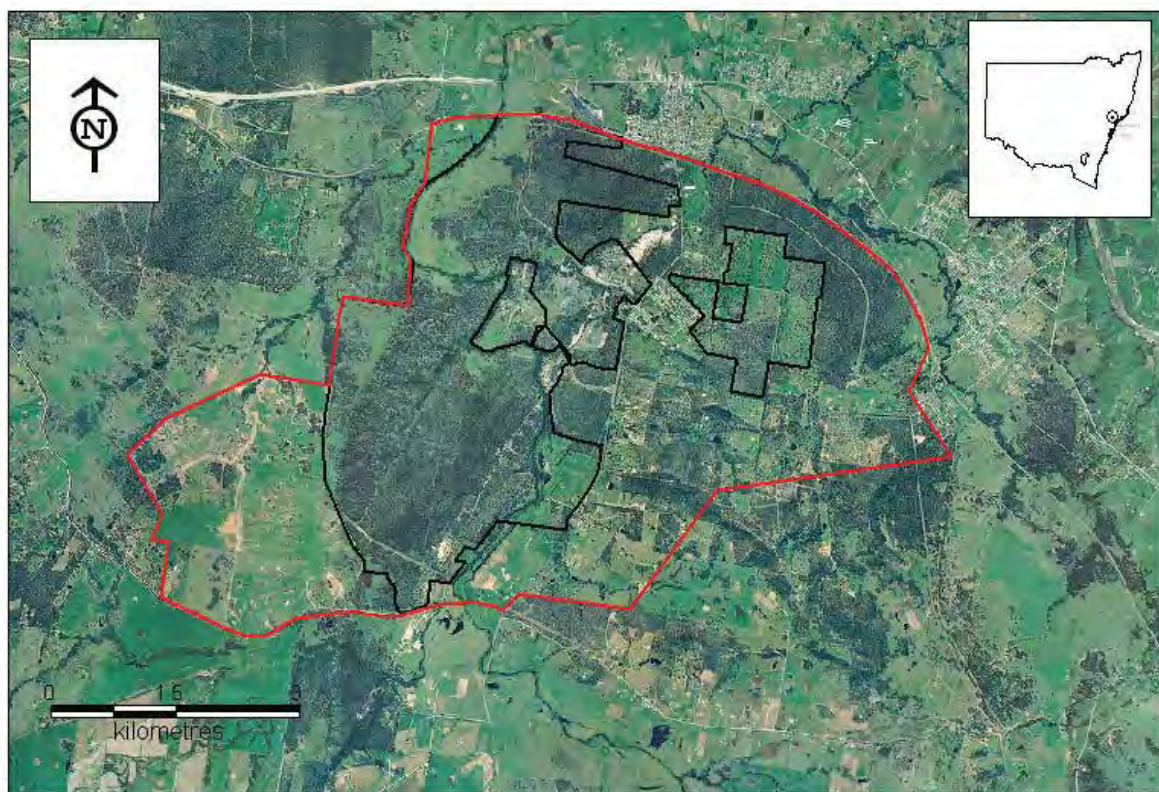


Figure 1 Original (black line) and expanded (red line) Sweetwater study area.

3.0 Methods

One day was spent driving around public access roads within the extended study area, viewing the remnant vegetation and making notes on a hard copy air photo of the area. In some locations waypoints were made on a hand-help GPS unit to assist in locating particular vegetation types. Where possible, foot traverses were also made to better assess the larger patches of vegetation. Significant plant species observed were waypointed with the GPS unit. No full floristic surveys were undertaken, and not all remnants were accessible due to private land tenures.

A preliminary vegetation map was prepared using the MapInfo GIS. Remnant vegetation was digitised directly on-screen using orthorectified, high resolution digital aerial photographs flown specifically for the project, and supplied by HSO. Vegetation polygons were attributed a community code using field notes and information extrapolated from previous mapping of the core Sweetwater study area. Apart from the single day assessing the area at the start of the project, no attempt has yet been made to ground truth the mapping (see Project Limitations in Section 6).

4.0 Results

4.1 Threatened and Rare Species

Seven significant plant species were recorded within the additional study area (Table 1). Two of these (*Acacia bynoeana* and *Eucalyptus* sp aff *agglomerata*) were not recorded within the core Sweetwater area.

Table 1 Significant species recorded within the additional Sweetwater study area.

Significance	Species
Undescribed	<i>Eucalyptus</i> sp. aff. <i>agglomerata</i>
Endangered	<i>Acacia bynoeana</i> <i>Persoonia pauciflora</i>
Vulnerable	<i>Eucalyptus glaucina</i>
Rare	<i>Eucalyptus fergusonii</i> subsp. <i>dorsiventralis</i> <i>Grevillea montana</i> <i>Macrozamia flexuosa</i>

Acacia bynoeana – this species was recorded at one location off Littlewood Road. This species is listed as Endangered under State and Vulnerable under Commonwealth legislation, and the population at North Rothbury is considered extremely significant, for two reasons:

- It extends the known distribution of this species a further 15km to the north of the previous limit at Kurri Kurri;
- It occurs in a completely new habitat type not previously recognised as supporting the species. Bell & Driscoll (in review) have documented the known population of this species from the Central Coast and lower Hunter Valley area, and no other known populations occur in a low woodland of *Eucalyptus* sp. aff. *agglomerata* (or related species). This new

habitat type has affinities to the Central Hunter & Lower Hunter Spotted Gum Ironbark Forest described by NPWS (2000), and it could be broadly included within either of these communities.

Eucalyptus fergusonii* subsp. *dorsiventralis – this rare species (ROTAP 2RC-) dominates the canopy in the area between Wine Country Drive and the existing rubbish dump, on the northern outskirts of North Rothbury. Although a small number of plants were previously noted in the west of the original Sweetwater study area, the occurrence adjacent to Cessnock Road is in a different habitat type. Patrick (1999) has previously noted this taxon in the area, although he referred to it as *E. fergusonii* subsp. *fergusonii*. Brooker et. al. (2002) briefly document the history of these two taxa, and they suggest that the type specimen for *E. fergusonii* subsp. *fergusonii* is possibly an obscure variant of *E. paniculata*, indicating that comparable material has not been collected for a long period of time. As a consequence, Brooker et. al. (2002) refer to this taxon as *Eucalyptus dorsiventralis*.

Eucalyptus glaucina – although not examined in detail, many individual redgum trees across the area show characteristics of the vulnerable *Eucalyptus glaucina*. This is evidenced by their general glaucousness on leaves and branchlets. The Sweetwater area has been previously identified as supporting various intergrading forms of this species with *Eucalyptus tereticornis* (Bell & Driscoll 2005), and conservation of this species is probably best achieved through a landscape approach of conserving larger stands of redgum eucalypts.

Eucalyptus* sp aff *agglomerata – a few locations within the study area support stunted trees that key out to *Eucalyptus capitellata*, but which have stronger affinities to *E. agglomerata*. Further taxonomic investigation may delineate a new species, however this is unlikely to occur in the near future due to the retirement of the NSW eucalypt specialist. *Eucalyptus agglomerata* (and the related *E. capitellata*) are unusual on the Hunter Valley floor (eg: not included in the species list for the mid to upper Hunter Valley; Peake 2005), although similar specimens occur in the Cessnock area (such as in the HEZ area, also documented as *Eucalyptus* sp aff *agglomerata*; Bell 2004). It is likely that the Sweetwater and Cessnock specimens represent the same taxon, but a full taxonomic review of this group of stringybark species is required. In the interim, it is recommended that this species be treated as 'threatened' in any land capability assessment.

Grevillea montana – this rare species (ROTAP 2RCa) is widespread in the eastern portions of the study area, particularly on the large vegetated ridge to the north-east. Elsewhere within the core Sweetwater site, only small concentrated populations are present, generally in the east (Bell & Driscoll 2005).

Macrozamia flexuosa – several specimens of this rare species (ROTAP 2K) were noted between the existing rubbish dump and Cessnock Road.

Persoonia pauciflora – A large concentration of this endangered species (TSC Act Schedule 1; Critically Endangered on EPBC Act 1999) was noted in the land immediately south of the existing Hanwood Estate, in the area proposed for Stage 5 of that development. Several tens of plants are present, including many young plants, and a large number of mature plants are fruiting well. Other specimens are present in the vicinity of Tuckers Lane and Littlewood Road.

4.2 Vegetation Communities

A preliminary vegetation map has been prepared for the expanded study area. This map has not been reproduced in this report, but has been supplied as a GIS map layer to HSO, using the same community nomenclature as that used in the original Sweetwater study area.

4.2.1 New Vegetation Types

As a consequence of the brief reconnaissance survey, four new vegetation types have been tentatively delineated for the study area. These are in addition to those identified during the detailed survey and mapping program for the core Sweetwater area (Bell & Driscoll 2005). Brief descriptions of each of these follow, and Table 2 shows all vegetation types described for the entire Sweetwater area:

Map Unit 13e: *Eucalyptus* sp. aff. *agglomerata* Gully Forest

A single gully dominated by a stringybark was observed to the south of Tuckers Lane. As this was on private property, it was not possible to closely examine the species involved, but from a distance it appeared to be the same *E. sp. aff. agglomerata* present on the broad ridges to the west. If this identification is correct, it would represent a very interesting habitat type, and possibly of some significance.

Map Unit 18q: *Eucalyptus fergusonii* – *Corymbia maculata* – *Melaleuca nodosa* Scrub-Forest

On the northern outskirts of North Rothbury, on the western side of Wine Country Drive, is an area of vegetation dominated by *Melaleuca nodosa* with emergent *Eucalyptus fergusonii*. *Corymbia maculata* and the occasional *Eucalyptus fibrosa* are also present. This vegetation type has not been observed elsewhere within the Sweetwater study area, although a similar form with emergent *Eucalyptus crebra* or *Eucalyptus fibrosa* has. *Eucalyptus fergusonii* is a listed rare species.

Map Unit 18r: *Eucalyptus tereticornis* – *Eucalyptus glaucina* Shrubby Open Forest

On some gentle rises in the north and east of the study area, a shrubby open forest dominated by redgum species occurs. The understorey is well developed and is dominated by *Pimelea linifolia* and *Daviesia ulicifolia*, together with a range of smaller shrubs, grasses and herbs. Without detailed survey, it is unclear how these areas relate to the drainage depressions elsewhere in the Sweetwater area that are also dominated by redgums. First impressions, however, suggest that the well-developed understorey may be significant. Specimens of redgum within this community are likely to include the vulnerable *Eucalyptus glaucina*.

Map Unit 18s: *Eucalyptus* sp. aff. *agglomerata* Heathy Low Forest

Three broad spurs running to the north off Littlewood Road support a distinctive low forest type dominated by *Eucalyptus* sp. aff. *agglomerata*. One of these spurs was traversed briefly on foot. This vegetation type is considered highly significant for a number of reasons, including the dominance of an as yet unknown stringybark species within the *E. agglomerata-capitellata* complex, neither of which have been recorded on the Hunter Valley floor previously. In addition, two plants of the Endangered *Acacia bynoeana* were noted within this vegetation type, extending the known geographical range of this species a further 15km north from Kurri Kurri. This vegetation type also supports a number of understorey species generally not present elsewhere within the Sweetwater study area, such as *Lomandra cylindrica* (another northerly range

extension), *Ptilothrix deusta*, and *Hibbertia pedunculata*. Further research into the floristic composition of this vegetation type is strongly recommended.

Table 2 Vegetation associations delineated for the entire Sweetwater site.

REMS Unit	REMS Community	Sweetwater Association
3	Hunter Valley Dry Rainforest	3 <i>Backhousia myrtifolia</i> Gallery Rainforest
13	Central Hunter Riparian Forest	13a <i>Casuarina glauca</i> Riparian Forest (regrowth) 13b <i>Melaleuca decora</i> Floodplain Woodland 13c <i>Allocasuarina luehmannii</i> Floodplain Low Forest 13d <i>Melaleuca nodosa</i> Floodplain Scrub 13e <i>E. sp. aff. agglomerata</i> Gully Forest
	<u>New</u>	
14	Wollombi Redgum - River Oak Woodland	14a <i>C. cunninghamiana</i> – <i>C. glauca</i> Riparian Forest 14b <i>A. floribunda</i> Dune Forest (greatly disturbed) 14c <i>E. amplifolia</i> Depression Forest
18	Central Hunter Ironbark – Spotted Gum – Grey Box Forest	18a <i>Allocasuarina luehmannii</i> Low Forest 18b <i>E. moluccana</i> Open Forest 18c <i>E. crebra</i> – <i>C. maculata</i> Open Forest 18d <i>C. maculata</i> – <i>Callitris endlicheri</i> Open Forest 18e <i>E. crebra</i> – <i>E. tereticornis</i> Open Forest 18f <i>E. eugenioides</i> Open Forest 18g <i>C. maculata</i> – <i>E. punctata</i> – <i>E. crebra</i> Open Forest 18h <i>E. fibrosa</i> – <i>C. maculata</i> Open Forest 18i <i>Angophora floribunda</i> Open Forest (regrowth) 18j <i>C. maculata</i> – <i>Allocasuarina torulosa</i> Open Forest 18k <i>Allocasuarina luehmannii</i> – <i>E. moluccana</i> Forest 18l <i>C. maculata</i> – <i>E. fibrosa</i> – <i>Melaleuca nodosa</i> Scrub-Forest 18m <i>C. maculata</i> – <i>E. crebra</i> – <i>Melaleuca nodosa</i> Scrub-Forest 18n <i>E. crebra</i> Grassy Open Forest 18o <i>E. glaucina</i> Grassy Forest 18p <i>E. albens</i> Grassy Forest 18q <i>E. fergusonii</i> – <i>C. maculata</i> – <i>M. nodosa</i> Scrub-Forest 18r <i>E. tereticornis</i> – <i>E. glaucina</i> Shrubby Open Forest 18s <i>E. aff. agglomerata</i> Heathy Low Forest
	<u>New</u>	
	<u>New</u>	
	<u>New</u>	
19	Hunter Lowlands Redgum Forest	19 <i>E. tereticornis</i> – <i>E. punctata</i> – <i>M. linariifolia</i> Riparian Forest
40a	<i>Phragmites</i> Rushland	40a <i>Phragmites</i> Rushland (old dams)

4.2.2 Significant Parcels of Land

The north-east Ridgeline - The ridgeline in the northeast immediately south of the Main Northern Railway supports vegetation considerably more complex than that depicted by NPWS (2000). In the regionally modeling project, NPWS (2000) mapped the entire area as supporting Lower Hunter Spotted Gum – Ironbark Forest. However, following the brief inspection at least four discernible associations are present in the area:

- *Eucalyptus fibrosa* – *Corymbia maculata* Shrubby Open Forest
- *Eucalyptus crebra* – *Corymbia maculata* Shrubby Open Forest
- *Eucalyptus tereticornis* Shrubby Open Forest

- *Melaleuca nodosa* – *Eucalyptus crebra* – *Corymbia maculata* Low Scrub-Forest

Without undertaking detailed plot data collection and subsequently analysing the data, it can only be assumed that, following the data analysis carried out for the main Sweetwater study area (Bell & Driscoll 2005), the area represents Central Hunter Spotted Gum – Grey Box – Ironbark Forest. This is based on the composition of grasses and herbs observed in the understorey during the brief inspection, and does not rely solely on the presence of *Eucalyptus fibrosa* and *Corymbia maculata*. However, it may eventuate that a new community becomes evident with future plot survey and analysis, dominated by *Eucalyptus fibrosa* and *Corymbia maculata*, over an understorey of species typical of the mid to upper Hunter Valley. A project currently in progress throughout the region may help to resolve this issue (Bell & Driscoll in prog.), provided access can be gained to adequately sample the area.

The vegetation along most of this ridge appears to be in excellent condition, and has not been grazed for some time. As a consequence, the understorey is well structured and reasonably diverse. In addition, this ridgeline also forms an important component of the Branxton sub-regional wildlife corridor identified by NPWS (2003). It is therefore considered that this ridgeline has very high conservation value. The proposed F3 freeway extension to Branxton passes through this parcel of land, and may detrimentally impact on these values by fragmenting the existing remnant.

Land south of the Hanwood Estate – the parcel of land west of Wine Country Drive and immediately south of the existing Hanwood Estate supports a large population of the endangered *Persoonia pauciflora*. Presumably, this is the reason that the expansion of that estate has not progressed, and protection of the entire parcel is warranted.

Land north of Littlewood Road – lands immediately north of Littlewood Road at the NW end of the Molly Morgan Ridge support a unique vegetation type dominated by the stringybark *Eucalyptus* sp. aff. *agglomerata*, with a disjunct and highly significant population of the endangered *Acacia bynoeana* also present. There is also some high quality forest dominated by *Eucalyptus fibrosa* to the east of the stringybark stand, which does not appear to have been disturbed for many years. Further investigation of these lands is recommended, particularly of the stringybark vegetation, as no other occurrence is known in this part of the Hunter Valley. This patch of vegetation also comprises part of the Molly Morgan Ridge, which provides a potential wildlife corridor to the larger remnants of the Sweetwater proposal and Werakata National Park to the south.

5.0 Conclusions and Recommendations

This brief assessment of the additional vegetation parcels within the expanded Sweetwater study area has revealed some perhaps surprising finds, given the rapid nature of the investigation. Two endangered (*Persoonia pauciflora*, *Acacia bynoeana*), one vulnerable (*Eucalyptus glaucina*), three rare (*Eucalyptus fergusonii* subsp. *dorsiventralis*, *Grevillea montana*, *Macrozamia flexuosa*) and one potential new species (*Eucalyptus* sp. aff. *agglomerata*) were identified. The *Acacia bynoeana* and *Eucalyptus* sp. aff. *agglomerata* were previously not recorded in the core Sweetwater study area, and both are considered highly significant. The habitat in which both were found also bears some strong similarities to some of the vegetation around Cessnock, 15km to the south, and requires further investigation.

Four potentially new vegetation types previously not mapped for the core Sweetwater study area were also uncovered. All four require detailed survey and mapping to gain a better understanding of their relationships to the surrounding vegetation elsewhere in the locality. Nowhere within the

expanded study area was there vegetation present that would fit within the Lower Hunter Spotted Gum – Ironbark Forest EEC, at least not within the definition documented in Bell and Driscoll 2005. Again, further sampling of representative areas and a re-analysis of all Spotted Gum – Ironbark data would be required to confirm this.

The following recommendations are made with regard to the additional parcels of land:

- Detailed survey be undertaken in the newly-identified *Eucalyptus* sp aff *agglomerata* Gully Forest (Unit 13e), to ascertain its relationship to other communities in the area;
- Detailed survey be undertaken in the newly-identified *Eucalyptus fergusonii* – *Corymbia maculata* – *Melaleuca nodosa* Scrub-Forest (Unit 18q), to ascertain its relationship to other scrubby forests dominated by *Melaleuca nodosa*;
- Detailed survey be undertaken in the newly-identified *Eucalyptus tereticornis* – *Eucalyptus glaucina* Shrubby Open Forest (Unit 18r), to ascertain its relationship to other communities dominated by redgum species;
- Detailed survey and mapping be undertaken for the newly-identified *Eucalyptus* sp aff *agglomerata* Heathy Low Forest (Unit 18s), to ascertain its relationship to similar vegetation in the Cessnock district, and also to gain a better appreciation of the size of the *Acacia bynoeana* population;
- Measures be taken to conserve the large remnant of vegetation in the north-east of the study area, immediately south of the Main Northern Railway, recognising the excellent condition of this vegetation and its role as a wildlife corridor. Current proposals to fragment this remnant via the F3 freeway extension may warrant revision to lessen the impacts on this parcel;
- Exclusion from potential development of the parcel of land immediately west of the Cessnock Road, and south of the existing Hanwood Estate, to protect the large population of *Persoonia pauciflora*.

6.0 Project Limitations

This report and the associated mapping of vegetation communities has been undertaken as a rapid assessment only and has not relied on detailed floristic survey, data analysis or ground truthing. Mapping has been assisted by field reconnaissance over the course of one day, largely restricted to public roads, together with extrapolation from the detailed mapping undertaken within the core Sweetwater area. Many parcels of land in private ownership were not inspected in the field. As a consequence, this report and the associated mapping should not be taken as a final assessment of the area.

7.0 References

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Appendix 3

Fauna Species Lists

EXPECTED FAUNA SPECIES LIST

Below are tabulated lists of fauna species (separated into class guilds) that could be *reasonably* expected to be found within the study area at some time. Such an approach has been taken given the unlikelihood to record *all* potentially occurring species within an area during formal fauna surveys (due to seasonality of certain species, climatic limitations, crypticism etc).

Family sequencing and taxonomy follow for each fauna class:

Birds – Christidis and Boles (1994).

Herpetofauna - Cogger (2000).

Mammals - Strahan (ed) (1995) and Churchill (1998).

KNOWN AND EXPECTED BIRD LIST

Appendix Key:	# = introduced species	? = species unable to be confirmed
	(E) = listed as Endangered in NSW.	(V) = listed as Vulnerable in NSW.
Data Source:	(J) = listed as JAMBA species	(EE) = Species listed under the
	(C) = listed as CAMBA species	Commonwealth EPBC Act as Endangered
	(EV) = Species listed under the	(EM) = Species listed under the
	Commonwealth EPBC Act as Vulnerable	Commonwealth EPBC Act as Migratory
	1 = Species recorded during surveys by RPS 2005-2010	
	2 = Species previously recorded (CT records, 2001-2004 Lot 1 DP 658074, Lot 102 DP 1040618 & Lot 300 DP 1029733)	
	3 = Species previously recorded on site (Ecotone 2003)	
	4 = Species previously recorded on site (Atlas of NSW Wildlife, 2010)	
	5 = Species reported to authors by personal communication	

Family	Scientific Name	Common Name	1	2	3	4	5
Casuariidae (Emu)	<i>Dromaius novaehollandiae</i>	Emu					
Megapodiidae (Mound Builders)	<i>Alectura lathamii</i>	Australian Brush-turkey					
Phasianidae (Quails, Pheasants and Fowls)	<i>Coturnix pectoralis</i>	Stubble Quail		✓			
	<i>Coturnix ypsilophora</i>	Brown Quail					
Anatidae (Swans, Geese and Ducks)	<i>Anas castanea</i>	Chestnut Teal		✓			
	<i>Anas gracilis</i>	Grey Teal					
	<i>Anas platyrhynchos</i>	*Mallard					
	<i>Anas rhynchotis</i>	Australian Shoveller					
	<i>Anas superciliosa</i>	Pacific Black Duck	✓				
	<i>Aythya australis</i>	Hardhead	✓				
	<i>Chenonetta jubata</i>	Australian Wood Duck	✓	✓			
	<i>Cygnus atratus</i>	Black Swan	✓				
	<i>Oxyura australis</i>	Blue-billed Duck (V)					
	<i>Stictonetta naevosa</i>	Freckled Duck (V)					
	<i>Biziura lobata</i>	Musk Duck	✓				
Podicipedidae (Grebes)	<i>Tachybaptus novaehollandiae</i>	Australasian Grebe	✓				
	<i>Poliiocephalus</i>	Hoary-headed Grebe					

	<i>poliocephalus</i>			
Anhingidae (Darters)	<i>Anhinga melanogaster</i>	Darter		
Phalacrocoracidae (Cormorants)	<i>Phalacrocorax carbo</i>	Great Cormorant		
	<i>Phalacrocorax melanoleucos</i>	Little Pied Cormorant	✓	
	<i>Phalacrocorax sulcirostris</i>	Little Black Cormorant		✓
	<i>Phalacrocorax varius</i>	Pied Cormorant		
Pelecanidae (Pelicans)	<i>Pelecanus conspicillatus</i>	Australian Pelican	✓	✓
Ardeidae (Hérons, Bitterns and Egrets)	<i>Ardea alba</i>	Great Egret (C,J, EM)		
	<i>Ardea ibis</i>	Cattle Egret (C,J, EM)		
	<i>Ardea intermedia</i>	Intermediate Egret		
	<i>Ardea pacifica</i>	White-necked Heron	✓	✓
	<i>Botaurus poiciloptilus</i>	Australasian Bittern (V)		
	<i>Butorides striatus</i>	Striated Heron		
	<i>Egretta garzetta</i>	Little Egret		
	<i>Egretta novaehollandiae</i>	White-faced Heron	✓	✓
	<i>Ixobrychus flavicollis</i>	Black Bittern (V)		
	<i>Nycticorax caledonicus</i>	Nankeen Night Heron		
Threskiornithidae (Ibises and Spoonbills)	<i>Platalea flavipes</i>	Yellow-billed Spoonbill		
	<i>Platalea regia</i>	Royal Spoonbill		
	<i>Threskiornis molucca</i>	Australian White Ibis	✓	
	<i>Threskiornis spinicollis</i>	Straw-necked Ibis	✓	✓
Accipitridae (Hawks, Kites and Eagles)	<i>Accipiter fasciatus</i>	Brown Goshawk	✓	
	<i>Accipiter cirrhocephalus</i>	Collared Sparrowhawk	✓	
	<i>Accipiter novaehollandiae</i>	Grey Goshawk		
	<i>Aquila audax</i>	Wedge-tailed Eagle	✓	✓
	<i>Aviceda subcristata</i>	Pacific Baza	✓	✓
	<i>Circus approximans</i>	Swamp Harrier		
	<i>Circus assimilis</i>	Spotted Harrier (V)	✓	
	<i>Elanus axillaris</i>	Black-shouldered Kite	✓	
	<i>Haliaeetus leucogaster</i>	White-bellied Sea-Eagle (C, EM)		
	<i>Haliastur sphenurus</i>	Whistling Kite	✓	✓
	<i>Hamirostra melanosternon</i>	Black-breasted Buzzard (V)		
	<i>Hieraaetus morphnoides</i>	Little Eagle (V)	✓	
	<i>Lophoictinia isura</i>	Square-tailed Kite (V)		✓
Falconidae (Falcons)	<i>Falco berigora</i>	Brown Falcon	✓	
	<i>Falco cenchroides</i>	Nankeen Kestrel	✓	
	<i>Falco longipennis</i>	Australian Hobby	✓	✓
	<i>Falco peregrinus</i>	Peregrine Falcon		
	<i>Falco subniger</i>	Black Falcon		
Rallidae (Crakes, Rails and Gallinules)	<i>Fulica atra</i>	Eurasian Coot	✓	
	<i>Gallinula philippensis</i>	Buff-banded Rail		
	<i>Gallinula tenebrosa</i>	Dusky Moorhen	✓	
	<i>Porphyrio porphyrio</i>	Purple Swampphen	✓	
	<i>Porzana fluminea</i>	Australian Spotted Crane		
	<i>Porzana pusilla</i>	Baillon's Crane		
	<i>Porzana tabuensis</i>	Spotless Crane		
	<i>Rallus pectoralis</i>	Lewin's Rail		

Turnicidae (Button-Quail)	<i>Turnix pyrrhotorax</i>	Red-chested Button-quail					
	<i>Turnix varia</i>	Painted Button-quail	✓				
Rostratulidae (Snipe)	<i>Rostratula benghalensis</i>	Painted Snipe (EM, V)					
	<i>Gallinago hardwickii</i>	Latham's Snipe					
Jacanidae (Jacanas)	<i>Irediparra gallinacea</i>	Comb-crested Jacana (V)					
Burhinidae (Stone-curlews)	<i>Burhinus grallarius</i>	Bush Stone-curlew (E)					
	<i>Tringa stagnatilis</i>	Marsh Sandpiper (C, J)					
Recurvirostridae (Stilts and Avocets)	<i>Himantopus himantopus</i>	Black-winged Stilt					
Charadriidae (Lapwings, Plovers and Dottrels)	<i>Erythronyx cinctus</i>	Red-kneed Dotterel					
	<i>Elsyornis melanops</i>	Black-fronted Dotterel					
	<i>Vanellus miles</i>	Masked Lapwing	✓		✓		
Columbidae (Pigeons and Doves)	<i>Columba livia</i>	Rock Dove #					
	<i>Macropygia amboinensis</i>	Brown Cuckoo Dove					
	<i>Columba leucomela</i>	White-headed Pigeon					
	<i>Streptopelia chinensis</i>	Spotted Turtle-Dove #					
	<i>Chalcophaps indica</i>	Emerald Dove					
	<i>Phaps chalcoptera</i>	Common Bronzewing	✓	✓			
	<i>Phaps elegans</i>	Brush Bronzewing					
	<i>Ocyphaps lophotes</i>	Crested Pigeon	✓	✓	✓	✓	
	<i>Geopelia striata</i>	Peaceful Dove	✓				
	<i>Geopelia humeralis</i>	Bar-shouldered Dove	✓				
	<i>Leucosarcia melanoleuca</i>	Wonga Pigeon					
	<i>Ptilinopus magnificus</i>	Wompoo Fruit-dove (V)					
	<i>Ptilinopus regina</i>	Rose-crowned Fruit-dove (V)					
	<i>Ptilinopus superbus</i>	Superb Fruit-dove (V)					
	<i>Lopholaimus antarcticus</i>	Topknot Pigeon	✓				
	<i>Calyptorhynchus funereus</i>	Yellow-tailed Black-Cockatoo	✓				
	<i>Calyptorhynchus lathami</i>	Glossy Black-Cockatoo (V)		✓			✓
	<i>Cacatua roseicapilla</i>	Galah	✓	✓	✓		
	<i>Cacatua tenuirostris</i>	Long-billed Corella	✓				
	<i>Cacatua sanguinea</i>	Little Corella					
Psittacidae (Parrots)	<i>Cacatua galerita</i>	Sulphur-crested Cockatoo	✓				
	<i>Callocephalon fimbriatum</i>	Gang-gang Cockatoo (V)					
	<i>Trichoglossus haematodus</i>	Rainbow Lorikeet	✓				
	<i>Trichoglossus chlorolepidotus</i>	Scaly-breasted Lorikeet	✓	✓			
	<i>Trichoglossus concina</i>	Musk Lorikeet	✓				
	<i>Glossopsitta pusilla</i>	Little Lorikeet (V)	✓				
	<i>Alisterus scapularis</i>	Australian King Parrot	✓	✓			
	<i>Lathamus discolor</i>	Swift Parrot (E, EE)	✓				✓
	<i>Platycercus elegans</i>	Crimson Rosella	✓	✓			
	<i>Platycercus eximius</i>	Eastern Rosella	✓	✓	✓	✓	
	<i>Neophema pulchella</i>	Turquoise Parrot (V)	✓				
	<i>Psephotus haematonotus</i>	Red-rumped Parrot	✓	✓			
Cuculidae (Old World Cuckoos)	<i>Cuculus saturatus</i>	Oriental Cuckoo (C,J, EM)					
	<i>Cuculus pallidus</i>	Pallid Cuckoo					

	<i>Cacomantis variolosus</i>	Brush Cuckoo	✓		
	<i>Cacomantis flabelliformis</i>	Fan-tailed Cuckoo	✓		✓
	<i>Chrysococcyx basalis</i>	Horsfield's Bronze-Cuckoo	✓	✓	
	<i>Chrysococcyx lucidus</i>	Shining Bronze-Cuckoo	✓		
	<i>Eudynamys scolopacea</i>	Common Koel	✓		
	<i>Scythrops novaehollandiae</i>	Channel-billed Cuckoo			
Centropodidae (Coucals)	<i>Centropus phasianinus</i>	Pheasant Coucal			
Strigidae (Hawk Owls)	<i>Ninox strenua</i>	Powerful Owl (V)			✓
	<i>Ninox connivens</i>	Barking Owl (V)			✓
	<i>Ninox boobook</i>	Southern Boobook	✓	✓	
Tytonidae (Barn Owls)	<i>Tyto alba</i>	Barn Owl			
	<i>Tyto novaehollandiae</i>	Masked Owl (V)			
Podargidae (Frogmouths)	<i>Podargus strigoides</i>	Tawny Frogmouth	✓		
Caprimulgidae (Nightjars)	<i>Eurostopodus mystacalis</i>	White-throated Nightjar			
Aegothelidae (Owlet-nightjars)	<i>Aegotheles cristatus</i>	Australian Owlet-nightjar	✓	✓	
Apodidae (Typical Swifts)	<i>Hirundapus caudacutus</i>	White-throated Needletail (C,J, EM)	✓	✓	
	<i>Apus pacificus</i>	Fork-tailed Swift (C,J, EM)			
Alcedinidae (True Kingfishers)	<i>Alcedo azurea</i>	Azure Kingfisher	✓		✓
Halcyonidae (Kingfishers and Kookaburras)	<i>Dacelo novaeguineae</i>	Laughing Kookaburra	✓	✓	✓
	<i>Todiramphus sanctus</i>	Sacred Kingfisher	✓	✓	
Meropidae (Bee-eaters)	<i>Merops ornatus</i>	Rainbow Bee-eater (J,EM)	✓	✓	
Coraciidae (Typical Rollers)	<i>Eurystomus orientalis</i>	Dollarbird	✓		
Menuridae (Lyrebirds)	<i>Menura novaehollandiae</i>	Superb Lyrebird			
Climacteridae (Australo-Papuan Treecreepers)	<i>Cormobates leucophaeus</i>	White-throated Treecreeper	✓	✓	
	<i>Climacteris erythrops</i>	Red-browed Treecreeper			
	<i>Climacteris picumnus</i>	Brown Treecreeper (V)	✓		
Maluridae (Fairy-Wrens and Emu-Wrens)	<i>Malurus cyaneus</i>	Superb Fairy-wren	✓	✓	✓
	<i>Malurus lamberti</i>	Variegated Fairy-wren	✓	✓	
	<i>Stipiturus malachurus</i>	Southern Emu-wren			
Pardalotidae (Pardalotes, Scrubwrens, Thornbills)	<i>Pardalotus punctatus</i>	Spotted Pardalote	✓	✓	✓
	<i>Paradalotus striatus</i>	Striated Pardalote	✓	✓	✓
	<i>Sericornis frontalis</i>	White-browed Scrubwren	✓		
	<i>Sericornis magnirostris</i>	Large-billed Scrubwren			
	<i>Chthonicola sagittata</i>	Speckled Warbler (V)	✓	✓	
	<i>Smicrornis brevirostris</i>	Weebill	✓		
	<i>Gerygone mouki</i>	Brown Gerygone			
	<i>Gerygone fusca</i>	Western Gerygone	✓		
	<i>Gerygone olivacea</i>	White-throated Gerygone	✓	✓	
	<i>Acanthiza pusilla</i>	Brown Thornbill	✓	✓	✓
	<i>Acanthiza reguloides</i>	Buff-rumped Thornbill	✓	✓	
	<i>Acanthiza chrysorrhoa</i>	Yellow-rumped Thornbill	✓		

	<i>Acanthiza nana</i>	Yellow Thornbill	✓	✓	✓
	<i>Acanthiza lineata</i>	Striated Thornbill	✓		
	<i>Hylacola pyrrhopygia</i>	Chestnut-rumped Heathwren			
Meliphagidae (Honeyeaters)	<i>Anthochaera carunculata</i>	Red Wattlebird	✓		✓
	<i>Plectrhncha lanceolata</i>	Striped Honeyeater	✓		
	<i>Anthochaera chrysoptera</i>	Brush Wattlebird		✓	
	<i>Philemon corniculatus</i>	Noisy Friarbird	✓	✓	
	<i>Philemon citeregularis</i>	Little Friarbird	✓		
	<i>Xanthomyza phrygia</i>	Regent Honeyeater (E, EE, EM)			✓
	<i>Manorina melanophrys</i>	Bell Miner			
	<i>Manorina melanocephala</i>	Noisy Miner	✓	✓	✓
	<i>Meliphaga lewinii</i>	Lewin's Honeyeater			
	<i>Lichenostomus chrysops</i>	Yellow-faced Honeyeater	✓	✓	✓
	<i>Lichenostomus melanops</i>	Yellow-tufted Honeyeater			
	<i>Lichenostomus fuscus</i>	Fuscous Honeyeater	✓	✓	
	<i>Lichenostomus penicillatus</i>	White-plumed Honeyeater	✓		✓
	<i>Lichenostomus leucotis</i>	White-eared Honeyeater	✓		
	<i>Melithreptus brevirostris</i>	Brown-headed Honeyeater	✓	✓	
	<i>Melithreptus lunatus</i>	White-naped Honeyeater	✓		
	<i>Melithreptus gularis</i>	Black-chinned Honeyeater (V)			✓
	<i>Entomyzon cyanotis</i>	Blue-faced Honeyeater	✓		
	<i>Lichmera indistincta</i>	Brown Honeyeater			
	<i>Phylidonyris novaehollandiae</i>	New Holland Honeyeater			
	<i>Phylidonyris nigra</i>	White-cheeked Honeyeater			
	<i>Acanthorhynchus tenuirostris</i>	Eastern Spinebill	✓	✓	✓
	<i>Grantiella picta</i>	Painted Honeyeater (V)			✓
	<i>Myzomela sanguinolenta</i>	Scarlet Honeyeater	✓		
	<i>Epthianura albifrons</i>	White-fronted Chat			
Eopsaltriidae (Robins)	<i>Melanodryas cucullata</i>	Hooded Robin (V)			
	<i>Microeca fascians</i>	Jacky Winter	✓		
	<i>Petroica multicolor</i>	Scarlet Robin (V)	✓	✓	
	<i>Petroica phoenicea</i>	Flame Robin (V)			
	<i>Petroica rosea</i>	Rose Robin	✓	✓	✓
	<i>Eopsaltria australis</i>	Eastern Yellow Robin	✓	✓	
Pomatostomidae (Australo-Papuan Babblers)	<i>Pomatostomus temporalis</i>	Grey-crowned Babbler (V)	✓	✓	✓
Cinclosomidae (Quail-thrushes and allies)	<i>Psophodes olivaceus</i>	Eastern Whipbird			✓
	<i>Cinclosoma punctatum</i>	Spotted Quail-thrush			
Neosittidae (Sittellas)	<i>Daphoenositta chrysoptera</i>	Varied Sittella (V)	✓	✓	
Pachycephalidae (Whistlers, Shrike-tit and Shrike-thrushes)	<i>Falcunculus frontatus</i>	Crested Shrike-tit	✓		
	<i>Pachycephala pectoralis</i>	Golden Whistler	✓		✓
	<i>Pachycephala rufiventris</i>	Rufous Whistler	✓	✓	
	<i>Colluricincla harmonica</i>	Grey Shrike-thrush	✓	✓	
Dicruridae (Monarchs, Fantails and Drongo)	<i>Monarcha melanopsis</i>	Black-faced Monarch			

	<i>Myiagra rubecula</i>	Leaden Flycatcher	✓		
	<i>Myiagra inquieta</i>	Restless Flycatcher			
	<i>Myiagra cyanoleuca</i>	Satin Flycatcher			
	<i>Grallina cyanoleuca</i>	Magpie-lark	✓		
	<i>Rhipidura rufifrons</i>	Rufous Fantail		✓	
	<i>Rhipidura fuliginosa</i>	Grey Fantail	✓	✓	✓
	<i>Rhipidura leucophrys</i>	Willie Wagtail	✓	✓	✓
	<i>Dicrurus bracteatus</i>	Spangled Drongo			
Campephagidae (Cuckoo-shrikes and Trillers)	<i>Coracina novaehollandiae</i>	Black-faced Cuckoo-shrike	✓	✓	✓
	<i>Coracina papuensis</i>	White-bellied Cuckoo-shrike	✓		
	<i>Coracina tenuirostris</i>	Cicadabird	✓		
	<i>Lalage sueurii</i>	White-winged Triller			
Oriolidae (Orioles and Figbird)	<i>Oriolus sagittatus</i>	Olive-backed Oriole	✓	✓	
	<i>Sphecotheres viridis</i>	Figbird			
Artamidae (Woodswallows, Butcherbirds and Currawongs)	<i>Artamus leucorhynchus</i>	White-breasted Woodswallow			
	<i>Artamus cyanopterus</i>	Dusky Woodswallow	✓		
	<i>Artamus personatus</i>	Masked Woodswallow	✓		
	<i>Cracticus torquatus</i>	Grey Butcherbird	✓	✓	✓
	<i>Cracticus nigrogularis</i>	Pied Butcherbird	✓	✓	✓
	<i>Gymnorhina tibicen</i>	Australian Magpie	✓	✓	✓
	<i>Strepera graculina</i>	Pied Currawong	✓	✓	
Corvidae (Crows and allies)	<i>Corvus coronoides</i>	Australian Raven	✓	✓	✓
Cororacidae (Mud-nesters)	<i>Corcorax melanorhamphos</i>	White-winged Chough	✓	✓	✓
	<i>Grallina cyanoleuca</i>	Magpie-lark	✓	✓	✓
Ptilinorhynchidae (Bowerbirds)	<i>Ptilinorhynchus violaceus</i>	Satin Bowerbird	✓		
Motacillidae (Old World Wagtails and Pipits)	<i>Anthus novaeseelandiae</i>	Richard's Pipit	✓	✓	
Passeridae (Sparrows, Weaverbirds, Waxbills and allies)	<i>Passer domesticus</i>	House Sparrow #			
	<i>Taeniopygia guttata</i>	Zebra Finch			
	<i>Taeniopygia bichenovii</i>	Double-barred Finch	✓	✓	
	<i>Stagonopleura guttata</i>	Diamond Firetail (V)			
	<i>Aegintha temporalis</i>	Red-browed Firetail	✓	✓	
	<i>Neochmia modesta</i>	Plum-headed Finch			
	<i>Neochmia temporalis</i>	Red-browed Finch	✓		
	<i>Lonchura castaneothorax</i>	Chestnut-breasted Mannikin			
Dicaeidae (Flowerpeckers)	<i>Dicaeum hirundinaceum</i>	Mistletoebird	✓		
Hirundinidae (Swallows and Martins)	<i>Hirundo neoxena</i>	Welcome Swallow	✓	✓	
	<i>Hirundo nigricans</i>	Tree Martin	✓	✓	
	<i>Hirundo ariel</i>	Fairy Martin	✓		
	<i>Cheramoeca leucosternus</i>	White-backed Swallow			
Sylviidae (Old World Warblers)	<i>Acrocephalus stentoreus</i>	Clamorous Reed Warbler	✓		
	<i>Cincloramphus mathewsi</i>	Rufous Songlark			
	<i>Cisticola exilis</i>	Golden-headed Cisticola			
	<i>Megalurus gramineus</i>	Little Grassbird	✓		

	<i>Megalurus timorensis</i>	Tawny Grassbird		
Zosteropidae (White-eyes)	<i>Zosterops lateralis</i> <i>lateralis</i>	Silvereye	✓	
	<i>Zosterops lateralis</i> <i>familiaris</i>	Silvereye	✓	✓
Muscicapidae (Thrushes)	<i>Zoothera lunulate</i>	Bassian Thrush		
Sturnidae (Starlings and allies)	<i>Sturnus vulgaris</i>	Common Starling #	✓	
	<i>Acridotheres tristis</i>	Common Myna #	✓	

KNOWN AND EXPECTED MAMMAL LIST

Appendix Key: # = introduced species (E) = listed as Endangered in NSW.
(V) = listed as Vulnerable in NSW.

Data Source: (EV) = Species listed under the Commonwealth EPBC Act as Vulnerable
1 = Species recorded during surveys by RPS 2005-20010
2 = Species previously recorded (CT records, 2001-2004 Lot 1 DP 707207, Lot 300 DP 1029733 & Lot 102 DP 1040618)
3 = Species previously recorded on site (Ecotone 2003)
4 = Species previously recorded on site (Atlas of NSW Wildlife, 2010)
5 = Species reported to authors by personal communication

Sub-Class	Family Name	Scientific Name	Common Name	1	2	3	4	5
Proteheria (Monotremes)	Tachyglossidae (Echidnas)	<i>Tachyglossus aculeatus</i>	Short-beaked Echidna	✓		✓		
		<i>Ornithorhynchus anatinus</i>	Platypus			✓		
Marsupalia (Marsupials)	Dasyuridae (Dasyurids)	<i>Antechinus flavipes</i>	Yellow-footed Antechinus	✓	✓			
		<i>Antechinus stuartii</i>	Brown Antechinus	✓	✓			
		<i>Antechinus swainsonii</i>	Dusky Antechinus					
		<i>Dasyurus maculatus</i>	Tiger Quoll (V)					
		<i>Phascogale tapoatafa</i>	Brush-tailed Phascogale (V)					
		<i>Planigale maculata</i>	Common Planigale (V)					
		<i>Sminthopsis murina</i>	Common Dunnart					
	Peramelidae (Bandicoots and Bilbies)	<i>Isodon macrourus</i>	Northern Brown Bandicoot					
		<i>Peremeles nasuta</i>	Long-nosed Bandicoot	✓				
	Phascolarctidae (Koala)	<i>Phascolarctos cinereus</i>	Koala (V)				✓	?
	Vombatidae	<i>Vombatus ursinus</i>	Common Wombat	✓		✓		
	Petauridae (Wrist-winged Gliders)	<i>Petaurus breviceps</i>	Sugar Glider					✓
		<i>Petaurus norfolcensis</i>	Squirrel Glider (V)	✓	✓			
		<i>Petaurus australis</i>	Yellow-bellied Glider (V)					
	Pseudocheiridae (Ringtail Possums and Greater Glider)	<i>Petauroides volans</i>	Greater Glider					
		<i>Pseudocheirus peregrinus</i>	Common Ringtail Possum	✓				
	Acrobatidae (Feathertail Glider)	<i>Acrobates pygmaeus</i>	Feathertail Glider					
	Phalangeridae (Brush-tail Possums and Cuscuses)	<i>Trichosurus vulpecula</i>	Common Brushtail Possum	✓	✓	✓		
	Macropodidae (Wallabies and Kangaroos)	<i>Macropus giganteus</i>	Eastern Grey Kangaroo	✓	✓	✓		
		<i>Macropus robustus</i>	Common Wallaroo					
		<i>Macropus rufogriseus</i>	Red-necked Wallaby	✓	✓	✓		
		<i>Wallabia bicolor</i>	Swamp Wallaby	✓		✓		
	Pteropodidae (Flying-foxes, Fruit-bats and)	<i>Pteropus poliocephalus</i>	Grey-headed Flying-fox (V, EV)				✓	

Blossum-bats)						
	Rhinolophidae (Horseshoe-bats)	<i>Rhinolophus megaphyllus</i>	Eastern Horseshoe- bat			
	Emballonuridae (Sheath-tail-bats)	<i>Saccolaimus flaviventris</i>	Yellow-bellied Sheath-tail-bat (V)	✓		
	Molossidae (Freetail-bats)	<i>Mormopterus norfolkensis</i>	East Coast Freetail- bat (V)	✓		✓
		<i>Mormopterus planiceps</i>	Southern Freetail-bat	✓		
		<i>Mormopterus</i> sp.1	Little Freetail-bat		✓	
		<i>Mormopterus</i> sp.2	Eastern Freetail-bat			
		<i>Tadarida australis</i>	White-striped Freetail-bat	✓		
	Vespertilionidae (Vespertilionid Bats)	<i>Miniopterus australis</i>	Little Bentwing-bat (V)	✓	✓	
		<i>Miniopterus schreibersii</i>	Eastern Bentwing- bat (V)	✓	✓	
		<i>Nyctophilus geoffroyi</i>	Lesser Long-eared Bat			
		<i>Nyctophilus gouldii</i>	Gould's Long-eared Bat		✓	
		<i>Chalinolobus dwyeri</i>	Large-eared Pied Bat (V)			
		<i>Chalinolobus gouldii</i>	Gould's Wattled Bat	✓		
		<i>Chalinolobus morio</i>	Chocolate Wattled Bat	✓		
		<i>Falsistrellus tasmaniensis</i>	Eastern Falsistrelle (V)			
		<i>Myotis adversus</i>	Large-footed Myotis (V)	✓		
		<i>Scoteanax orion</i>	Eastern Broad- nosed Bat		✓	
		<i>Scoteanax rueppellii</i>	Greater Broad-nosed Bat (V)		✓	
		<i>Scotorepens balstoni</i>	Little Broad-nosed Bat	✓		
		<i>Vespadelus darlingtoni</i>	Large Forest Bat			
		<i>Vespadelus regulus</i>	Southern Forest Bat			
		<i>Vespadelus troughtoni</i>	Eastern Cave Bat (V)			
		<i>Vespadelus pumilus</i>	Eastern Forest Bat		✓	
		<i>Vespadelus vulturinus</i>	Little Forest Bat	✓	✓	
Eutheria (Non-Flying Placental Mammals)	Muridae (Murids)	<i>Hydromys chrysogaster</i>	Water Rat			
		<i>Melomys burtoni</i>	Grassland Melomys			
		<i>Mus musculus</i>	House Mouse #			
		<i>Pseudomys novaehollandiae</i>	New Holland Mouse			
		<i>Rattus fuscipes</i>	Bush Rat		✓	
		<i>Rattus lutreolus</i>	Swamp Rat			
		<i>Rattus norvegicus</i>	Brown Rat #			
		<i>Rattus rattus</i>	Black Rat #			
	Canidae (Dogs)	<i>Canis familiaris</i>	Dog #	✓	✓	✓
		<i>Canis familiaris dingo</i>	Dingo	✓		
		<i>Vulpes vulpes</i>	Red Fox #	✓		✓
	Felidae (Cats)	<i>Felis catus</i>	Feral Cat #			
	Leporidae (Rabbit and Hare)	<i>Oryctolagus cuniculus</i>	European Rabbit #	✓		✓

	<i>Lepus capensis</i>	Brown Hare #	✓	✓	
Equidae (Horse Donkey)	and				
	<i>Equus caballus</i>	Horse #	✓		✓
	<i>Equus asinus</i>	Donkey			
Suidae (Pigs)	<i>Sus scrofa</i>	Pig #			
Bovidae (Horned Ruminants)	<i>Bos taurus</i>	Cow #	✓	✓	✓
	<i>Capra hircus</i>	Goat #	✓		
Cervidae (Deer)	<i>Cervus timorensis</i>	Rusa Deer #			

KNOWN AND EXPECTED REPTILE LIST

Appendix Key: (EV) = listed under the Commonwealth EPBC Act as Vulnerable (E) = listed as Endangered in NSW.
(V) = listed as Vulnerable in NSW.

Data Source: 1 = Species recorded during surveys by RPS 2005-2010
2 = Species previously recorded (CT records, 2001-2004 Lot 1 DP 707207, Lot 300 DP 1029733 & Lot 102 DP 1040618)
3 = Species previously recorded on site (Ecotone 2003)
4 = Species previously recorded on site (Atlas of NSW Wildlife, 2010)

Order	Family Name	Scientific Name	Common Name	1	2	3	4
Testudines	Chelidae (Tortoises)	<i>Chelodina longicollis</i>	Long-necked Tortoise	✓			
Squamata (Sauria)	Agamidae (Dragons)	<i>Amphibolurus muricatus</i>	Jacky Lizard				
		<i>Physignathus lesuerii</i>	Eastern Water Dragon	✓			
		<i>Pogona barbata</i>	Eastern Bearded Dragon	✓	✓		
	Pygopodidae (Legless Lizards)	<i>Lialis burtonis</i>	Burton's Snake Lizard				
		<i>Pygopus lepidopus</i>	Common Scaly-foot				
		<i>Delma plebeia</i>	Leaden Delma				
	Varanidae (Monitors)	<i>Varanus gouldii</i>	Gould's Monitor				
		<i>Varanus rosenbergi</i>	Heath Monitor (V)				
		<i>Varanus varius</i>	Lace Monitor	✓	✓		
	Scincidae (Skinks)	<i>Cryptoblepharus virgatus</i>					
		<i>Ctenotus taeniolatus</i>	Copper-tailed Skink				
		<i>Ctenotus robustus</i>	Striped Skink				
		<i>Cyclodomorphus casuarinae</i>	She-oak Skink				
		<i>Egernia cunninghamii</i>	Cunningham's Skink				
		<i>Egernia major</i>	Land Mullet				
		<i>Egernia modesta</i>					
		<i>Egernia striolata</i>	Tree-crevice Skink				
		<i>Egernia saxatilis</i>	Black Rock Skink				
		<i>Egernia whitii</i>	White's Skink				
		<i>Eulamprus quoyii</i>	Eastern Water Skink	✓			
		<i>Eulamprus tenuis</i>					
		<i>Lampropholis delicata</i>	Grass Skink	✓			
		<i>Lampropholis guichenoti</i>	Garden Skink		✓		
		<i>Lygisaurus foliorum</i>	Tree-base Litter-skink				
		<i>Morethia boulengeri</i>	South-eastern Morethia				
		<i>Pseudomoia platynota</i>	Red-throated Skink				
		<i>Saiphos equalis</i>					
		<i>Saproscincus mustelinus</i>	Weasel Skink				
		<i>Tiliqua scincoides</i>	Eastern Blue-tongued Lizard	✓			
Squamata (Serpente)	Typhlopidae (Blind Snakes)	<i>Ramphotyphlops bituberculatus</i>	Prong-snouted Blind Snake				
		<i>Ramphotyphlops weidii</i>	Brown-snouted Blind Snake				
		<i>Ramphotyphlops nigrescens</i>	Black Blind Snake				
	Boidae (Pythons)	<i>Morelia spilota</i>	Diamond Python				
	Colubridae	<i>Boiga irregularis</i>	Brown Tree Snake				

(Tree Snakes)					
	<i>Dendralaphis punctulata</i>	Green Tree Snake			
Elapidae (Venomous Snakes)	<i>Furina diadema</i>	Red-naped Snake			
	<i>Acanthopis antarcticus</i>	Death Adder			
	<i>Cacophis krefftii</i>	Dwarf Crowned Snake			
	<i>Cacophis squamulosus</i>	Golden Crowned Snake			
	<i>Demansia psammophis</i>	Yellow-faced Whip Snake			
	<i>Furina diadema</i>	Red-naped Snake			
	<i>Hoplocephalus bungaroides</i>	Broad-headed Snake (V, EV)			
	<i>Hoplocephalus bitorquatus</i>	Pale-headed Snake (V)			
	<i>Notechis scutatus</i>	Eastern Tiger Snake			
	<i>Pseudonaja textilis</i>	Eastern Brown Snake	✓		✓
	<i>Rhinoplocephalus nigrescens</i>	Eastern Small-eyed Snake			
	<i>Vermicella annulata</i>	Bandy Bandy			
	<i>Hemiaspis signata</i>	Black-bellied Swamp Snake			
	<i>Pseudechis porphyriacus</i>	Red-bellied Black Snake	✓		✓

KNOWN AND EXPECTED FROG LIST

Appendix Key: (EV) = Species listed under the (E) = listed as Endangered in NSW.
Commonwealth EPBC Act as Vulnerable (V) = listed as Vulnerable in NSW.

Data Source: 1 = Species recorded during surveys by RPS 2005 – 2010.
2 = Species previously recorded (CT records, 2001-2004 Lot 1 DP 707207, Lot 300 DP 1029733 & Lot 102 DP 1040618)
3 = Species previously recorded on site (Ecotone 2003)
4 = Species previously recorded on site (Atlas of NSW Wildlife, 2010)

Family Name	Scientific Name	Common Name	1	2	3	4
Hylidae (Tree Frogs)	<i>Litoria aurea</i>	Green and Golden Bell Frog (E, EV)				
	<i>Litoria brevipalmata</i>	Green-thighed Frog (V)				
	<i>Litoria caerulea</i>	Green Tree Frog				
	<i>Litoria chloris</i>	Red-eyed Green Tree Frog				
	<i>Litoria dentata</i>	Bleating Tree Frog	✓			
	<i>Litoria fallax</i>	Eastern Dwarf Tree Frog	✓	✓		
	<i>Litoria latopalmata</i>	Broad-palmed Frog	✓			
	<i>Litoria lesueuri</i>	Lesueur's Frog				
	<i>Litoris nasuta</i>	Rocket Frog		✓		
	<i>Litoria peronii</i>	Peron's Tree Frog	✓			
	<i>Litoria phyllochroa</i>	Leaf Green Tree Frog				
	<i>Litoria tyleri</i>	Tyler's Tree Frog				
	<i>Litoria verreauxii</i>	Verreaux's Frog	✓	✓		
Myobatrachidae (Ground Frogs)	<i>Crinia signifera</i>	Common Eastern Froglet	✓	✓	✓	
	<i>Limnodynastes dumerilli</i>	Eastern Banjo Frog				
	<i>Limnodynastes ornatus</i>	Ornate Burrowing Frog	✓			
	<i>Limnodynastes peronii</i>	Striped Marsh Frog		✓		
	<i>Limnodynastes tasmaniensis</i>	Spotted Grass Frog	✓			
	<i>Pseudophryne coriacea</i>	Red-backed Toadlet				
	<i>Pseudophryne bibronii</i>	Brown Toadlet				
	<i>Uperoleia fusca</i>	Dusky Toadlet	✓	✓		
	<i>Uperoleia laevis</i>	Smooth Toadlet	✓			

Appendix 4

Persoonia pauciflora Report

Appendix 5

RPS Key Staff Qualifications



Curriculum Vitae

MATTHEW DOHERTY

Manager - Ecology & GIS

Newcastle, NSW

Bachelor of Landscape Management and Conservation (Land & Water Conservation Major), University of Western Sydney, 2002

Bushland Regeneration Certificate II, Western Sydney Institute of TAFE, 1999

Spikeless Tree Climbing Techniques, Total Height Safety, 2004

OH&S Induction Training (Green Card)

NPWS Scientific Investigation Licence

NSW Animal Ethics Research Authority

Senior First Aid

AREAS OF EXPERTISE:

Matt has seven years experience in the environmental industry with key skills in project management, survey design, GIS and client relations. In his position as Ecology & GIS Manager, Matt manages environment department including the day to day running of projects, verification of reports and other outputs and ensures clients are well informed of project progress and key findings. Matthew's background in local government, state government and private consultancy gives him a high level of appreciation of the environmental and consultancy sector, thus allowing him to take a pragmatic approach to providing successful conservation and development outcomes whilst meeting the aims and objectives of clients and determining authorities.

SELECTED PROJECT EXPERIENCE:

Ecology and GIS

- **Various large-scale land development, mining, energy and infrastructure projects** – Matt has project managed and/or participated in numerous large-scale land development, mining, energy and infrastructure projects including Queensland Hunter Gas Pipeline (850km); Hunter Gas Pipeline; Rio Tinto Lower Hunter Lands Project; GIS biodiversity, large scale vegetation, habitat and predictive modelling mapping works; wind farms and coordination of environmental monitoring programs for mines

PREVIOUS EXPERIENCE:

Ecologist – Andrews Neil Pty Ltd

2004 - 2005

Duties included: preparation of Fee Proposals for Ecological Services; General and Targeted Flora and Fauna Surveys including Flora and Fauna Identification; Desktop Studies and Literature Searches; Interpretation and Application of Legislation; report preparation including Threatened Species Assessments (8 part test), Vegetation Management Plans (Riparian Restoration/ Rehabilitation, Bush Regeneration), Species Impact Statements, Weed Management Strategies, Habitat Management Strategies and Tree Assessments; GIS/ Spatial Analysis and Database Management; Liaison with Client, Stakeholder Groups, State and Local Governing Bodies; Site Supervision of Ecological Conditions; Tree Climbing for installation, maintenance and monitoring of nestboxes.

Project Officer / Horticultural Services – Gosford City Council

06/2003 – 05/2004

Comprehensively reviewed noxious weed management; performed vegetation surveys on GCC landfills to identify the presence of noxious weeds; quantify the extent of infestation of each noxious weeds species and map the



Curriculum Vitae

- CONTINUED -

affected areas; developed a management plan for the control of NW species identified in the survey in accordance with relevant legislation; maintained Japanese Gardens along with City Wide Gardens and Streetscapes.

Various Roles whilst at University

1997 - 2002

Environmental Officer - Dept of Land & Water Conservation, Newcastle

01/1999 – 12/1999

Liaised with relevant agency and stakeholder groups; researched and prepared an extensive literature review of issues pertaining to riparian vegetation; assessed current best practice for revegetation and rehabilitation of degraded sites; prepared a Riparian Revegetation Management Strategy

Volunteer – Maitland City Council

07/1999 – 12/1999

Assisted with Rivercare implementation throughout LGA. Utilised primary, secondary and field research to prepare a River Plan under 'Rivercare' guidelines.

Volunteer – Brisbane Waters & Gosford Lagoons Catchment Management Committee

03/1998 – 05/1998

Prepared Riparian Zone Rehabilitation Plan for Degraded Creek Management, Research and prepared a Riparian Zone Rehabilitation Project. Member on several Gosford City Council steering committees and working groups.

MEMBERSHIPS & ACHIEVEMENTS:

- Fire Protection Association Australia (FPAA)



Curriculum Vitae

CRAIG ANDERSON

Senior Ecologist – Senior Project Manager

Newcastle, NSW

Bachelor Applied Science (Environmental Assessment & Management), University of Newcastle, 1994

Graduate Diploma in Archaeological Heritage, UNE, Current

RFS/PIA NSW Consulting Planners Bushfire Training

AREAS OF EXPERTISE:

Craig has over 15 years experience in a wide range of environmental consulting. He has undertaken and managed commissions for a diverse range of projects within land development, energy, mining, infrastructure and conservation, including State Significant developments.

Craig has an extensive background in ecological field surveys, encompassing all aspects of flora and fauna identification, targeted surveying and mapping. He was involved in the initial formulation of an Association of Consulting Ecologists for NSW in 1998 and has acted as an expert witness in several Land and Environment Court matters relating to ecology and bushfire assessment. He is an experienced negotiator of ecological / development outcomes, and has a detailed understanding of legislation related to ecological matters.

Craig has been actively involved in representations to the Department of Environment on behalf of the NSW Urban Taskforce in regards to proposed changes to the NSW Threatened Species Conservation Act, and for the Urban Development Institute of Australia (UDIA) on matters relating to issues such as the proposed listing of endangered ecological communities, regional environmental biodiversity strategies, and the Native Vegetation Act and the operations of the Catchment Management Authority (CMA).

SELECTED PROJECT EXPERIENCE:

Ecology

- **Buttaba Hills (336 Lots) – Species Impact Statement**
- **Hunter Economic Zone (800+ ha industrial estate) – Species Impact Statement**
- **Pelaw Main By-Pass to Hunter Economic Zone – Species Impact Statement**
- **Residential development / Eco-Resort / Fauna Sanctuary at Paxton - Flora and Fauna Assessment incorporating Seven Part Tests of Significance of Impact under Threatened Species Legislation**
- **SEPP 5 Aged Care facilities, Kariong, Hawks Nest, Wallsend, Glenhaven - Flora and Fauna Assessment incorporating Seven Part Tests of Significance of Impact under Threatened Species Legislation**
- **Caravan Park extensions, Fern Bay - Flora and Fauna Assessment incorporating Seven Part Tests of Significance of Impact under Threatened Species Legislation**
- **Road & Rail Infrastructure for the Hunter Economic Zone - Flora and Fauna Assessment incorporating Seven Part Tests of Significance of Impact under Threatened Species Legislation**
- **Alignments for Hunter Gas Pipeline Infrastructure - Flora and Fauna Assessment incorporating Seven Part Tests of Significance of Impact under Threatened Species Legislation**
- **Landscape Concept Plan, rural subdivision at Oakhampton Heights - Vegetation Management Plan**
- **Creek Rehabilitation Plan, Warners Bay - Vegetation Management Plan**
- **Vegetation Management Plan for a retained creek line with Sugar Valley Golf Course, West Wallsend - Vegetation Management Plan**
- **Individual Koala Plan of Management under SEPP 44 at Hawks Nest – Management Plan**



Curriculum Vitae

- CONTINUED -

- **Ecological Constraints Management Plan, Hawks Nest North** - Management Plan
- **Management Plan for the Green & Golden Bell Frog at Culburra** - Management Plan
- **Fuel Management Plan over lots within a rural-residential estate at Glen Oak** - Management Plan
- **Ecological Constraints Master Plan for Hunter Economic Zone** - Management Plan
- **Environmental Plan of Management for Residential / Tourism Sanctuary Project at Paxton** - Management Plan
- **Green and Golden Bell Frog Survey and Management Plan, Gillieston Heights** - Targeted Species Study
- Targeted Species Studies as part of the Ecological Constraints Master Plan for the Hunter Economic Zone

PREVIOUS EXPERIENCE:

Senior Ecologist, Wildthing Environmental Consulting

1995 – 2000

Oversaw operations in NSW and Qld, and project managed and undertook numerous ecological and bushfire assessments for a diverse array of clients / projects.

Environmental Officer, Pulver Cooper & Blackley / Kel Nagle Cooper & Associates

1994 - 1995

Undertook a range of environmental, planning and survey investigations; fieldwork; reporting for a range of land development; and golf course development projects.

MEMBERSHIPS & ACHIEVEMENTS:

- Frog and Tadpole Study Group (FATS)
- Hunter Birds Observers Club (HBOC). Committee Member 2009. Records Appraisal Committee, 2008 – present
- Bird Observers Club of Australia (BOCA)
- Donaldson Conservation Trust. Board member (independent environmental expert). 2009 – present.

Curriculum Vitae

Name: Paul Hillier

Office: RPS Newcastle

Position in Company: Ecologist

Qualifications / Awards

- B.Env.Sc. (Environmental Management)
- OH&S Induction Training (Green Card)
- NSW Driver's Licence (Class C)
- St John Ambulance Senior First Aid Certificate
- Dive Master (PADI Scuba Diver)

Areas of Expertise:

- Targeted and general Terrestrial flora and fauna surveys
- Threatened Flora & Fauna Assessment, Reporting and Legislation
- GPS Survey and GIS Mapping Projects

Recent Experience Includes:

Paul Hillier has broad range of Ecological Assessment reporting experience from 5 years of professional ecological work both in Australia and abroad. Project experience has primarily included a range of flora and fauna assessment disciplines as required by a wide range of corporate and domestic client requirements. Paul has been employed both within the private and public sector, providing a strong knowledge and understanding of the role of both developers and government in legislation and planning.

Paul has the majority of his experience within the consultancy industry, primarily focussing on the preparation of Flora and Fauna Assessments, Environmental Assessments, Environmental Impact Statements, Review of Environmental Factors and Statement of Environmental Effects. Paul has experience with targeted threatened flora and fauna surveys, including a strong knowledge of Geographic Information Systems mapping and analyses.



Curriculum Vitae

Name: Allan Richardson

Office: RPS Harper Somers O'Sullivan

Position in Company: Senior Ecologist

Qualifications / Awards

- B.Env.Sc. (Environmental Management)
- B.Env.Sc. (Hons) (Biology) – Migratory Wading Bird Study
- 2002 Hunter Environmental Institute Scholarship
- Waterways Authority Boating Licence
- OH&S Induction Training (Green Card)
- NSW Driver's Licence (Class C)
- NPWS Scientific Licence
- NSW Animal Ethics Research Authority
- St John Ambulance Senior First Aid Certificate

Memberships:

- Hunter Bird Observers Club
- Victorian Wader Study Group

Areas of Expertise:

- Ornithological Surveys and Research
- Targeted and general Terrestrial flora and fauna surveys
- Threatened Flora & Fauna Assessment, Reporting and Legislation
- GPS Survey and GIS Mapping Projects
- High Level Nature Photography
- Tertiary and General Ecological Tutoring, Demonstrating and Presenting

Recent Experience Includes:

Allan Richardson has broad range of Ecological Assessment reporting experience underpinned by over 27 years of ecological field experience. Over four and a half years of project experience has primarily included a range of flora and fauna assessment disciplines as required by a wide range of corporate and domestic client requirements. Allan has a strong grounding in threatened species ecology in both coastal and western NSW regional areas, with specialist migratory wader studies expertise in Central NSW and Roebuck Bay in North Western Australia.

Allan's wide ranging interest across different ecological disciplines, has been a central part of important threatened species projects, including, the Critically Endangered North Rothbury Persoonia, Hunter Estuary Green and Golden Bell Frog populations, Migratory Wader habitat usage surveys, seasonal Swift Parrot movements and specialised Avifauna Wind Farm Surveys on the east and west coast. Allan's broad ecological experience also represents an important part of RPS HSO's threatened flora and vegetation community mapping, targeted fauna survey works and threatened species habitat assessments over both small and large spatial areas for a range of client needs. His depth of experience and a strong knowledge of Australian fauna and regional vegetation contribute strongly to RPS HSO's ability to meet the consultation and regulatory needs of the development community.