

BIODIVERSITY SURVEY AND ASSESSMENT

CHARLES STURT UNIVERSITY BATHURST



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March 2012

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EXECUTIVE SUMMARY AND RECOMMENDATIONS

A biodiversity survey was conducted on lands managed by Charles Sturt University, Bathurst over four days between January and March 2012. The key findings of the survey were:

Flora

- The CSU Bathurst campus (the study area) supports at least 189 species of flora, of which 83 (43.9%) are native and 106 (56.1%) are introduced.
- The original vegetation of the study area is considered to have been a grassy woodland dominated by Yellow Box, Blakely's Red Gum and Apple Box with Ribbon Gum occurring along the drainage lines. This vegetation, known commonly as Box-Gum Woodland, is part of the *White Box Yellow Box Blakely's Red Gum Woodland Endangered Ecological Community* listed under the NSW *Threatened Species Conservation Act 1995* (TSC Act) and the *White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland Critically Endangered Ecological Community* listed under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).
- Searches of the study area revealed that pre-European native trees, or their descendants, are absent from all of the built parts of the campus between Research Station Drive, Panorama Avenue, the western boundary and almost to Hawthornden Creek. Remnant native trees are confined largely to the banks of Hawthornden Creek with only a few in nearby open space to the north of the creek and one in cleared paddocks south of the creek.
- The vegetation associations on the study area are described. The majority of the vegetation comprises man-made (anthropogenic) plant associations including mixed native and exotic grasslands and mixed native and exotic woodlots. One very small remnant of native grassland derived from the original Box-Gum Woodland community persists at the western end of Hawthornden Creek.
- Mixed native and exotic grasslands occur on the former golf course, in the grazing paddocks south of Hawthornden Creek and on undisturbed landforms between Hawthornden Creek and the built areas of the campus. Woodlots comprising mainly native trees occur around the former golf course, the dam, Parking Areas 1 and 4, the university entrance and The Grange.
- The woodlots comprise a wide variety of native Eucalypts including local species and species from distant parts of south eastern Australia.
- Eight weeds listed as Noxious under the NSW Noxious Weeds Act were found on the study area. Four of these, Blackberry, Chilean Needle Grass, Serrated Tussock and Willows are listed as Weeds of National Significance by the Australian Weeds Committee.

Fauna

- Sixty two native and introduced fauna species were recorded for the study area, including 50 birds (46 native, 4 introduced), six mammals (3 native, 3 introduced), two reptiles (both native) and four frogs (all native).
- The highest number of birds (41 species) was observed along Hawthornden Creek which has a number of favourable habitat features, including mature old growth eucalypt trees, tall

seeding grasses, dense cover provided by plantings of *Acacia rubida*, surrounding open space and paddocks, and a supply of water in the creek.

- Five habitat trees, all Ribbon Gums, with hollows suitable for wildlife occur along Hawthornden Creek. No habitat trees occur elsewhere on the study area.
- A fauna habitat assessment found that the existing vegetation on all parts of the study area compares very poorly with the benchmarks for the original vegetation and can be regarded as highly degraded.
- All three introduced mammal species recorded by the survey, the European Rabbit, Red Fox and House Cat, are regarded as pest animals. The effects of each on the environment and biodiversity are listed as Key Threatening Processes under the NSW TSC Act.

Threatened Biodiversity

- One native eucalypt species that is common in planted woodlots on the study area, the Narrow-leaved Black Peppermint (*Eucalyptus nicholii*), is listed as Vulnerable under the TSC and EPBC Acts in its native habitat on the NSW Northern Tablelands.
- No other threatened flora or fauna species was detected or reported during the survey.
- The small remnant of native grassland at the western end of Hawthornden Creek is part of the Box-Gum Woodland endangered ecological community. However, it is only approximately 460 m² (<0.05 ha) and is not considered to be viable in the medium term.

Environmentally Important Areas

- The most environmentally important parts of the CSU Bathurst campus are all associated with Hawthornden Creek. These include the remnant native grassland, remnant native trees including habitat trees, and the potential role of the creek and associated vegetation as a wildlife corridor.
- The remnant native grassland is derived from the Box-Gum Woodland endangered ecological community and represents the only relatively intact sample of it remaining on CSU land. Although the remnant is too small to be viable in the long term without sympathetic management, it deserves recognition and protection as part of efforts to rehabilitate and rejuvenate Hawthornden Creek.
- A rehabilitated and revegetated Hawthornden Creek has potential to act as a wildlife corridor between the Mount Panorama and Boundary Road Reserve bushland and the Macquarie River. However, it is unlikely the creek currently has a major role as a corridor, since there is little native vegetation on much of Hawthornden Creek between Panorama Avenue and the Macquarie River.
- Although Hawthornden Creek contains by far the highest biodiversity values on CSU land, it is not in good condition. Significant problems that need addressing include severe soil erosion and weed infestation.

Impact Assessment

- Assessments under the NSW TSC Act of the likely impact (Seven Part Tests of Significance) of future development projects on the study area showed there would not be significant effects on any threatened flora or fauna.
- It is concluded that future developments on the CSU Bathurst campus that adversely affected trees of the Narrow-leaved Black Peppermint would have no impact on natural populations of the species on the NSW Northern Tablelands. However, the trees planted in the university woodlots are part of a large cultivated population, scattered over many parts of south eastern Australia, that guarantees the survival of the species should it decline further in the wild. It is therefore desirable that harm to these trees is avoided wherever feasible.
- It is concluded that future developments on the CSU Bathurst campus would not adversely affect populations of the Yellow Eyebright, the Eyebright *Euphrasia arguta*, Narrow Goodenia, Aromatic Peppergrass, Silky Swainson-pea or Austral Toadflax, as suitable habitat for most of these species is absent, and no populations are known or likely to occur on CSU land.
- It is concluded that future developments on the CSU Bathurst campus would not significantly affect populations of the ten threatened fauna species under consideration here, as suitable breeding habitat for all of the species is absent, and no populations are known or likely to occur on CSU land. However, future developments that affect food resources for these species may result in a slight decrease in the foraging habitat available.
- Ribbon Gums are listed in Schedule 2 of NSW SEPP 44 as a preferred food tree of the Koala. Remnant mature and regenerating Ribbon Gum trees occur along Hawthornden Creek on the study area. SEPP 44 requires consideration of the study area as potential Koala habitat. However, the study area does not include 'core' Koala habitat and a SEPP 44 plan of management is not required.
- No matters that would require referral to the Commonwealth Department of Sustainability Environment Water Population and Communities relating to Commonwealth listed threatened species and ecological communities, migratory species or wetlands of international importance, were revealed by this study.

RECOMMENDATIONS

- The report includes a detailed set of recommendations for enhancement of the biodiversity values associated with Hawthornden Creek, including the following;
- that soil protection works be carried out in Hawthornden Creek to stabilise the creek bed and side slopes, in consultation with a soil conservation expert.
- that the Box-Gum Woodland native grassland remnants identified in Figure 4 be protected from future disturbances by renewing the fencing between them and the open space to the north and that it be identified for protection in CSU land management systems and plans. Control of invasive grass species should also be undertaken.
- that wildlife habitat trees identified along Hawthornden Creek (Figure 5) be recognised and formerly protected in CSU management systems and plans.

- that a wildlife corridor be established along Hawthornden Creek using seedlings grown from seed collected from remnant trees currently growing there.
- that control programs be implemented along Hawthornden Creek for the declared noxious weeds African Lovegrass and Serrated Tussock.

Additional recommendations are;

- that a control program be implemented for the European Rabbit on campus and that CSU participates in local and regional control programs for the Red Fox.
- that any future development proposals avoid, as far as practicable, harm to plantings of the Narrow-leaved Black Peppermint (*Eucalyptus nicholii*) on the study area.
- and that urgent consideration be given to the control of Chilean Needlegrass around Parking Area 1 and on the former golf course. Training for grounds staff in recognition and control of Chilean Needlegrass can be provided by Weeds Officers with the Upper Macquarie County Council.

INTRODUCTION

FloraSearch was commissioned by Charles Sturt University (CSU) to conduct a biodiversity survey and assessment on the Bathurst campus (the Study Area) of the university as part of a planning process for future developments. The survey and assessment is conducted in accordance with Part 5 of the *Environmental Planning and Assessment Act 1979* (EP&A Act), *NSW State Environmental Planning Policy No. 44* (SEPP44) and the *Commonwealth Environmental Protection and Biodiversity Conservation Act 1995* (EPBC Act).

The objectives of the surveys and this report are to:

- define, describe and map the natural vegetation communities occurring on the Study Area;
- compile lists of flora and fauna species found on the Study Area;
- conduct targeted searches for threatened flora and fauna species, populations, ecological communities and critical habitat, considered possible occurrences within the study area (including those listed under the schedules of the *NSW Threatened Species Conservation Act 1995* (TSC Act) and the EPBC Act, and any flora species listed as rare or poorly known in *Rare or Threatened Australian Plants* [ROTAP]), and map the location of any threatened species identified;
- assess the condition of the vegetation;
- assess the potential impact of possible future developments on threatened flora and fauna species, populations, ecological communities and critical habitat via Seven Part Tests of Significance;
- define areas of environmental significance;
- define areas that harbour noxious weeds or pests;
- identify any land subject to Local, State or Federal environmental planning instruments or other legislation having implications for planning or land management;
- recommend how current levels of biodiversity can be maintained or enhanced in the longer term.

THE STUDY AREA

The study area comprises all lands occupied by the university including the built areas of the campus and undeveloped paddocks on the southern side of Hawthornden Creek (Figure 1). The study area is bounded on the east side by Panorama Avenue, to the north by Research Station Drive and the Primary Industries Centre, to the west by the Boundary Road Reserve and to the south by the Mount Panorama Motor Racing Circuit. Also included is a small discrete parcel of land (Lot 186) on the north eastern side of Leena Street, a short distance from the main campus to the east of Panorama Avenue.

Hawthornden Creek traverses the southern half of CSU controlled lands from west to east (Figure 1). It marks a boundary between the built and intensively managed parts of the campus to the north and open paddocks to the south. The altitude of the study area is approximately 680 m AHD.

Current and Former Land Use

The land occupied by the CSU Bathurst campus is part of the former Bathurst Experiment Farm established in 1895 for agricultural research and education. In 1951 the Bathurst Teachers College was established on the Bathurst Experiment Farm, which in turn became the Mitchell College of Advanced Education (1971) and then part of Charles Sturt University upon its incorporation in 1989 (<http://www.csu.edu.au/about/history/university-history>). Consequently, campus land was used for .



agricultural research and education for the first half of last century and primarily educational activities thereafter.

Broadly speaking, the CSU Bathurst campus currently includes the following predominant land uses:

- Buildings occupy significant areas of the campus. Construction of these buildings would have involved substantial earthworks for the buildings and associated roadways, parking areas, paths and garden beds. These works would have removed any native flora communities that may have survived the agricultural phase of land use. Several large playing fields have been constructed. These also involve earth moving machinery for levelling, and the sowing of introduced grasses for the playing surface. Any original vegetation communities would be eliminated by these processes.
- Other areas of the campus have been maintained as open space, particularly the former golf course in the north east corner, the environs of the residential areas and the space between the built parts of the campus and the north side of Hawthornden Creek. Excavated soil from building sites on campus has been spread over some of these areas such that their surfaces have been considerably reshaped from the original. This process has eliminated any remnants of the original native vegetation that may have survived the agricultural era. Open space areas are maintained as lawns by regular mowing.
- A large dam has been constructed between Residences R01 to R11 and Ordinance Road. This dam is for aesthetic purposes and the stored water is not used on campus.
- The paddocks south of Hawthornden Creek are leased for livestock grazing for most of the year. However, they are also used for car parking and visitor camping for events on the adjoining Mt. Panorama motor racing circuit.

Geology and Soils

The study area is underlain by the Bathurst Batholith geological formation, comprising the Bathurst Granite, a coarse grained, porphyritic biotite granite (Pogson and Watkins, 1998). Rocks of the Bathurst Batholith are considered to be of Middle to Late Carboniferous age; 325 to 330 million years old. Erosion of the Bathurst Batholith has formed the Bathurst Basin, which is drained by the Macquarie River, and has sunk below the surrounding landscapes comprising less erodible older rock types.

The Bathurst Granite comprises predominantly non-calcic brown soils on the hills and upper slopes and yellow solodic soils on the lower slopes and drainage lines. The original soils of the CSU campus persist in a relatively undisturbed state only in the vicinity of the 'golf course', Hawthornden Creek and the paddocks south of Hawthornden Creek. Over most of the campus, where considerable earthworks have occurred historically, the surface soils are likely to be a mix of the original topsoils and subsoils.

Climate

Accurate weather data is available for CSU Bathurst owing to its close proximity to the long running Bureau of Meteorology weather station (commenced 1908) on the adjoining Primary Industry Centre (formerly part of Bathurst Experiment Farm, later known as Bathurst Agricultural Research Station). The climate of the Study Area is generally mild with moderate maximum temperatures in summer, but cold winters. Rainfall is moderate by Australian standards. The mean daily maximum temperatures for the CSU campus vary from 11.2 degrees C in July to 28.0 degrees C in January. The corresponding mean daily minimum temperatures vary from 0.6 degrees C in July to 13.3 degrees C in January and February. Frosts are common in winter.

Average annual rainfall is 638.1 mm and is spread fairly evenly throughout the year with slight spring and summer dominance. The lowest average rainfall tends to be in April (41.9 mm), May (41.9 mm) and June (43.4 mm), while the highest average rainfall is in December (66.1 mm) and January (68.3 mm).

Biogeographical and Botanical Regions

The study area lies in the north of the South Eastern Highlands Bioregion (SEH) as defined in the Interim Biogeographic Regionalisation of Australia (IBRA) (Thackway and Cresswell, 1995). Within the SEH Bioregion, the study area falls within the Bathurst Subregion (Sahukar *et al.*, 2003), which is characterised by landscapes of rounded hills in a granite basin surrounded by steep slopes on the contact margin (Sahukar *et al.*, 2003).

The study area also lies within the NSW Central Tablelands Botanical Division (Anderson, 1961) and the Central West Catchment Authority area.

LITERATURE REVIEW

The accounts of various early European explorers and travellers to the 'Bathurst Plains', including the surveyor G. Evans (in 1813), Governor L. Macquarie (in 1815), Major H. Antill (in 1815), A. Cunningham (in 1822), and Charles Darwin (in 1836), provide general descriptions of the landscape and vegetation (Semple, 1997). These indicate the vegetation around Bathurst was savannah grassland on the floodplain and the adjoining undulating lower slopes, and lightly timbered savannah woodland on higher slopes and hills (Semple, 1997). The ground cover was herb rich grassland with few shrubs (Semple, 1997). The paucity of shrubs persists on the Bathurst Granite to this day, although there is evidence that tree numbers have increased in some areas in the absence of fire (Semple, 1997).

No formal region-wide studies of the vegetation in the Bathurst Basin, or on the western Central Tablelands as a whole, have been published (DEC, 2006). Consequently, the vegetation of the Bathurst region has not been surveyed, analysed, classified or mapped. All vegetation classification and mapping studies within the nearby region have been confined to relatively small parcels of land, mainly conservation reserves under state or local government control, including Nature Reserves (NR), State Conservation Areas (SCA) and other smaller reserves. Reserves that have been surveyed within the northern part of the South Eastern Highlands Bioregion around Bathurst include Barton NR, Mount Canobolas SCA, Mullion Range SCA, Freemantle NR, Winburndale NR, Giralang NR and Wambool NR. Most of these studies were commissioned by the Office of Environment and Heritage, or its predecessors, and only one has been published in a scientific journal, Hunter's survey of the Mount Canobolas SCA (Hunter, 2002). However, these studies generally have limited relevance to this study, as they involve lands on different geologies with quite different vegetation types than those on the study area.

The most relevant previous survey work is two studies of the flora and fauna in the Boundary Road Reserve that adjoins the study area to the west (Fisher *et al.*, 1997; Mjadwesch Environmental Service Support [MESS], 2008). Fisher *et al.* (1997) reported that the vegetation in the Boundary Road Reserve includes remnant native woodland dominated by Yellow Box (*Eucalyptus melliodora*) and Blakely's Red Gum (*Eucalyptus blakelyi*) with Apple Box (*Eucalyptus bridgesiana*) as an associate throughout the woodland. Ribbon Gum (*Eucalyptus viminalis*) dominates the drainage line of Hawthornden Creek. Fisher *et al.*, (1997) identified 120 flora species in the reserve, of which 60 percent were introduced species. Seventy five vertebrate fauna species were recorded, including three bird species currently listed as endangered or vulnerable. Totals of three frog species, six reptiles, six mammals (4 introduced) and 60 birds (4 introduced) were also recorded. The condition of

the native vegetation and wildlife habitat in the Boundary Road Reserve varied from lightly to highly degraded with conservation values ranging from low to moderate (Fisher *et al.* 1997).

The recent study of the Boundary Road Reserve by MESS (2008) is more comprehensive than that of Fisher *et al.* (1997) owing to the employment of a wider range of survey techniques and more intensive sampling. MESS (2008) found the same dominant tree species and distribution patterns as Fisher *et al.* (1997) and recorded 221 flora species from the reserve. The remnant areas of native woodland were identified as belonging to the Box-Gum Woodland endangered ecological community which is formally called the *White Box Yellow Box Blakely's Red Gum Woodland Endangered Ecological Community* under the NSW *Threatened Species Conservation Act 1995* and the *White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland Critically Endangered Ecological Community* under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*.

The 2008 survey recorded the same three frog species in the reserve as the 1997 survey, while finding greater numbers of reptiles (11 species), more native birds (87 species), more native terrestrial mammals (6 species) and seven native bat species. The 2008 survey also recorded three introduced bird species and six introduced mammals (MESS, 2008).

Neither Fisher *et al.* (1997) nor MESS (2008) detected any threatened flora, amphibian, reptile or mammal species. Only one of the three threatened bird species recorded in the 1997 survey was detected again in 2008, although one, the Speckled Warbler, has been seen subsequently (Marshall, 2010). The third species, the Regent Honeyeater (*Xanthomyza phrygia*), is nomadic and appears mainly in response to the availability of nectar from the Yellow Box trees.

It can be expected that the CSU Bathurst campus has potential to support some part of the extant biodiversity of the Boundary Road Reserve.

THREATENED BIODIVERSITY

Database searches were made in March 2012 of the following data sources to compile lists of threatened biodiversity that has been recorded in the surrounding region and may therefore have potential to occur on the study area. This involved searching for historical records of threatened flora and fauna species, populations, ecological communities and critical habitat. The databases consulted, and the search areas within them, were:

- BioNet website – Searches the NSW National Parks and Wildlife Service, NSW State Forests, Australian Museum and Royal Botanic Gardens Sydney databases. The search area was the Bathurst Subregion of the Interim Biogeographic Regionalisation of Australia (IBRA) (Thackway and Cresswell, 1995). The Bionet website provides information on actual records for the search area.
- Commonwealth Department of the Environment and Heritage website – Protected Matters search tool. A 20 × 20 km area centred on CSU Bathurst was searched. The Protected Matters search tool uses actual records and habitat modelling to return a list of species that are known or predicted to occur in the search area.

Table 1
Threatened Flora Species Returned by Database Searches of the Surrounding Region.

Family Name	Scientific Name	Common Name	Conservation Status		Likely former presence?	Justification
			TSC Act ¹	EPBC Act ²		
Brassicaceae	<i>Lepidium hyssopifolium</i>	Basalt or Aromatic Peppercross	E	E	High	A small population of the Basalt Peppercross occurs on private land south of Mt. Panorama at Bathurst and is one of only two known populations remaining in NSW. From 14 plants in 2004 the Bathurst population had declined to 3 plants by 2008 (Tumino, 2010). Little is known of the former distribution of this species.
Fabaceae (Faboideae)	<i>Swainsona sericea</i>	Silky Swainson-pea	V	-	High	The Silky Swainson-pea was formerly a widespread, common species in Box-Gum woodlands and is likely to have been common in the Bathurst Basin (OEH, 2012a).
Goodeniaceae	<i>Goodenia macbarronii</i>	Narrow Goodenia	-	V	High	The Narrow Goodenia formerly occurred widely on the inland side of the Great Dividing Range from the Darling Downs in Queensland to northern Victoria. It is generally associated with drainage lines, creeks, soaks, swamps, small lagoons, alluvial fans and moist areas, most frequently on sandy soils (Berwick 1996; SEWPaC, 2012a).
Myrtaceae	<i>Eucalyptus pulverulenta</i>	Silver-leaved Mountain Gum	V	V	Nil	Silver-leaved Mountain Gum occurs on the crests or upper slopes of moderately steep hillsides or mountains at altitudes of 800–1000 m, usually on well-drained skeletal soils with frequent rock outcrops (SEWPaC, 2012a). Such habitat does not occur on or near the study area.
Proteaceae	<i>Persoonia marginata</i>	Clandulla Geebung	V	V	Nil	The species inhabits dry sclerophyll forest and woodland on sandstone in heavier clayey, gravelly loam derived from Permian rocks, at approximately 700 m altitude on low ridges (OEH, 2012a; SEWPaC, 2012a). This habitat does not occur on or near the study area.
Rutaceae	<i>Philotheca ericifolia</i>	-	-	V	Nil	<i>Philotheca ericifolia</i> grows chiefly in dry sclerophyll forest and heath on damp sandy flats and in gullies. The species has been collected from a variety of habitats including open woodland, heathland, dry sandy creek beds and rocky ridge and cliff tops. Preferred soils have a sandy, gravelly or rocky component (SEWPaC, 2012b). The study area lacks suitable habitat for this species.

Family Name	Scientific Name	Common Name	Conservation Status		Likely former presence?	Justification
			TSC Act ¹	EPBC Act ²		
	<i>Zieria obcordata</i>	-	E	E	Nil	<i>Zieria obcordata</i> grows on gentle to moderately steep, west-to north-facing slopes of low hills or ridges at altitudes from 500 to 830 m. All sites have granite boulders, outcrops, and/or exposed granite. Plants typically occur around the base of granite boulders and in crevices between them (OEH, 2012a). No habitat for <i>Z. obcordata</i> occurs on the study area.
Santalaceae	<i>Thesium australe</i>	Austral Toadflax	V	V	High	Austral Toadflax was formerly widespread in grasslands and grassy woodlands in eastern Australia from the Bunya Mountains in Queensland to Tasmania. It is hemiparasitic on Kangaroo Grass (<i>Themeda australis</i>) and possibly <i>Poa</i> species on a wide range of substrates (DSE, 2003).
Scrophulariaceae	<i>Euphrasia arguta</i>	-	CE	CE	Medium	<i>Euphrasia arguta</i> has been recorded from grassy areas near rivers at elevations up to 700 m above sea level, with an annual rainfall of 600 mm and grassy forests or regrowth vegetation (SEWPaC, 2012a). There are early records from the Bathurst region.
	<i>Euphrasia scabra</i>	Yellow Eyebright	E	-	Medium	The Yellow Eyebright grows in open damp grassy situations; chiefly south from the Jenolan Caves, with an early record from the Bathurst Plains (OEH, 2012a).

¹ NSW Threatened Species Conservation Act, 1995.

² Commonwealth Environment Protection and Biodiversity Conservation Act, 1999.

E Endangered.

CE Critically Endangered

V Vulnerable.

**Table 2
Threatened Fauna Species Returned by Database Searches of the Surrounding Region**

Class	Family Name	Scientific Name	Common Name	Conservation Status		Likelihood to be on Study Area	Justification
				TSC Act ¹	EPBC Act ²		
Actinopterygii (ray-finned fishes) ³	Percichthyidae	<i>Maccullochella macquariensis</i>	Trout Cod	E	E	Nil	Both Cod species only occur in large permanent rivers with deep waterholes. Such habitat does not occur on the study area.
		<i>Maccullochella peelii</i>	Murray Cod	-	V	Nil	
Amphibia (frogs)	Hylidae	<i>Litoria aurea</i>	Green and Golden Bell Frog	E	V	Low	There are eight records of the Green and Golden Bell Frog from the Bathurst Plains in the NSW Atlas of Wildlife (NSW BioNet, 2012), all from 1 January 1973. It has not been recorded in the Bathurst area since 1973.
		<i>Litoria booroolongensis</i>	Booroolong Frog	E	E	Nil	The Booroolong Frog is a small riverine frog that inhabits rocky permanent streams ranging from small slow-flowing creeks to large rivers (SEWPaC, 2012a). Suitable habitat for this species does not occur on the study area.
Reptilia (reptiles)	Elapidae	<i>Hoplocephalus bungaroides</i>	Broad-headed Snake	E	V	Nil	The Broad-headed Snake has preferred habitats centred on the Triassic sandstone of the Sydney Basin. The sites where they occur are typified by exposed sandstone outcrops and benching (OEH, 2012a). Suitable habitat does not occur on the study area.
Aves (birds)	Megapodiidae	<i>Leipoa ocellata</i>	Mallee Fowl	E	V	Nil	The Mallee Fowl is found in semi-arid to arid shrublands and low woodlands, especially those dominated by mallee and/or acacias. A sandy substrate and abundance of leaf litter are required for breeding (Benshemesh, 2007). Suitable habitat is absent from the study area and surrounding region.
	Anseranatidae	<i>Anseranas semipalmata</i>	Magpie Goose	V	-	Nil	The Magpie Goose lives and nests colonially in swampy country (Blakers <i>et al.</i> , 1984). It is likely to have inhabited swamps along the Macquarie River and tributaries pre-European settlement and occasional vagrants are still recorded in the area (NSW BioNet, 2012). Suitable habitat is absent from the study area.
	Phaethontidae	<i>Phaethon rubricauda</i>	Red-tailed Tropicbird	V	-	Nil	Red-tailed Tropic Bird is an oceanic species. A record for Bathurst in 1991 (NSW BioNet, 2012) is likely to have been blown inland by storms (Blakers <i>et al.</i> , 1984). No habitat for this species occurs on the study area.
	Accipitridae	<i>Circus assimilis</i>	Spotted Harrier	V	-	Moderate	The Spotted Harrier is distributed Australia-wide ranging over plains and wooded grasslands (Blakers <i>et al.</i> , 1984). It could possibly hunt over the grazing paddocks east of Hawthornden Creek.
<i>Hieraaetus morphnoides</i>		Little Eagle	V	-	High	Little Eagle occurs throughout NSW and soars over open country looking for prey (Blakers <i>et al.</i> , 1984). It has been recorded recently as nesting in the Boundary Road Reserve (Marshall, 2010) and is likely to hunt over the grazing paddocks east of Hawthornden Creek.	

Class	Family Name	Scientific Name	Common Name	Conservation Status		Likelihood to be on Study Area	Justification
				TSC Act ¹	EPBC Act ²		
Aves (birds)	Rostratulidae	<i>Rostratula benghalensis australis</i>	Australian Painted Snipe	E	V	Nil	Australian Painted Snipe inhabits freshwater swamps and marshes (Blakers <i>et al.</i> , 1984). Suitable habitat is absent from the study area.
	Cacatuidae	<i>Callocephalon fimbriatum</i>	Gang-gang Cockatoo	V	-	High	The Gang-gang Cockatoo breeds in eucalypt forests on the coast and ranges south of Newcastle, NSW. It may disperse into urban parks and gardens in winter and has been recorded in the Boundary Road Reserve (Marshall, 2010). It has potential to occur on the CSU campus in winter.
	Psittacidae	<i>Polytelis swainsonii</i>	Superb Parrot	V	V	Nil	The Superb Parrot occurs in tall woodlands and forests west of the Tablelands (Blakers <i>et al.</i> , 1984). Although there are many records of the species in the Orange and Cowra areas, it has not been recorded close to Bathurst (NSW BioNet, 2012).
		<i>Lathamus discolor</i>	Swift Parrot	E	E	Low	The Swift Parrot is a migratory species that breeds in Tasmania and winters on the mainland, where it feeds on flowering eucalypts. There is only one historic record near Bathurst (NSW BioNet, 2012). It may potentially feed on flowering Red Ironbark (<i>Eucalyptus sideroxylon</i>) trees on the CSU campus.
	Strigidae	<i>Ninox connivens</i>	Barking Owl	V	-	Low	The Barking Owl occurs in eucalypt woodland and is widespread in eastern NSW. There is one previous record in the Bathurst area (NSW BioNet, 2012).
	Acanthizidae	<i>Chthonicola sagittata</i>	Speckled Warbler	V	-	Low	A sedentary species of open woodland on rocky ridges or in gullies. Recorded regularly in the Boundary Road Reserve (Fisher <i>et al.</i> , 1997; Marshall, 2010).
	Meliphagidae	<i>Anthochaera phrygia</i>	Regent Honeyeater	E	E	Low	A nomadic nectar-dependent species found in flowering eucalypts, which has been recorded rarely in the Boundary Road Reserve (Fisher <i>et al.</i> , 1997; Marshall, 2010).
		<i>Melithreptus gularis gularis</i>	Black-chinned Honeyeater (eastern subspecies)	V	-	Low	A bird of woodlands throughout much of eastern NSW (Blakers <i>et al.</i> , 1984), although there are very few records close to Bathurst (NSW BioNet, 2012). Study area habitat is considered to be marginal.
	Neosittidae	<i>Daphoenositta chrysoptera</i>	Varied Sittella	V	-	Low	Birds of woodlands and open forests, usually with rough-barked eucalypts. Known to occur in the Boundary Road Reserve (Marshall, 2010).
	Petroicidae	<i>Petroica boodang</i>	Scarlet Robin	V	-	Low	Breeds in eucalypt forest with an open understorey (Blakers <i>et al.</i> , 1984). Juveniles disperse in autumn and most likely represent the few records near Bathurst (NSW BioNet, 2012).
Estrildidae	<i>Stagonopleura guttata</i>	Diamond Firetail	V	-	High	Widespread in open forest and woodland mostly on the inland side of the Great Dividing Range in eastern NSW (Blakers <i>et al.</i> , 1984). Recorded in the Boundary Road Reserve (MESS, 2008; Marshall, 2010).	

Class	Family Name	Scientific Name	Common Name	Conservation Status		Likelihood to be on Study Area	Justification
				TSC Act ¹	EPBC Act ²		
Mammalia (mammals)	Dasyuridae	<i>Dasyurus maculatus</i>	Spotted-tailed Quoll	V	E	Nil	Generally confined to areas of native forest and woodland where it nests in rock caves or hollow logs (Edgar, 1983). It occurs in wooded country to the east and west of Bathurst NSW (NSW BioNet, 2012), but no suitable habitat remains on the study area.
	Phascolarctidae	<i>Phascolarctos cinereus</i>	Koala	V	-	Low	Koalas are widespread in eastern NSW with several significant populations in timbered country to the south and south west of Bathurst (NSW BioNet, 2012). However, there are no records close to Bathurst.
	Macropodidae	<i>Petrogale penicillata</i>	Brush-tailed Rock Wallaby	E	V	Nil	Inhabits rocky areas in sclerophyll forest, usually slopes that receive direct sunlight for most of the day and with caves, crevices or jumbled boulders to provide shelter (Maynes and Sharman 1983). No such habitat occurs on the study area.
	Pteropodidae	<i>Pteropus poliocephalus</i>	Grey-headed Flying-fox	V	V	Low	The Grey-headed Flying Fox mostly occurs on the eastern side of the Great Dividing Range, but may establish temporary roosts west of the divide when food supplies are abundant. There are two records in NSW BioNet (2012) close to Bathurst in 2006 and 2010.
	Vespertilionidae	<i>Chalinolobus dwyeri</i>	Large-eared Pied Bat	V	V	Nil	A species of moderately well wooded habitats, the Large Pied Bat roosts in caves, mine tunnels and the abandoned nest of Fairy Martins (Dwyer, 1983). Suitable habitat is lacking on the study area.
Insecta (Insects)	Lycaenidae	<i>Paralucia spinifera</i>	Bathurst Copper Butterfly	E	V	Nil	The Bathurst Copper Butterfly occurs above 900 m altitude in the ranges east of Bathurst where there are populations of its larval host plant, <i>Bursaria spinosa</i> subsp. <i>lasiophylla</i> (NPWS, 2001). The altitude of the study area is approximately 680 m AHD and the host plant is absent.

¹ NSW *Threatened Species Conservation Act, 1995.*

² Commonwealth *Environment Protection and Biodiversity Conservation Act, 1999.*

³ NSW *Fisheries Management Act 1994.*

E Endangered.

CE Critically Endangered

V Vulnerable.

Threatened Flora and Fauna Species

The searches returned ten threatened flora species and 26 threatened fauna species that may have potential to occur in the broader Bathurst region (Tables 1 and 2). The habitat requirements of these species were reviewed and compared with the habitats available on the study area. Threatened species whose habitats do not occur on the study area are not considered further in this report. Habitat filtering identified six flora species that are likely to have once occurred on the study area and 13 fauna species for which habitat may be available on the study area. These six plants and 13 animals were targeted in searches of potential habitat on the study area. The possible impact of developments on the study area on these species is also evaluated in the assessment sections of this report.

Endangered Populations

Twenty four plant populations and 19 terrestrial fauna populations are listed as endangered under NSW TSC Act, as at March 2012. None are applicable to the study area.

Threatened Ecological Communities

One endangered ecological community listed in the schedules of the NSW TSC Act, the '*White Box Yellow Box Blakely's Red Gum Woodland endangered ecological community*', is considered a possible occurrence in the study area. The community is also listed under the Commonwealth EPBC Act as the '*White Box-Yellow Box-Blakely's Red Gum grassy woodlands and derived native grasslands critically endangered ecological community*'. This community is commonly referred to as Box-Gum Woodland.

Box-Gum Woodland is widespread on the western slopes and tablelands of New South Wales and was formerly the dominant community in the region around Bathurst. Because it occurs on relatively deep high fertility soils, it has been extensively cleared historically for cropping and grazing over its entire range. Remnants of this community were searched for as part of this survey.

Critical Habitat

No Critical Habitat for flora has been declared on or near the study area under the TSC Act or the EPBC Act.

METHODS

Field surveys were carried out over 4 days in January (31st), February (1st and 8th) and March (9th) 2012. The survey encompassed all remnants of native vegetation, areas of open space and amenity tree plantings within the study area in order to sample and identify all vegetation communities and wildlife present. All habitat types were surveyed to maximise the chances of finding populations of any threatened species that may occur.

WEATHER CONDITIONS

Field sampling was carried out in a 'La Nina' season in which temperatures were mild, rainfall abundant and cloud cover frequent. The conditions were ideal for plant growth and reproduction with dense vigorous ground cover throughout summer. It is normal in most years for grasses to have died back by the time the survey was conducted. The conditions were also ideal for amphibians with water



flowing in Hawthornden Creek and pooling in many low lying areas. Conditions were less ideal for reptile activity with relatively low temperatures and cloud cover.

VEGETATION SAMPLING

Two methods of documenting the vegetation were employed; quadrat sampling and spot sampling, detailed below. Figure 2 shows the locations of flora sample sites.

Quadrat Sampling

Seven 20 × 20 m (0.04 ha) flora quadrat sites were sampled on the study area (Figure 2). Within each plot the dominant species in each vegetation stratum were recorded, with an estimate of the percentage of the ground surface covered by their canopies. A list of all vascular plant species present within the quadrat was also made with each being assigned a cover abundance rating using a modified Braun-Blanquet scale (Table 3). Details recorded for each site included its Global Positioning System (GPS) position, landform, physiography, soil characteristics, disturbance, vegetation structural formation and general comments. Plots were placed in areas of unmown vegetation (Table 4).

Table 3
Modified Braun-Blanquet Cover Abundance Rating Scale

Rating	Percent Ground Cover	Rating	Percent Ground Cover
1	<1, rare	5	6 to 25
2	<5, uncommon	6	26 to 50
3	<5, common	7	51 to 75
4	<5, abundant	8	76 to 100

Table 4
Locations of Vegetation Quadrat Samples

Quadrat Sample Number	Easting ¹	Northing	Location
1	0738233	6297526	Within riparian zone of Hawthornden Creek, east end
2	0737577	6297500	Top of bank of Hawthornden Creek, west end
3	0738512	6298291	Unmown area of former golf course, centre
4	0737749	6297486	Within riparian zone of Hawthornden Creek, west of centre
5	0738610	6298311	Unmown area of former golf course, north east
6	0738147	6297256	Grazing paddock east of Hawthornden Creek, east
7	0737746	6397414	Grazing paddock east of Hawthornden Creek, west

¹ GDA94

Spot Sampling

In addition to the quadrat samples, and in order to comprehensively document the native and introduced weed flora over the entire study area, seven spot samples were conducted (Figure 2). Spot samples listed all vascular plants within discrete areas of grasslands or significant plantings of native trees and shrubs. A GPS reading was taken within each spot sample site. The locations of spot samples are given in Table 5.

Table 5
Locations of Vegetation Spot Samples

Spot Sample Number	Easting	Northing	Location
1	0738612	6298268	Former golf course
2	0738206	6298128	Parking Area 1
3	0738138	6297843	Parking Area 4
4	0737748	6297816	Surrounds of dam
5	0737645	6297499	Native grassland (west end of Hawthornden Creek)
6	0738455	6297967	Surrounds of the Grange and CSU entrance driveway
7	0738627	6297604	Leena Street annexe paddock

Searches for Threatened Species

The entire area of the campus and CSU managed lands were searched for potential habitat of threatened flora species. The known habitats of the species in Tables 1 and 2 are described in fact sheets and profiles of threatened species published on the websites of the NSW OEH and the Commonwealth SEWPaC, as well as on the PlantNet website of the Royal Botanic Gardens Sydney. The high levels of historical disturbance and the relatively concentrated infrastructure development on the site suggest there is a low likelihood that any habitat for threatened flora species remains.

Flora Species Listing

All observed plant species were recorded, whether identified on formal sample sites or not. Some less common plants were only observed on one occasion whilst moving around the site. Where plants could not be quickly identified in the field, a sample was taken for later examination. Samples were preserved in a plant press and identified later using a binocular microscope and flora keys. The principal reference was the Flora of New South Wales (Ed. G. Harden 1990-2002) and it is used as the basis for nomenclature in this report along with any updates on the PlantNet web site of the Royal Botanic Gardens Trust, Sydney.

FAUNA SAMPLING

Owing to the highly modified and developed nature of the study area, surveys for fauna comprised observational techniques and habitat quality assessment, rather than intensive trapping methods. Additional observations of wildlife on the campus were provided by the head of CSU grounds maintenance staff.

Amphibians

Searches for amphibians were conducted along Hawthornden Creek, an unnamed tributary extending between the two western residential complexes, and in the dam. Amphibians were identified by their calls using the David Stewart (2001) frog call CD to confirm their identities. Searches were conducted on two nights, 31 January and 9 March 2012.

Reptiles

Reptiles were searched for under tree bark, below and in objects on the ground such as old tyres in Hawthornden Creek, slabs of wood and sheets of tin. Unfortunately, the weather throughout the survey was cool and not ideal for reptile activity.

Birds

Birds were systematically surveyed on a transect along Hawthornden Creek where six observation sites were established at approximately 100 m intervals. The numbers of each bird species seen and/or heard during 10 minute morning and/or evening observations at each site were recorded. Observations were made on 31 January (morning and evening), 1 February (morning), 8 February (morning) and 9 March (morning); five sets of observations in all. The characteristics of each observation site are given in Table 6.

Birds were also recorded opportunistically while conducting the flora surveys; bird lists were made for each of the flora spot sample sites.

**Table 6
Characteristics of Bird Observation Sites on Hawthornden Creek**

Site Number	Easting ¹	Northing	Characteristics
1	0737879	6297583	Two large Apple Box, one small Ribbon Gum, River Sheoak planted in creek. Surrounded by rank grassland.
2	0737998	6297577	Two mature Apple Box and a few mature planted <i>Acacia rubida</i> .
3	0738121	6297573	Two large Apple Box, Ribbon Gum regeneration, dense planted band of <i>Acacia rubida</i> on top of creek bank.
4	0738244	6297543	Three large Ribbon Gums, several scattered large <i>Acacia rubida</i> .
5	0737786	6297538	Dense plantation of River Sheoak on both sides within creek gully, Dense <i>Acacia rubida</i> on northern bank plus rank grassland.
6	0737606	6297503	Two mature Yellow Box and two Apple Box, River Sheoaks planted in narrow, deeply incised gully.

¹ GDA94

Mammals

Native and introduced mammals were recorded while moving around the study area and by spot lighting on the nights of 31 January and 9 March 2012. Spot lighting was carried out along the whole length of Hawthornden Creek where there are remnant Ribbon Gum trees with hollow limbs suitable for wildlife denning. Spot lighting was also conducted in the tree plantings around the dam and at the eastern end of the former golf course adjacent to Panorama Avenue. Observations were also made of claw marks on trees indicating use by arboreal mammals. Fauna footprints were observed in moist silt in Hawthornden Creek and identified using the Triggs (2004) field guide. Fauna scats were sought, but none other than those of macropods and rabbits were found.

Habitat Quality

The value of the native vegetation on the study area as fauna habitat was measured using methodology adapted from the 'BioMetric' terrestrial biodiversity assessment tool (Gibbons *et al.* 2005). 'BioMetric' measurements form part of the input to the NSW Property Vegetation Plan Developer, which is used to assist decision making for applications to clear native vegetation under the NSW *Native Vegetation Act*. This methodology allows the value of vegetation to be assessed in a repeatable fashion for comparison with established benchmarks for the original vegetation likely to have occurred on the study area (DECC, 2008).

The seven 20 × 20 m flora survey plots were extended to 50 × 20 m for 'Biometric' measurements (Figure 2). The ten condition parameters used in BioMetric to assess site value were measured in each plot. The measurement methods were based on Appendix 3 of the BioMetric Operational Manual (Gibbons *et al.*, 2005). The parameters and methodology are:

- Native plant species diversity: - the number of native plant species in the 20 × 20 m subplot.
- Native overstorey cover: – mean percent cover of ground by the foliage of the uppermost vegetation layer; trees or tall shrubs (>1m) at 10 points along a 50 m transect along the long axis of the plot.
- Native midstorey cover: – mean percent cover of ground by the foliage of the middle vegetation layer; tall shrubs (>1m), low trees and regeneration at 10 points along a 50 m transect along the long axis of the plot.
- Native groundcover – grasses: - presence or absence of native grasses at 50 points 1m apart on a 50m transect along the long axis of the plot.
- Native groundcover – shrubs: - mean percent cover of ground by the foliage of low shrubs (>1m) and regeneration at 10 points along a 50 m transect along the long axis of the plot.
- Native groundcover – other: - Presence or absence of native herbs, sedges, rushes, ferns and other groundcover species at 50 points 1m apart on a 50m transect along the long axis of the plot.
- Exotic plant cover: – Presence or absence of exotic species at 50 points 1m apart on a 50m transect along the long axis of the plot.
- Number of trees with hollows: - All living and dead standing trees with their centres in the 50 × 20 quadrat were examined for hollows capable of harbouring wildlife. Hollows are defined as tree holes > 5 cm diameter, having depth, and > 1 m above the ground.
- Regeneration: - The proportion of overstorey trees species on the 50 × 20 m quadrat that are regenerating.
- Total length of fallen logs: - The length of fallen logs > 10 cm diam and > 0.5 m long was totalled for the whole 50 × 20 m quadrat.

Fauna Species Listing

Lists were compiled of all amphibian, reptile, bird and mammal species either observed, or inferred from evidence such as footprints, or other observers, on the study area.

RESULTS AND DISCUSSION

FLORA

A complete list of the plant species found on the study area is given in Appendix A. A total of 189 species was recorded, of which 83 (43.9%) are native and 106 (56.1%) are introduced. This list is confined mainly to wild native and introduced plants and planted native species. While some ornamental species on the CSU campus have been listed, many are not. The main plant families represented are the Poaceae (Grasses) (50 species), Asteraceae (Daisies) (27 species), Myrtaceae (Eucalypts and relatives) (19 species) and the Faboideae (Pea flowers) (11 species).

Native Vegetation Communities

The original vegetation

Searches of the study area revealed that pre-European native trees, or their descendants, are absent from all of the built parts of the campus between Research Station Drive, Panorama Avenue, the western boundary and almost to Hawthornden Creek. Remnant native trees are confined largely to the banks of Hawthornden Creek with only a few in nearby open space to the north of the creek and one in cleared paddocks south of the creek. These trees are predominantly Ribbon Gum (*Eucalyptus viminalis*) and Apple Box (*Eucalyptus bridgesiana*) and occur on the eastern two thirds of the creek. At the western end of the creek are specimens of Yellow Box (*Eucalyptus melliodora*) and Blakely's Red Gum (*Eucalyptus blakelyi*).

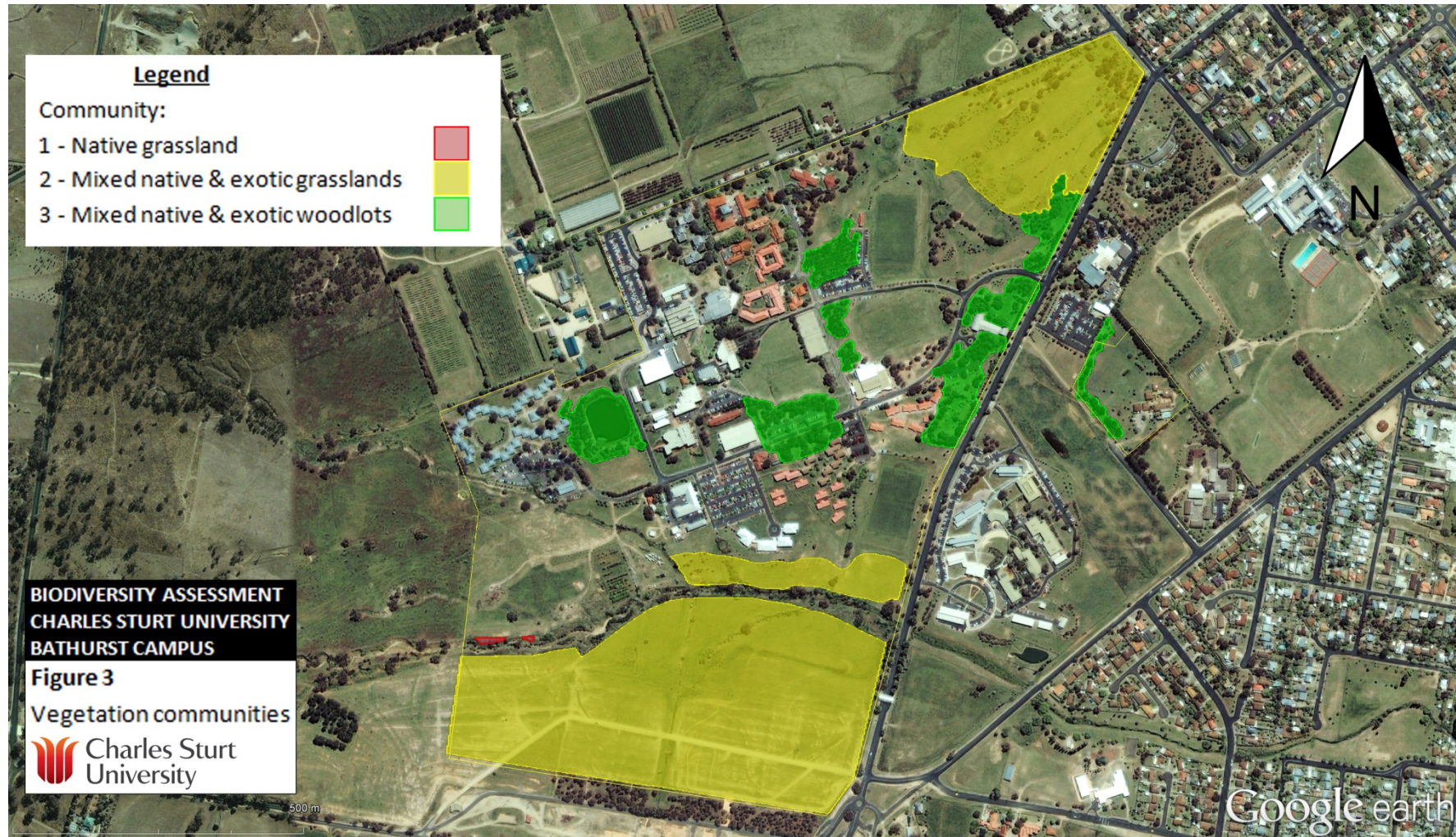
These species are the same as in the Boundary Road Reserve to the west of the study area (Fisher *et al.* 1997; MESS, 2008). The main tree association in the Boundary Road Reserve is Yellow Box, Blakely's Red Gum and Apple Box, with Ribbon Gum confined to drainage lines. It is likely that a similar pattern formerly occurred on the study area and the distribution of the few remaining pre-European trees conforms to it. Yellow Box and Blakely's Red Gum are characteristic species of the Box-Gum Woodland EEC and it is considered this community once occurred across the whole study area as grassy open woodland.

Current Vegetation Communities

Very few of the original native trees remain on the study area, such that the pre-European native vegetation has been almost entirely removed. Apart from two very small areas beside Hawthornden Creek, the majority of the vegetation on the study area now comprises man-made (anthropogenic) plant associations. The vegetation types identified on the study area include:

1. Native grassland derived from Box-Gum Woodland
2. Mixed native and exotic grasslands
 - a. North of Hawthornden Creek (open space on campus)
 - b. South of Hawthornden Creek (grazing paddocks)
 - c. Riparian areas of Hawthornden Creek
3. Mixed native and exotic woodlots (on campus)
4. Exotic grasslands and garden beds (on campus)

The distribution of vegetation types 1 to 3 is shown on Figure 3.



Native grassland derived from Box-Gum Woodland

Two very small (approximately 352 m² and 111 m²), but relatively high quality remnant grassland areas derived from the original Box-Gum Woodland community persist at the western end of Hawthornden Creek (Figure 4). These areas occur between an old fence and the top of the northern bank of Hawthornden Creek (Plate 1). The fence has historically prevented disturbance to this area by grazing, mowing and soil spreading, such that the original ground cover vegetation has survived largely intact.

Quadrat 2 and spot sample 5 were conducted within the larger and smaller patches, respectively. Both patches have central core areas that are dominated by native grasses. However, both are being encroached by introduced grasses around their margins and scattered introduced herbs occur within the core areas. A fifty meter line transect through the centre of the large western patch showed that 86 percent of the ground cover comprised native grasses, ten percent was introduced herbs and grasses, and 2 percent was native herbs.

The combined flora species list for both areas comprises 22 native species and 31 introduced species. The dominant native grasses are *Austrostipa bigeniculata*, Red Grass (*Bothriochloa macra*), Two-color Panic (*Panicum simile*), Ringed Wallaby Grass (*Rytidosperma caespitosum*) and a Wallaby Grass (*R. fulvum*) (Appendix A). Introduced grasses were largely confined to the margins of the patches and included Cocksfoot (*Dactylis glomerata*), African Lovegrass (*Eragrostis curvula*), Paspalum (*Paspalum dilatatum*) and Phalaris (*Phalaris aquatica*). A small patch of the noxious grass Serrated Tussock (*Nassella trichotoma*) occurred within the native grassland. Introduced herbs were present in only low numbers, the most common being Viper's Bugloss (*Echium plantagineum*), Narrow-leaved Clover (*Trifolium angustifolium*), Common Centaury (*Centaureum erythraea*) and Lamb's Tongues (*Plantago lanceolata*).



Plate 1. Remnant native grassland (facing west). [Hawthornden Creek on left, planted trees on right].



A more diverse range of native herbs occurred on these grasslands than elsewhere on the study area, including Yellow Burr-daisy (*Calotis lappulacea*), Common Everlasting (*Chrysocephalum apiculatum*), a Cudweed (*Euchiton sphaericus*), Woolly New-Holland Daisy (*Vittadinia gracilis*), Tufted Bluebell (*Wahlenbergia communis*), a Bindweed (*Convolvulus graminetinus*), an Oxalis (*Oxalis thompsoniae*), Common Woodruff (*Asperula conferta*), as well as Knob Sedge (*Carex inversa*) and Wattle Matrush (*Lomandra filiformis* subsp. *filiformis*). None of these herbs are particularly noteworthy in themselves and most also occur in the adjoining Boundary Road Reserve (MESS, 2008). However, together with the native grasses, they comprise a tiny remnant of the endangered Box-Gum Woodland ecological community, the last remaining examples of this community on CSU land.

Mixed native and exotic grasslands (open space on campus)

Open space areas of the campus that have not been shaped by earth moving equipment may support a mixture of native and exotic grasses and herbs. These include the former golf course and some slopes adjacent to the eastern end of Hawthornden Creek on its north side (Figure 3). Two flora quadrats (nos. 3 and 5) were sampled on the golf course in order to quantify grassland composition (Plate 2). A total of 32 flora species was found on the two quadrats (Appendix A), of which 13 (40.6%) are native and 19 (59.4%) are introduced. The average cover by native species was 55 percent, while cover by introduced species was slightly higher at 61 percent (note: the sum of the percentages is greater than 100 because at some transect points both native and introduced species are present). As these two quadrats were selected to sample parts of the grassland with higher concentrations of native grasses, it is clear that the composition of the grassland overall is greatly dominated by introduced species. Consequently, it is in 'low' condition as defined by the Biobanking methodology (OEH, 2012b).



Plate 2. Mixed grassland on the former golf course.

The main native grass species in the golf course grassland are Red Grass (*Bothriochloa macra*), Windmill Grass (*Chloris truncata*) and the Wallaby Grasses (*Rhytidosperma bipartitum*, *R. caespitosum* and *R. fulvum*). The dominant introduced grasses are Paspalum (*Paspalum dilatatum*) and Goose Grass (*Eleusine tristachya*) with some Kikuyu (*Pennisetum clandestinum*). Very few native herbs are present and those that occur are in generally low densities; the only species recorded as common or abundant were the Fuzzweed (*Vittadinia muelleri*), Sprawling Bluebell (*Wahlenbergia gracilis*) and an oxalis (*Oxalis thompsoniae*). In contrast, common or abundant introduced herbs included Tall Fleabane (*Conyza sumatrensis*), Purple Cudweed (*Gamochaeta purpurea*), Flatweed (*Hypochaeris radicata*), White Clover (*Trifolium repens*), Subterranean Clover (*T. subterraneum*) and

Lamb's Tongues (*Plantago lanceolata*). Although this grassland has native elements that have likely been derived from the original Box-Gum Woodland community, very little of the original diversity remains. It is especially lacking in the original herbaceous species and is not considered to be representative of the Box-Gum Woodland EEC.

Mixed native and exotic grasslands (grazing paddocks)

South of Hawthornden Creek are several cleared paddocks leased for grazing and used for car parking and visitor camping during motor racing events on the adjoining Mount Panorama circuit (Figure 3). There is a permanent unsealed access road in the south of the paddocks and numerous unformed side tracks. Two quadrat samples (6 and 7) conducted in the paddocks showed the vegetation is weedy native grassland (Plate 3). Two 50 m transect samples at the same locations indicated an average of 79 percent cover of the ground by native grasses versus 49 percent for introduced species. Despite the higher ground cover by native grasses, more introduced species were present than natives. Of the total of 46 species on the two quadrats, 18 (39.2%) were native and 28 (60.9%) introduced.



Plate 3. Mixed native and exotic grassland, grazing paddocks south of Hawthornden Creek.

The main native grasses were Red Grass (*Bothriochloa macra*), a Lovegrass (*Eragrostis alveiformis*), Windmill Grass (*Chloris truncata*), Ringed Wallaby Grass (*Austrodanthonia caespitosa*), Wheat Grass (*Elymus scaber*), *Panicum obseptum* and Couch (*Cynodon dactylon*) (Appendix A). The main introduced grasses were Paspalum (*Paspalum dilatatum*) and Goose Grass (*Eleusine tristachya*). The relative abundance of introduced and native herbaceous species was the reverse of that for the grasses. The introduced herb Flatweed (*Hypochaeris radicata*) formed carpets of leaf rosettes in disturbed sites and other common species were Tall Fleabane (*Conyza sumatrensis*), Purple Cudweed (*Gamochaeta purpurea*), White Clover (*Trifolium repens*), Subterranean Clover (*Trifolium subterraneum*) and Lamb's Tongues (*Plantago lanceolata*). The only common native herb was Sprawling Bluebell (*Wahlenbergia gracilis*) (Appendix A).

The native grassland in the cleared paddocks is highly disturbed and degraded by vehicle access and stock grazing. There is also high grazing pressure from kangaroos. Only grazing tolerant native grasses have been able to maintain populations in the paddocks. Native herbs are all but absent.

Riparian areas of Hawthornden Creek

The section of Hawthornden Creek through CSU land is deeply incised with steep banks. Recently, work by Bathurst Regional Council has cleared out a large infestation of Willows (*Salix* spp.) from the creek line. One or two juveniles were overlooked in this work and some regeneration is occurring.

Two quadrats (1 and 4) were conducted in the riparian zone of Hawthornden Creek, one of which supported remnant Ribbon Gum (*Eucalyptus viminalis*) trees (Plate 4) (Quadrat 1) while the other (Quadrat 4) was in a rehabilitated area containing planted River Sheoaks (Plate 5). The quadrats on Hawthornden Creek supported more plant species than elsewhere on the study area; a total of 74 species of which 20 (27.0%) are native and 54 (73%) are introduced (Appendix A). The proportion of introduced species is also higher than recorded elsewhere. Two 50 m ground cover transects conducted at the same locations showed that the average cover by exotic species, mainly grasses, was 94 percent. No native ground cover species appeared on either transect.



Plate 4. Site of Quadrat 1 on lower bank of Hawthornden Creek.

The dominant introduced grass was African Lovegrass (*Eragrostis curvula*) which infests the entire length of Hawthornden Creek (Appendix A). Also prominent are Phalaris (both *Phalaris aquatica* and *P. minor*), Prairie Grass (*Bromus catharticus*) and Cocksfoot (*Dactylis glomerata*). By contrast with the drier grazing paddocks and some of the open grassland areas, native grasses were far less common than introduced species in Hawthornden Creek. The main native species recorded were Windmill Grass (*Chloris truncata*) and Water Couch (*Paspalum distichum*). Introduced herbaceous species were also much more prominent than native herbs; the most prominent were Skeleton Weed (*Chondrilla juncea*), the Sowthistles (*Sonchus asper* and *S. oleraceus*), Viper's Bugloss (*Echium vulgare*), Hairy Brassica (*Hirschfeldia incana*), Hairy Vetch (*Vicia incana*), Narrow-leaved Vetch (*Vicia sativa* subsp. *nigra*) and Lambs' Tongues (*Plantago lanceolata*). The only native herbs that occurred commonly were Small Crumbweed (*Dysphania pumilio*) and an Oxalis (*Oxalis thompsoniae*). The native Sharp Rush (*Eleocharis acuta*) occurred in wet areas of the creek.



Plate 5. Site of Quadrat 4, Hawthornden Creek (planted River Sheoaks and exotic grasses).

Overall, Hawthornden Creek is rated as being in very poor condition floristically. Apart from scattered remnant eucalypt trees, mainly Ribbon Gum and Apple Box (Table 6), very little remains of the original vegetation. The creek line is heavily infested with exotic grasses in common with most waterways on the Central Tablelands.

Mixed native and exotic woodlots (on campus)

The built area of the CSU campus has been planted with a wide variety of native and exotic trees and tall shrubs. The exotic trees are not fully documented in this report as they have little significance for native biodiversity. In several places relatively dense woodlots of mainly native trees have been established, which potentially provide resources for a range of wildlife. The main concentrations of native trees are located around:

- Parking Area 1 (extending to building E1)
- Parking Area 4 (Plate 6)
- The Dam
- The Grange
- The Golf Course

The native trees planted in these areas are listed in Appendix A. While the plantings include species native to the Bathurst area, there are also many species from much further afield. Prominent local species in the plantings include Yellow Box (*Eucalyptus melliodora*) and Ribbon Gum (*Eucalyptus viminalis*). Species from other parts of the NSW Central West include Argyle Apple (*Eucalyptus cinerea*) and Mugga Ironbark (*Eucalyptus sideroxylon*). Other prominent species in the plantings originate much further away, including Narrow-leaved Black Peppermint (*Eucalyptus nicholii*) from the NSW Northern Tablelands and Tasmanian Blue Gum (*Eucalyptus globulus*) from Tasmania. Some of these species may flower prolifically, especially Yellow Box and Red Ironbark, and can be important food sources for nectar feeding birds, potentially including threatened species such as the Regent Honeyeater and Swift Parrot.



Plate 6. Planted woodlot at Parking Area 4.

Exotic grasslands and garden beds

Highly artificial environments such as playing fields and garden beds are not considered in this report.

Noxious and Nationally Significant Weeds

Weeds declared as Noxious in the Bathurst Regional Council area under the NSW *Noxious Weeds Act 1993* and/or are listed as Weeds of National Significance that were found on the study area are listed in Table 7. Weeds of National Significance are declared by the Australian Weeds Committee of the Commonwealth Government (www.weeds.org.au).

Table 7
Noxious Weeds and Weeds of National Significance

Common Name	Scientific Name	Noxious Class in NSW	Weed of National Significance
African Lovegrass	<i>Eragrostis curvula</i>	4	
Blackberry	<i>Rubus fruticosus</i> species aggregate	4	✓
Chilean Needle Grass	<i>Nassella neesiana</i>	4	✓
Mexican Poppy	<i>Argemone mexicana</i> (= <i>A. ochroleuca</i>)	5	
Serrated Tussock	<i>Nassella trichotoma</i>	4	✓
St. John's Wort	<i>Hypericum perforatum</i>	4	
Sweet Briar	<i>Rosa rubiginosa</i>	4	
Willows	<i>Salix</i> spp.	5	✓

NSW Noxious Class 4 The growth of the plant must be managed in a manner that reduces its numbers, spread and incidence and continuously inhibits its reproduction and the plant must not be knowingly sold or distributed.

NSW Noxious Class 5 The requirements in the Noxious Weeds Act 1993 for a notifiable weed must be complied with.

Most of the species listed in Table 7 were found only in low numbers indicating that either effective control programs are in place for them on CSU land or that they do not thrive there. It is likely that Blackberry, St. John's Wort and Sweet Briar, which are well known and easily recognisable, are being

effectively controlled by an existing weed control program. Willows have recently been cleared from the CSU section of Hawthornden Creek by Bathurst Regional Council, although a couple of small trees remain and regeneration is occurring. However, there are three species in the Table 7 that either require further attention, or have been overlooked; African Lovegrass, Chilean Needle Grass and Serrated Tussock. These are discussed individually below.

African Lovegrass

African Lovegrass is a dominant species throughout the length of Hawthornden Creek and small amounts were also found in the grazing paddocks (Appendix A). The dominance of African Lovegrass along Hawthornden Creek is a concern and suggests there have been no recent attempts to control it.

Chilean Needle Grass

Chilean Needle Grass is a less conspicuous species than African Lovegrass. A significant infestation of Chilean Needle Grass occurs along a drain and its surrounds on the northern edge of the large woodlot at Parking Area 1. There are also plants within the woodlot itself. Small patches and isolated plants also occur on the former golf course (Quadrats 3 and 5, Appendix A). This species is a Weed of National Significance. Advice on identification and control can be obtained from officers of the Upper Macquarie County Council.

Serrated Tussock

Serrated Tussock is a well-known weed and has likely been the subject of control efforts on CSU land in the past. Small amounts of Serrated Tussock were observed along Hawthornden Creek. It was recorded in Quadrats 2 and 4 (Appendix A). Quadrat 2 is in the native grassland remnant where there is a small group of Serrated Tussock plants. Others were found within the creek gully. Serrated Tussock is also a Weed of National Significance.

FAUNA

Birds

A total of 50 bird species was recorded on CSU land (Appendix B) of which 46 are native and four are introduced. The highest number of birds (41 species) was observed along Hawthornden Creek which has a number of favourable habitat features, including mature old growth eucalypt trees, tall seeding grasses, dense cover provided by plantings of *Acacia rubida*, surrounding open space and paddocks, and a supply of water in the creek. Fewer bird species were observed in the woodlots on the campus (Appendix B) owing to less shrub and ground cover, human activity and distance from water. The highest numbers of birds on the campus area were recorded in the dam area and on the golf course. The numbers at the dam were boosted by the presence of several water bird species including Wood Duck, Black Duck, Australasian Grebe, White-faced Heron and Little Pied cormorant. The large open spaces and low human activity of the former golf course favoured species such as Crested Pigeon, Australian Magpie, PeeWee, Common Starling and Red-rumped Parrot.

The mature native trees along Hawthornden Creek provide a corridor for birds moving through the landscape. It was obvious that many of the smaller birds were flying from tree to tree either up or down the creek. Hawthornden Creek potentially provides a link between the relatively large Box-Gum woodland remnants in the Boundary Road Reserve and south of Mount Panorama, and the Macquarie River. However, there are few mature trees along the creek downstream of Panorama

Avenue. Consequently, it is perhaps more likely that birds resident in the Boundary Road Reserve simply utilise the CSU part of Hawthornden Creek as an extension of the habitat available to them.

Mammals, Reptiles and Frogs

The mammals, reptiles and frogs observed in the survey, or reported to occur by the head groundsman, are listed in Table 8. Only three native mammals were observed during the survey. The most common is the Eastern Grey Kangaroo (*Macropus giganteus*). Up to 100 kangaroos share CSU land with that on the Boundary Road Reserve. They were commonly seen in the grazing paddocks south of Hawthornden Creek and between Hawthornden Creek and the built parts of the campus. The Common Brushtail Possum (*Trichosurus vulpecula*) was observed at the eastern end of Hawthornden Creek and in the trees around the dam. In the latter area, many of the trees have possum claw marks on the bark. One Swamp Wallaby (*Wallabia bicolor*) was disturbed several times from the cover of long grass beside Hawthornden Creek.

Three introduced mammals were recorded or reported for CSU land. The most abundant is the European Rabbit (*Oryctolagus cuniculus*), which occurs all over the campus, and is commonly seen during the day. Large numbers of rabbits feed at night in the grassland north of the western end of Hawthornden Creek. The tracks of a Red Fox (*Vulpes vulpes*) were seen in Hawthornden Creek and the presence of two or three House Cat (*Felis catus*) was reported by the head groundsman. It is likely that vermin including the Black Rat (*Rattus rattus*) and the House Mouse (*Mus musculus*) also occur.

The weather throughout the survey period was relatively cool and overcast, such that little reptile activity was observed. Only a single courting pair of Jacky Lizards (*Amphibolurus muricatus*) was seen. The Common Brown Snake has also been observed by CSU gardening staff. Both these species are several others have been recorded in the Boundary Road Reserve (MESS, 2008).

Wetter than normal conditions in the summer of 2011/12 was favourable for frogs, which called commonly in the evenings during the survey. Four species were identified with the largest populations in wet grassy areas associated with the tributary of Hawthornden Creek that runs west and south of Buildings S11 and S12. Relatively few frogs were heard around the dam or in Hawthornden Creek. A large population of the Common Froglet (*Crinia signifera*) occurs in the propagation glasshouse.

Habitat Trees

All trees on CSU land were inspected for the presence of hollow limbs that could potentially provide nesting or denning sites for birds, bats or arboreal mammals. Five habitat trees with hollow limbs were identified (Figure 5). All were mature Ribbon Gums in the vicinity of Hawthornden Creek. None of the mature Apple Box trees along the creek possessed hollows and it appears this species is not prone to developing hollow limbs. All the many native trees in the plantings on the built parts of the campus lacked hollows, mainly because they are too young. It is known that hollows generally don't begin to develop until eucalypts are 80 or more years old. The five identified habitat trees have value for native wildlife and should be protected.



Plate 7. Mature Apple Box tree on Hawthornden Creek with planted *Acacia rubida* behind.



Plate 8. Stand of mature Ribbon Gums on lower Hawthornden Creek with planted *Acacia rubida* on the right bank.



Table 8
Mammals, Reptiles and Frogs Recorded on CSU land

Scientific Name	Common Name	Observed in Survey	Reported by Head Groundsman
MAMMALIA			
Marsupialia/Diprotodontia			
Phalangeridae			
<i>Trichosurus vulpecula</i>	Common Brushtail Possum	Two, one carrying young	
Macropodidae			
<i>Macropus giganteus</i>	Eastern Grey Kangaroo	Common	Mob of 100
<i>Wallabia bicolor</i>	Swamp Wallaby	One; Hawthornden Creek gully	
Eutheria/Carnivora			
Canidae			
* <i>Vulpes vulpes</i>	Red Fox	Footprints in creek bed	✓
Felidae			
* <i>Felis catus</i>	House Cat		✓
Eutheria/Lagomorpha			
Leporidae			
* <i>Oryctolagus cuniculus</i>	European Rabbit	Common throughout	
REPTILIA			
Squamata			
Agamidae			
<i>Amphibolurus muricatus</i>	Jacky Lizard	One pair	
Elapidae			
<i>Pseudonaja textilis</i>	Common Brown Snake		✓
AMPHIBIA			
Anura			
Limnodynastidae			
<i>Limnodynastes peronii</i>	Striped Marsh Frog	Tributary of Hawthornden Creek, dam	
<i>Limnodynastes tasmaniensis</i>	Spotted Grass Frog	Common throughout	
Myobatrachidae			
<i>Crinia parinsignifera</i>	Beeping Froglet	One only	
<i>Crinia signifera</i>	Common Froglet	Hawthornden Creek, wet areas, glasshouse	

* Introduced species

Fauna Habitat Value Assessment

Assessment of habitat complexity was undertaken using the NSW Department of Environment and Conservation's 'BioMetric' Terrestrial Biodiversity Assessment Tool (Gibbons *et al.* 2005). Ten variables were assessed at the seven flora quadrat sites; summarised in Table 9. The field data is compared in Table 9 with benchmark data for pristine examples of the pre-European vegetation community that formerly occurred on the study area, viz. '*Blakely's Red Gum - Yellow Box grassy woodland of the NSW South Western Slopes Bioregion*'. The benchmark data was obtained from <http://www.environment.nsw.gov.au/projects/biometrictool.htm>. It should be noted that the flora quadrat sites sample those parts of CSU land with the highest representations of the original biodiversity.

On most measures the habitat value of the study area does not compare favourably with pristine habitat (Table 9). This is to be expected given past disturbances to the area, including complete clearing of all of the original vegetation cover, except for some trees along Hawthornden Creek, grazing and pasture improvement during the Agricultural Research Station era, and considerable earth movement and disturbance during construction of the university infrastructure. Native plant species richness is well below the benchmark on most parts of the study area, although it approaches the benchmark on the native grassland remnants (Figure 4), 17 species in the grassland versus a benchmark of 25.

On most measures the habitat quality of the remnant native vegetation on the study area compares very poorly with the benchmarks and can be regarded as highly degraded. Hawthornden Creek meets or approaches the benchmarks for two of the ten measures; viz, native overstorey cover and the number of trees with hollows, owing to the presence of some mature old growth eucalypts. However, on all other measures Hawthornden Creek is in very poor condition and has low wildlife habitat value. The other areas surveyed, the former golf course, the grazing paddocks and the native grassland remnant, all exceed the benchmark for native grass cover, but fall well short of the benchmarks on all other measures. Overall, it can be concluded that the study area has low habitat value for most native fauna, except those with very broad ecological tolerances.

PEST ANIMALS

Three pest animals known to occur on CSU Bathurst land, the House Cat, the Red Fox and Rabbits are listed as Key Threatening Processes under the *NSW Threatened Species Conservation Act 1995*. Key Threatening Processes are agents that adversely affect threatened species, populations or ecological communities or have potential to cause species, populations or ecological communities that are not threatened to become threatened. There is no requirement for all landholders to control these pest species, if there is no direct threat to threatened species, populations or ecological communities. However, it is possible that the large rabbit population present on CSU land could be perceived as a threat to the integrity of the Box-Gum Woodland endangered ecological community in the Boundary Road Reserve and the cooperation of landholders surrounding the reserve may be sought to reduce rabbit numbers in the environs of the reserve. Similarly, House Cats and Red Foxes on CSU land may pose a threat to wildlife in the reserve. Consequently, it is recommended that CSU initiates control of rabbits, House Cats and Red Foxes to minimise harm to local biodiversity, both on and off the campus.

**Table 9
Fauna Habitat Quality Data**

Vegetation type	No. of replicates	Recorded Values			Benchmarks	
		Lower	Upper	Average	Lower	Upper
Native plant species richness (number of species)						
Golf course	2	11	13	12	25	25
Hawthornden Creek	2	9	13	11		
Grazing paddocks	2	11	14	12.5		
Native grassland	1	17	17	17		
Native overstorey cover (%)						
Golf course	2	10	15.5	12.75	12	35
Hawthornden Creek	2	19.5	42.5	31		
Grazing paddocks	2	0	0	0		
Native grassland	1	7.5	7.5	7.5		
Native midstorey cover (%)						
Golf course	2	0	0	0	1	25
Hawthornden Creek	2	0	0	0		
Grazing paddocks	2	0	0	0		
Native grassland	1	0	0	0		
Native groundcover – grasses (%)						
Golf course	2	46	64	55.5	15	70
Hawthornden Creek	2	0	0	0		
Grazing paddocks	2	70	88	79		
Native grassland	1	86	86	86		
Native groundcover – shrubs (%)						
Golf course	2	0	0	0	3	5
Hawthornden Creek	2	0	0	0		
Grazing paddocks	2	0	0	0		
Native grassland	1	0	0	0		
Native groundcover – other (%)						
Golf course	2	0	0	0	3	20
Hawthornden Creek	2	0	0	0		
Grazing paddocks	2	0	2	1		
Native grassland	1	0	2	1		
Exotic plant cover (%)						
Golf course	2	58	64	61	-	-
Hawthornden Creek	2	90	98	94		
Grazing paddocks	2	44	54	0		
Native grassland	1	10	10	10		
Number of trees with hollows						
Golf course	2	0	0	0	20.8	0.8
Hawthornden Creek	2	0	2	1		
Grazing paddocks	2	0	0	0		
Native grassland	1	0	0	0		
Regeneration (proportion of tree species)						
Golf course	2	0	0	0	-	-
Hawthornden Creek	2	0	0	0		
Grazing paddocks	2	0	0	0		
Native grassland	1	0.5	0.5	0.5		
Total length of fallen logs (m)						
Golf course	2	0	0	0	66	66
Hawthornden Creek	2	0	4.6	2.3		
Grazing paddocks	2	0	0	0		
Native grassland	1	0	0	0		

THREATENED BIODIVERSITY

Threatened Flora Species

One threatened flora species, the Narrow-leaved Black Peppermint (*Eucalyptus nicholii*), that is listed as Vulnerable under the NSW *Threatened Species Conservation Act, 1995* and the Commonwealth *Environment Protection and Biodiversity Conservation Act, 1999* has been planted in some campus woodlots (Plate 9). Some 32 individuals were recorded by the survey with the main concentration on the north side of Parking Area 4 (Figure 5). Other groups of trees occur on the northern and eastern sides of the former golf course and on the western and southern sides of the Leena Street annexe (Figure 5).



Plate 9. Planted Narrow-leaved Black Peppermint, Leena Street annexe.

No other threatened flora species were found, including any of the six species listed in Table 1 as likely to have formerly occurred on the study area. Nor were any species identified that are listed as Rare or Poorly Known in *Rare or Threatened Australian Plants* (ROTAP) (Briggs and Leigh, 1995).

The assessment section below considers the impact of potential future campus development on the Narrow-leaved Black Peppermint. Although none of the threatened species listed in Table 1 was found by the survey, there is a possibility that small residual populations of one or more of them may have been overlooked, since they are generally small inconspicuous species when not in flower. Consequently, the six species considered likely to have once occurred on the study area are also subjected to impact assessments below. These species are listed in Table 10 with brief descriptions.

Table 10
Threatened Flora Species that may once have occurred on the Study area.

Scientific Name	Common Name	Description
<i>Eucalyptus nicholii</i>	Narrow-leaved Black Peppermint	A small to medium-sized tree with rough bark to the twigs. Juvenile leaves are narrow, linear, opposite for a few pairs, then alternate. Adult leaves are bluish green, narrow, linear to narrow-lanceolate, to 13 × 1 cm. Inflorescences 7 flowered. Natural distribution is restricted to the Northern Tablelands of NSW, mainly from Walcha to Glen Innes. It has been widely cultivated and planted as an ornamental street and park tree.
<i>Euphrasia arguta</i>	An Eyebright	An erect, semi-parasitic annual herb growing up to 45 cm high. The branches are very hairy with recurved stiff, non-glandular hairs. The plant has 18–30 pairs of sessile, opposite, toothed leaves along the stem. The white to pinkish-lilac flowers are numerous in terminal branched racemes.
<i>Euphrasia scabra</i>	Yellow Eyebright	A semi-parasitic, annual herb, growing to about 0.5 m tall with stems branching just below the flower-clusters. The stalkless, toothed leaves are variable; those closer to the inflorescences tend to be narrower and have more teeth (up to five pairs). The hairy green calyx is four-lobed and the yellow flower tube is five-lobed.
<i>Goodenia macbarronii</i>	Narrow Goodenia	An annual herb that grows to 30 cm high (Harden, 1992). Flowers are in racemes on almost leafless scapes and flowering occurs mainly between October and March followed by ovoid fruit with yellow-brown seeds (<i>ibid</i>).
<i>Lepidium hyssopifolium</i>	Basalt or Aromatic Peppercress	An erect perennial herb growing 30 to 50 cm tall. Variable leaves grow to 40 × 2.5 mm, are fern-like in the rosette stage, and ultimately narrow and grass-like, with or without teeth, on the mature stems. The greenish flowers are very small and grow in long racemes. The flattened fruits are oval-shaped and grow to 5 × 2 mm.
<i>Swainsona sericea</i>	Silky Swainson-pea	A prostrate or low growing herb to 10 cm high. Plants are densely hairy, including the 2 to 7 cm long leaves with 5 to 13 leaflets. It has upright racemes of 2 to 8 purple pea flowers.
<i>Thesium australe</i>	Austral Toadflax	A small, straggling perennial herb to 40 cm tall with pale green to yellow-green, somewhat succulent leaves, 1 - 4 cm long and 0.5 - 1.5 mm wide. Flowers are minute, pale green, yellow or white and emerge singly from the leaf axils. The fruit is small and nut-like. <i>T. australe</i> is hemiparasitic on the roots of other plants, especially Kangaroo Grass, <i>Themeda triandra</i> .

Threatened Ecological Communities

The available evidence indicates that the Box-Gum Woodland EEC which is listed as the '*White Box Yellow Box Blakely's Red Gum Woodland endangered ecological community*' under the NSW TSC Act, and as the '*White Box-Yellow Box-Blakely's Red Gum grassy woodlands and derived native grasslands critically endangered ecological community*' under the Commonwealth EPBC Act, formerly occurred on the study area. The remnant native flora on the study area is considered to be derived from the original Box-Gum Woodland. However, remnant grassland areas, including the former golf course and grazing paddocks, are highly degraded and have been alienated for over a century. It is considered there is no potential for natural recovery of the original community from the soil seed bank on any part of the study area, with the possible exceptions of the two tiny remnants of natural grassland beside the western end of Hawthornden Creek. No developments by Charles Sturt University are proposed to disturb the natural grassland remnants and, in any event, they are unlikely to be viable in the medium term since their total area is less than 0.05 hectares. It is concluded that the study area lacks viable Box-Gum Woodland remnants and consequently it is not considered necessary to evaluate the impact of potential developments on the EEC.

Threatened Fauna Species

No threatened fauna species was found by the survey. However, the fauna survey techniques were not designed to detect all potential threatened species, particularly bats and owls. Rather, owing to the highly modified nature of the study area, the approach taken was to conduct an assessment of the value of the habitats on the study area for threatened fauna. The 'Biometric' habitat value assessment (Table 9) showed the natural values of the study area are highly degraded as a result of past land use practices. The following list summarises key wildlife habitat values that have been lost:

- There is no native shrub layer
- Native herbs are reduced to a minor component of the ground cover
- The ground cover has a high level of introduced species
- Except along Hawthornden Creek, the study area lacks trees with hollows
- There are no fallen trees, hollow logs, branches or leaf litter on the ground

Other site characteristics that operate against most wildlife are:

- High levels of human activity
- Grazing, parking and camping on the paddocks south of Hawthornden Creek
- Mowing of most areas of open space

These factors indicate that the habitat is unsuitable for native fauna that require:

- Relatively large natural areas to maintain viable population sizes
- Natural shrub and ground cover vegetation layers
- Old growth native trees, except along parts of Hawthornden Creek
- Ground debris including logs, branches and leaf litter

The above considerations can be applied to the threatened species listed in Table 2 that are considered to have low, moderate or high probabilities of occurring on the study area to determine whether suitable habitat critical to the survival of local populations exists on the Study Area. This analysis, given in Table 11, and using the habitat value results presented in Table 9, shows that for many threatened fauna species, one or more critical habitat requirements are missing from the study area. Consequently, some of the threatened fauna species in Table 11 are considered unlikely to occur on the study area at all and are not considered further here. The remainder are only likely to utilise the study area for foraging and none are considered able to breed and establish viable populations in it.

Table 11
Analysis of Habitat Suitability of the Study Area for Threatened Fauna Species.

(X = factor missing or unsuitable, ✓ = factor present, NA = not applicable)

Species	Factor					Special Requirements	Comments	Habitat Suitable?
	Area	Shrub Layer	Ground Cover	Tree Canopy	Hollows			
Green and Golden Bell Frog	✓	X	X	✓	NA	Logs, rocks, crevices, dense cover for shelter (OEH, 2012a).	Could possibly utilise the campus dam. Other water sources are too ephemeral (OEH, 2012a).	No
Spotted Harrier	✓	NA	✓	NA	NA	Open grasslands with abundant prey (mice, rabbits)	Could forage over the CSU grazing paddocks and nest in wooded areas nearby.	Partially (foraging)
Little Eagle	✓	NA	✓	X	NA	Tall trees as lookouts (Blakers <i>et al.</i> , 1984). woodland for nesting.	Could forage over the CSU grazing paddocks and is known to nest in the Boundary road Reserve.	Partially (foraging)
Gang-gang Cockatoo	✓	✓	NA	✓	NA	Winter foraging habitat in requires cultivated plants with fruits, e.g. hawthorn, pine, quince, pyracantha or cotoneaster (Blakers <i>et al.</i> , 1984). Some of these are regarded as environmental weeds and have been removed from CSU land.	Winter visitor to the Bathurst area. Breeds in ranges to the east.	Partially (winter foraging only)
Swift Parrot	✓	NA	NA	✓	NA	Requires winter flowering eucalypts	Migratory species, a favoured food tree in the NSW Central West, Red Ironbark, is planted in the study area	Partially (winter foraging only)
Barking Owl	✓ (30-200 ha)	NA	NA	✓ (for perching)	X	Need open spout-like hollows in woodland for nesting; suitable hollows not present and study area too open	Could potentially nest elsewhere in the district and forage in the study area.	Partially (foraging only)
Speckled Warbler	✓	X	X	X	NA	Nests on rough ground below grass cover. Marginal habitat in Hawthornden Creek gully.	A bird of open eucalypt woodlands. Insufficient tree cover on study area.	No
Regent Honeyeater	NA	NA	NA	✓	NA	Flowering eucalypts	Nomadic, feeds mainly on nectar	Partially (foraging visitor only)

Species	Factor					Special Requirements	Comments	Habitat Suitable?
	Area	Shrub Layer	Ground Cover	Tree Canopy	Hollows			
Black-chinned Honeyeater	✓	NA	NA	X	NA	Appears to require large tracts of natural bushland with flowering shrubs.		No
Varied Sitella	✓	NA	NA	✓	NA	Rough-barked eucalypts for nesting and feeding.	Recorded for the Boundary Road Reserve. Restricted to natural woodland.	No
Scarlet Robin	✓	✓	✓	✓	NA	Feeds on insects on the ground in winter and perches within 3 m of the ground.	Juveniles may visit in winter.	Partially (possible winter visitor)
Diamond Firetail	✓	X	✓	✓	NA	Native grass seed. Could utilise the native grassland area on Hawthornden Creek.	Open, grassy native woodlands	May visit Hawthornden Creek.
Koala	✓	NA	NA	✓	NA	Preferred food trees, which include <i>Eucalyptus viminalis</i> , must be present	Food trees present in study area, but too few in number and area	Vagrants may potentially visit
Grey-headed Flying Fox	✓	NA	NA	✓	NA	Feeds on eucalypt nectar and succulent fruits.	May be attracted to flowering eucalypts in the Bathurst area when poor feeding conditions occur on the coast.	Yes (sporadic visitation only)

Table 12
Threatened Fauna Species that may Utilise the Study Area

Scientific Name	Common Name	Likely Status
<i>Circus assimilis</i>	Spotted Harrier	Foraging visitor - paddocks
<i>Hiraaetus morphnoides</i>	Little Eagle	Foraging visitor - paddocks
<i>Callocephalon fimbriatum</i>	Gang-gang Cockatoo	Foraging visitor – fruiting ornamentals
<i>Lathamus discolor</i>	Swift Parrot	Foraging visitor – flowering eucalypts
<i>Ninox connivens</i>	Barking Owl	Foraging visitor – whole area
<i>Anthochaera phrygia</i>	Regent Honeyeater	Foraging visitor – flowering eucalypts
<i>Petroica boodang</i>	Scarlet Robin	Foraging visitor – whole area
<i>Stagonopleura guttata</i>	Diamond Firetail	Foraging visitor – Hawthornden Creek
<i>Phascolarctos cinereus</i>	Koala	Vagrant – Ribbon Gums, Hawthornden Creek
<i>Pteropus poliocephalus</i>	Grey-headed Flying Fox	Foraging visitor – flowering eucalypts

Table 12 lists the threatened fauna species that may possibly spend time in the study area because suitable feeding resources are available. In general, these species would breed elsewhere, some nearby. The impact of potential development of parts of the study area on these species is considered in the assessment part of this report.

ENVIRONMENTALLY IMPORTANT AREAS

The most environmentally important parts of the CSU Bathurst campus are all associated with Hawthornden Creek. These include the remnant native grassland, remnant native trees including habitat trees, and the potential role of the creek and associated vegetation as a wildlife corridor. Each of these aspects is discussed below.

Remnant Native Grassland

A very small area (approximately 460 m²) of remnant native grassland at the western end of Hawthornden Creek (Figure 4) is a tiny sample of the ground layer of the original grassy woodland that formerly covered much of the study area. Larger and less vulnerable samples of similar grassland would occur in the Boundary Road Reserve. This grassland is a derived remnant of the Box-Gum Woodland endangered ecological community and represents the only relatively intact sample of it remaining on CSU land. Although the remnant is too small to be viable in the long term without sympathetic management, it deserves recognition and protection as part of efforts to rehabilitate and rejuvenate Hawthornden Creek. The remnant is also too small to qualify for legal protection under the TSC (NPWS, undated) and EPBC Acts (DEH, 2006). It is recommended that this remnant be protected by renewing the fencing between it and the open space to the north and that it be identified for protection in CSU land management systems and plans. Control of invasive grass species should also be undertaken.

Remnant Native Trees/Habitat Trees

Hawthornden Creek and its surrounds support the only remaining native trees on CSU land with a lineage on the study area going back to pre-European times. The main surviving trees are Ribbon Gums and Apple Box, including patches of regeneration of the former. There are also five Ribbon Gums old enough (80+ years) to have developed hollow limbs suitable for denning and nesting by

birds, microbats and native mammals. These trees should be protected and used as seed sources for the cultivation of seedlings for the revegetation of Hawthornden Creek.

Wildlife Corridor

A rehabilitated and revegetated Hawthornden Creek has potential to act as a wildlife corridor between the Mount Panorama and Boundary Road Reserve bushland and the Macquarie River. However, it is unlikely the creek currently has a major role as a corridor, since there is little native vegetation on much of Hawthornden Creek between Panorama Avenue and the Macquarie River. Currently, there is heavy use by small birds of the sparse tree cover along the creek within CSU land. These birds are certainly moving up and down the creek, possibly more as an extension of the Boundary Road Reserve bushland than as a corridor to other areas. To achieve a role for Hawthornden Creek as a wildlife corridor would require a cooperative creek rehabilitation program with landholders downstream.

Condition of Hawthornden Creek

Although Hawthornden Creek contains by far the highest biodiversity values on CSU land, it is not in good condition. Significant problems that need addressing include severe soil erosion and weed infestation.

Soil Erosion

Historic tree clearing has allowed deep gullying of the relatively erodible soils that form the base of the creek. The creek is continuing to deepen and widen owing to ongoing erosion and bank slumping (Plates 10 and 11). The floor of the gully is flat and sandy with no pools except at the westernmost extremity where there are narrow, long shallow pools. There is evidence of substantial past attempts to stabilise the soils in the gully using walls constructed of disused car tyres. The walls were backfilled and planted with River Sheoaks (*Casuarina cunninghamiana*) to stabilise the soil (Plate 12). High volumes of water generated by storm events and deep low pressure systems, have broken down the walls in places and displaced the tyres downstream (Plate 13). This is likely to continue and worsen over time. Stabilisation of the soil in Hawthornden Creek is critically important for the sustainability of any revegetation works.



Plate 10. Active erosion in Hawthornden Creek following heavy rain in February – March, 2012.



Plate 11. Bank slumping (foreground) in Hawthornden Creek)



Plate 12. Broken tyre wall overplanted with River Sheoaks



Plate 13. Tyres washed downstream from old soil erosion works

Weeds

Hawthornden Creek is heavily infested with weeds, especially by the noxious species, African Lovegrass. Native ground cover species have largely been displaced. The fertile alluvial soils and moist conditions in the creek line favour a wide range of exotic grasses and herbs. It is unlikely that reintroduced native ground cover species could outcompete the exotics. The best strategy for rehabilitating the creek is to re-establish a continuous native eucalypt canopy. Shading by the eucalypts and allelopathy associated with their fallen leaves and bark may suppress exotic species sufficiently in the long term for some natives to be able to re-establish. However, a short term priority is to control the noxious grasses currently infesting the creek line, namely African Lovegrass and Serrated Tussock.

RECOMMENDATIONS FOR BIODIVERSITY ENHANCEMENT – HAWTHORNDEN CREEK

Soil stabilisation

- Soil stabilisation is likely to require major works. The advice of a soil conservation expert should be sought. A decision would need to be made as to whether to remove the previous extensive structures based on disused tyres, or to incorporate those structures into more durable works.
- The loose tyres washed downstream from the existing retention walls should be removed.
- It is recommended that structures to reduce stream velocities be placed at regular intervals along the creek. These could comprise semi-permeable barriers of heavy rocks that slow stream flow resulting in sediment deposition, thereby raising stream height towards its original levels.

Revegetation

- It is recommended that a fenced biodiversity enhancement zone (corridor) 25 to 30 metres wide be established on either side of Hawthornden Creek.
- The corridor should be planted with Box-Gum Woodland eucalypts grown from seed collected from CSU old growth trees or the Boundary Road Reserve. (Ribbon Gum and Apple Box should be planted on the lower half of the corridor and Yellow Box and Blakely's Red Gum on the western half).
- Appropriate shrubs should be planted amongst the trees, i.e. species that would have originally occurred in this habitat (Semple, 1997).

Remnant native grassland

- The fence between the remnant native grassland and the adjoining mown area should be renewed.
- Serrated Tussock within the grassland should be controlled carefully so as not to destroy the surrounding native species.
- It is recommended that trees or shrubs not be planted in the grassland as these may reduce the vigour and density of the native ground covers, which could potentially be used as sources of seed for re-establishing the native ground cover in the rest of the corridor.

Protect existing mature native trees

- The existing Box-Gum Woodland trees along Hawthornden Creek have high wildlife values due to the presence of hollow limbs in some, and the ability to provide nectar to wildlife when flowering, and should be retained.
- It will take a long time for planted trees to achieve similar value for wildlife.
- Regeneration of Hawthornden Creek should also aim to maintain structural diversity in the habitat by varying tree densities along the corridor, leaving some more open areas to provide habitat for native grasses and grass dependent wildlife.

Weed control

- Hawthornden Creek is dominated by introduced ground cover weeds, mainly the noxious species African Lovegrass.
- While it is desirable to remove African Lovegrass, wide scale weed control may expose the soils to excessive erosive forces.
- It may be better to adopt a longer term strategy based on attempting to suppress African Lovegrass with a developing eucalypt tree canopy, then selectively removing it and sowing appropriate native species, such as Weeping Grass, *Microlaena stipoides*.

IMPACT ASSESSMENT – Seven Part Tests

This section provides an assessment of the impacts of potential future development of the CSU Bathurst campus on flora and fauna based on the preceding survey findings and analysis. The assessment meets the requirements of Section 5A of the NSW *Environmental Planning and Assessment Act (1979)* (EP&A Act), NSW *State Environmental Planning Policy No. 44* (SEPP 44) and the Commonwealth *Environmental Protection and Biodiversity Conservation Act (1995)* (EPBC Act).

The likelihood of development significantly affecting the seven flora species in Table 10 and the 12 fauna species in Table 12 or their habitats is assessed below in accordance with the seven factors of assessment (Seven Part Tests of Significance) set out in the *Threatened Species Assessment Guidelines: The Assessment of Significance* (DECC, 2007) which are:

- (a) *In the case of a threatened species, whether the action proposed is likely to have an adverse effect on the lifecycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.*
- (b) *In the case of an endangered population, whether the action proposed is likely to have an adverse effect on the lifecycle 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.*
- (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.*
- (d) *Whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly).*
- (e) *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;*
 - (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*
 - (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.*
- (f) *Whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan.*
- (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.*

ASSESSMENTS OF SIGNIFICANCE**FLORA****Narrow-leaved Black Peppermint (*Eucalyptus nicholii*)****Factors of Assessment**

- (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.***

All Narrow-leaved Black Peppermints on the study area are cultivated trees up to approximately 50 years old. Some 32 individuals have been planted with concentrations around Parking Area 4, the northern and eastern margins of the former golf course and along the western and southern sides of the Leena Street annexe. All trees are part of amenity plantings for aesthetic reasons, a common use of the Narrow-leaved Black Peppermint which has a visually attractive dense rounded crown (Plate 9).

Narrow-leaved Black Peppermint is native to the Northern Tablelands of NSW, mainly in the Walcha to Glen Innes area (Brooker and Kleinig, 1999). No natural populations occur in the Bathurst area or in the South Eastern Highlands Bioregion. The planted population on the study area is not self-sustaining; no juvenile trees derived from the plantings are present. Nor is the 'population' part of a specific conservation program for this species. Consequently, future development projects on CSU land would not threaten a viable local population of the species.

- (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.***

Not applicable. As at March 2012, no Endangered Populations have been declared for this species in the Central West CMA area or elsewhere (NSW Scientific Committee, 2012).

- (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,***

Not applicable.

- (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, and***
 - (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***
 - (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.***

As indicated above, future developments would not remove or fragment any natural habitat of the Narrow-leaved Black Peppermint. All trees on the study area have been planted and have not established a viable, self-maintaining population of the species. The study area is not the natural habitat of the species and has no importance for the long term survival of the species in its natural habitats on the NSW Northern Tablelands. However, plantings such as those on the CSU Bathurst campus have potential importance as sources of material for recovery programs for the species should the wild population decline to dangerously low levels.

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

Critical habitat, as defined by the TSC Act or the EPBC Act, has not been declared for the Narrow-leaved Black Peppermint on the NSW Critical Habitat register (OEH, 2012c) or the Commonwealth Register of Critical Habitat (SEWPaC, 2012d) in the Project area or surrounds.

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

There is no recovery plan for the Narrow-leaved Black Peppermint. The following recovery actions are listed in the NSW Threatened Species Profile (OEH, 2012a):

- Only buy seed from appropriately licensed dealers.
- Only buy plants from appropriately licensed nurseries.
- Support local Landcare groups.
- Manage fire to promote regeneration.
- Practice sustainable grazing in areas of habitat and protect regenerating trees from grazing stock.
- Limit firewood collection in areas of habitat.
- Identify roadside populations and protect during road-works.
- Protect dry grassy woodland from clearing and fragmentation.

The following recovery actions are listed in the Commonwealth Approved Conservation Advice (SEWPaC, 2008):

Regional Priority Actions

Habitat Loss, Disturbance and Modification

- *Monitor known populations to identify key threats.*
- *Monitor the progress of recovery,*
- *Identify populations of high conservation priority.*
- *Manage threats to areas of vegetation that contain populations/occurrences/remnants of Narrow-leaved Peppermint.*
- *Ensure road widening and maintenance activities (and other infrastructure or development activities involving substrate or vegetation disturbance) in areas where Narrow-leaved Peppermint occurs do not adversely impact on known populations.*
- *Monitor collection of Narrow-leaved Peppermint seed from wild populations to ensure legal and sustainable collection is being undertaken.*

Trampling, Browsing or Grazing

- *Develop and implement a stock management plan for roadside verges and travelling stock routes.*

Fire

- *Develop and implement a suitable fire management strategy for Narrow-leaved Peppermint.*

- *Provide maps of known occurrences to local and state rural fire services and seek inclusion of mitigative measures in bush fire risk management plans, risk register and/or operation maps.*

Conservation Information

- *Raise awareness of Narrow-leaved Peppermint within the local community, particularly among land-holders with this species on their properties.*

Local Priority Actions

Habitat Loss, Disturbance and Modification

- *Minimise adverse impacts from land use at known sites.*
- *Control fire wood collection in the known habitat.*
- *Protect populations of the listed species through the development of conservation agreements and/or covenants.*

Trampling, Browsing or Grazing

- *Prevent grazing pressure at known sites on leased crown land through exclusion fencing or other barriers.*
- *Manage known sites on private property to ensure appropriate stock grazing regimes are conducted, including the protection of seedlings to ensure regeneration.*

Fire

- *Implement an appropriate fire management regime for local populations.*

These recovery actions all refer to natural populations in northern NSW. The Project would not affect the implementation of these actions. No recovery actions have been proposed for cultivated populations of the species. Any development on CSU land that affected the Narrow-leaved Black Peppermint would not be inconsistent with recovery actions currently listed for the species.

(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.*

The following threats to the Narrow-leaved Black Peppermint are listed in the Commonwealth Approved Conservation Advice (SEWPaC, 2008). The relevant NSW listed Key Threatening Processes are given in brackets:

1. Clearing and fragmentation of habitat for agriculture and grazing (*Clearing of native vegetation*).
2. Destruction and disturbance of habitat for road construction and maintenance (*Clearing of native vegetation*).
3. Inappropriate fire regimes (*High frequency fire resulting in the disruption of life cycle processes in plants and animals and loss of vegetation structure and composition*).
4. Firewood collection (*Removal of dead wood and dead trees*).
5. Seed collection for horticulture.

These threats and Key Threatening Processes refer to natural populations in northern NSW. Any development on the CSU Bathurst campus would not affect the operation of these threats on natural populations.

Conclusion.

It is concluded that future developments on the CSU Bathurst campus that adversely affected trees of the Narrow-leaved Black Peppermint would have no impact on natural populations on the NSW Northern Tablelands. However, the trees planted in the university woodlots are part of a large

cultivated population, scattered over many parts of south eastern Australia, that guarantees the survival of the species should it decline further in the wild. It is therefore desirable that harm to these trees is avoided wherever feasible.

EPBC Act

The Narrow-leaved Black Peppermint is listed as Vulnerable under the EPBC Act. The above analysis indicates that any future development projects on the CSU Bathurst campus would have no impacts on natural populations of this species. Consequently, there is no requirement to refer such projects to SEWPaC on account of the Narrow-leaved Black Peppermint.

Other Threatened Flora

***Euphrasia arguta* (An Eyebright),
Euphrasia scabra (Yellow Eyebright),
Goodenia macbarronii (Narrow Goodenia),
Lepidium hyssopifolium (Basalt or Aromatic Peppercress),
Swainsona sericea (Silky Swainson-pea),
Thesium australe (Austral Toadflax)**

The above six threatened flora species that are likely to have occurred on the study area prior to European settlement are considered together here. All are small herbaceous species (Table 10) and none was observed during the survey. All, except *Goodenia macbarronii*, are highly intolerant of disturbance to the natural communities in which they occur. Three of the species, the two Eyebrights and Austral Toadflax are hemiparasitic, that is, they obtain some nutrition from the roots of other plants. Consequently, they depend on the presence of suitable hosts to survive. Eyebrights are not host specific and can utilise a range of herbaceous, sedge and grass hosts (Yeo, 1964). Austral Toadflax on the other hand is largely dependent on Kangaroo Grass, *Themeda australis*, which was not recorded on the study area.

All six of the above species are likely to succumb to competition from exotic grasses. Moist parts of the study area, that were most likely the original habitats of the Eyebrights and the Narrow Goodenia, are now completely overgrown with a range of tall, dense introduced grass species. All six species are also likely to be intolerant of grazing by introduced herbivores, especially sheep and rabbits. The apparent absence of these species from the study area, the adjoining Boundary Road Reserve and the wider region (except for three plants of the Aromatic Peppercress), is attributable to a long history of habitat disturbance and grazing by introduced mammals.

Factors of Assessment

- (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.***

Future developments on the CSU Bathurst campus would involve removal of vegetation and earth works for new buildings, roads and car parks. Such activities would result in the death and permanent loss of individual plants of the Eyebrights, Narrow Goodenia, Aromatic Peppercress, Silky Swainson-pea and Austral Toadflax, if they were present on the site, and would have the potential to place local populations at risk of extinction. However, no populations were found by the survey and it is considered highly unlikely that these species occur anywhere on CSU land owing to the long history of agriculture and grazing on the site and, more recently, by considerable habitat modification by earth moving equipment for the development of university infrastructure over many decades.

- (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.**

Not applicable. As at March 2012, no Endangered Populations have been declared for any of these species in the Central West CMA area (NSW Scientific Committee, 2012).

- (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,**

Not applicable.

- (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, and**
- (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**
- (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.**

As indicated above, future development projects on the CSU Bathurst campus would have potential to remove, modify, fragment and isolate habitat for the Eyebrights, Narrow Goodenia, Aromatic Peppercreese, Silky Swainson-pea and Austral Toadflax, if they were present on the site. However, it is clear that considerable habitat modification has occurred in the past on the built parts of the campus such that habitat for these species has already been eliminated over most of the study area. Only one small part of the study area, a natural grassland less than 0.5 hectares in area, has been unaffected by earthworks, severe weed invasion or heavy grazing. There is no indication that this grassland supports any of the six threatened species, or that they occur elsewhere on parts of the study area that have not been completely reshaped by earth moving equipment, such as the former golf course, land adjacent to the east end of Hawthornden Creek on the north side, or the grazing paddocks south of Hawthornden Creek. Consequently, it is considered highly unlikely that future developments on the CSU Bathurst campus would result in the loss, modification, fragmentation or isolation of habitat of the Eyebrights, Narrow Goodenia, Aromatic Peppercreese, Silky Swainson-pea or Austral Toadflax.

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

Critical habitat, as defined by the TSC Act or the EPBC Act, has not been declared for the Eyebrights, Narrow Goodenia, Aromatic Peppercreese, Silky Swainson-pea or Austral Toadflax on the NSW Critical Habitat register (OEH, 2012c) or the Commonwealth Register of Critical Habitat (SEWPaC, 2012d) in the study area or surrounds.

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

A recovery plan exists only for the Basalt or Aromatic Peppercross (Tumino, 2010). Recovery actions are listed for the other five species in their profiles on the threatened species pages of the NSW OEH website (OEH, 2012a).

All recovery actions in the recovery plan and profiles refer to the protection and management of known populations of the species. Since no populations of the Eyebrights, Narrow Goodenia, Aromatic Peppercross, Silky Swainson-pea or Austral Toadflax are known or likely to occur on the CSU Bathurst campus, the recovery actions are not relevant to any future developments on the campus.

(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.

Key Threatening Processes that may be relevant to future developments on the CSU Bathurst campus include:

- Clearing of native vegetation, and
- Invasion of native plant communities by exotic perennial grasses

Depending on where developments take place, some clearing of mixed exotic and native grasslands may occur on the former golf course, adjacent to Hawthornden Creek or in the grazing paddocks. Soil disturbed by earth works for building projects is likely to be colonised by introduced grass species and may result in a change from mixed exotic and native grassland to exotic grassland. However, these actions would not threaten the Eyebrights, Narrow Goodenia, Aromatic Peppercross, Silky Swainson-pea or Austral Toadflax, since no populations of these species are known or likely to occur on these areas.

Conclusion.

It is concluded that future developments on the CSU Bathurst campus would not adversely affect populations of the Eyebrights, Narrow Goodenia, Aromatic Peppercross, Silky Swainson-pea or Austral Toadflax, as suitable habitat for these species is absent, and no populations are known or likely to occur on CSU land.

EPBC Act

Three of the above species, *Euphrasia arguta*, the Basalt Peppercross and the Austral Toadflax are listed as threatened under the EPBC Act. The above analysis indicates that any future development projects on the CSU Bathurst campus would have no impacts on natural populations of these species. Consequently, there is no requirement to refer such projects to SEWPaC on account of *Euphrasia arguta*, the Basalt Peppercross and the Austral Toadflax.

FAUNA

In this section ten species of threatened fauna (Table 12) that may utilise food sources on the study area are subjected to a Seven Part Test of Significance. The previous analysis of the value for fauna of the habitats on the study area concluded that none of the threatened fauna is likely to breed or establish a viable population there. However, two birds of prey, the Spotted Harrier and Little Eagle, and one owl, the Masked Owl, may potentially hunt for prey over the grazing paddocks and other open spaces. The Koala has potential food trees in the Ribbon Gums along Hawthornden Creek. Two species of threatened birds, the Swift Parrot and the Regent Honeyeater, and the Grey-headed Flying

Fox may forage for nectar in flowering eucalypts. The Gang-gang Cockatoo is likely to visit in winter to feed on the fruits of ornamental shrubs, juvenile Scarlet Robins may also appear in autumn and winter to forage for insects on the ground and the Diamond Firetail is likely to visit from the Boundary Road Reserve to feed on grass seeds.

Factors of Assessment

- (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.**

As indicated above it is highly unlikely that any of the ten threatened fauna species could breed in the study area or establish a viable population there. The main potential impact of a future building project on threatened fauna may be a reduction in available food resources for migratory or nomadic species visiting the site. The main potential food resources that may be affected are nectar from flowering eucalypts, prey such as mice and rabbits from open space or grazing paddocks, fruit from ornamental shrubs, seeds from native grasses and foliage from Ribbon Gums.

Since none of the species under consideration is known or likely to depend on the study area for maintaining an existing viable population, it is highly unlikely that a future development could put such a population at risk. Rather, the study area would most likely function as a minor occasional supplementary source of food. While this is obviously useful, it is not likely to be critical to the survival of populations of these species, which depend on the availability of food over a wide area. Local populations of such migratory and nomadic species may encompass very large areas. Their success is often more dependent on climatic conditions than the availability of resources at a point source.

- (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.**

Not applicable. As at March 2012, no Endangered Populations have been declared for any of these species in the Central West CMA area (NSW Scientific Committee, 2012).

- (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,

Not applicable.

- (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, and**
(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
(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.

Areas potentially available for development at CSU Bathurst include the former golf course, some areas of open space and the grazing paddocks south of Hawthornden Creek. None of these areas comprises native bushland or prime breeding habitat for the ten threatened fauna species. Nor do the areas form part of vegetation corridors that might be used by wildlife to move through the landscape.

Consequently, development of these areas would not remove, modify, fragment or isolate any habitat important to the long term survival of the subject species.

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

Critical habitat, as defined by the TSC Act or the EPBC Act, has not been declared for any of the subject species on the NSW Critical Habitat register (OEH, 2012c) or the Commonwealth Register of Critical Habitat (SEWPaC, 2012d) in the study area or surrounds.

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

Recovery plans have been prepared only for the Swift Parrot (Swift Parrot Recovery Team, 2001) and Regent Honeyeater (Menkhorst *et al.*, 1999). Recovery actions are listed for the all species in their profiles on the threatened species profiles on the NSW OEH website (OEH, 2012a) summarised as follows;

Action	Spotted Harrier	Little Eagle	Gang-gang	Swift Parrot	Barking Owl	Regent Honeyeater	Scarlet Robin	Diamond Firetail	Koala	GH Flying Fox
Protect areas of habitat from overgrazing	✓				✓			✓		
Protect known populations and areas of potential habitat from clearing, fragmentation or disturbance, including grazing	✓	✓			✓		✓	✓		
Retain and protect nesting, roosting and foraging habitat, including standing dead trees, hollow bearing trees, feeding trees	✓	✓			✓	✓	✓		✓	✓
Buffer or fence habitat areas from the impacts of other activities		✓			✓		✓			
Rehabilitate known and potential habitat, increase remnant size		✓				✓	✓	✓		
Reduce collisions in areas where birds are foraging by closing window blinds etc.				✓						
Retain stands of preferred feed-trees, particularly large mature individuals and mistletoe				✓		✓			✓	✓
Revegetate with preferred feeding tree species				✓					✓	
Participate in surveys to locate the winter foraging areas				✓						
Apply mosaic patter hazard reduction techniques					✓				✓	
Retain and enhance vegetation along watercourses and surrounds, remove stock					✓	✓				
Maintain a captive population						✓				
Use incentives on private land to encourage landholders to manage key areas						✓				
No further loss of woodland and forest habitat from development						✓				
Conduct research into non-breeding habitat and long distance movements						✓				

Action	Spotted Harrier	Little Eagle	Gang-gang	Swift Parrot	Barking Owl	Regent Honeyeater	Scarlet Robin	Diamond Firetail	Koala	GH Flying Fox
Investigate impacts of interspecific competition and nest predation						✓				
Retain dead timber on the ground in open forests and woodlands							✓	✓		
Avoid exotic berry-producing shrubs to minimise predation by Currawongs							✓	✓		
Control domestic cats near habitat							✓			
Link remnant populations via corridors in the landscape								✓	✓	
Control feral predators and reduce attacks by domestic dogs									✓	
Signage on roads to minimise road kills									✓	
Manage and enforce licensed shooting and investigate non-lethal crop protection measures										✓

All of the above recovery actions relate to known populations of the species. No populations of any of the species were detected during the field survey of the study area. In the absence of any populations of the above species on the study area, the recovery actions are not directly relevant. Accordingly, the any future development would be not inconsistent with the recovery actions for these species.

(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.*

Key Threatening Processes that may be relevant to future developments on the CSU Bathurst campus include:

- Clearing of native vegetation, and
- Invasion of native plant communities by exotic perennial grasses

Depending on where developments take place, some clearing of mixed exotic and native grasslands may occur on the former golf course, adjacent to Hawthornden Creek or in the grazing paddocks. Soil disturbed by earth works for building projects is likely to be colonised by introduced grass species and may result in a change from mixed exotic and native grassland to exotic grassland. These changes may reduce the foraging habitat available for some of the fauna species under consideration. This in combination with other developments and landscape changes can be expected to place increasing pressure on wide ranging native species resulting in gradual contraction of their ranges. Consequently, future developments, especially on the less disturbed parts of the campus around Hawthornden Creek and in the grazing paddocks may slightly increase the impact of these key threatening processes.

Conclusion.

It is concluded that future developments on the CSU Bathurst campus would not significantly affect populations of the ten threatened fauna species under consideration here, as suitable breeding habitat for all of the species is absent, and no populations are known or likely to occur on CSU land. However, future developments that affect food resources for these species may result in a slight decrease in the foraging habitat available.

EPBC Act

Three of the above fauna species, the Swift Parrot, Regent Honeyeater and the Grey-headed Flying Fox are listed as threatened under the EPBC Act. The above analysis indicates that any future development projects on the CSU Bathurst campus would have no significant impacts on the survival of natural populations of these species. Consequently, there is no requirement to refer such projects to SEWPaC on account of the Swift Parrot, Regent Honeyeater and the Grey-headed Flying Fox.

SEPP 44

NSW SEPP 44 aims to protect habitat utilised by the Koala, *Phascolarctos cinereus*, which is known to occur in the areas surrounding Bathurst. Ribbon Gum, *Eucalyptus viminalis*, is a favoured Koala food tree listed in Schedule 2 of SEPP 44. Remnant mature and regenerating Ribbon Gum trees occur along Hawthornden Creek on the study area. SEPP 44 requires consideration of the study area as potential Koala habitat.

Since the vegetated parts of Hawthornden Creek may exceed one hectare in size and may have 15 percent or more coverage by Ribbon Gums, it is considered to be potential Koala habitat. However, the area does not have an extant Koala population, and none is known to occur closeby (BioNet, 2012). Accordingly, the study area does not include 'core' Koala habitat and a SEPP 44 plan of management is not required.

EPBC Act

No matters that would require referral to the Commonwealth Department of Sustainability Environment Water Population and Communities relating to Commonwealth listed threatened species and ecological communities, migratory species or wetlands of international importance, were revealed by this study.

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APPENDIX A. Flora Species List

Scientific Name	Common Name	Quadrat Number							Spot Sample							Opp.
		1	2	3	4	5	6	7	1	2	3	4	5	6	7	
CLASS CONIFEROPSIDA																
Cupressaceae																
<i>Callitris</i> sp.	Ornamental Cypress															•
<i>Callitris verrucosa</i>	Mallee Pine								•	•						
Pinaceae																
* <i>Cedrus deodara</i>	Himalayan Cedar			2		1			•	•						
* <i>Pinus radiata</i>	Radiata Pine								•							•
* <i>Pinus</i> sp.										•						
CLASS MAGNOLIOPSIDA																
SUBCLASS MAGNOLIIDAE																
Amaranthaceae																
<i>Alternanthera denticulata</i>	Lesser Joyweed															•
Amygdalaceae																
* <i>Prunus cerasus</i>	Sour Cherry				2											•
Anacardiaceae																
* <i>Schinus areira</i>	Pepper Tree										•					
Apiaceae																
* <i>Cyclospermum leptophyllum</i>	Slender Celery										•					
Asteraceae																
* <i>Arctotheca calendula</i>	Capeweed															
<i>Calotis lappulacea</i>	Yellow Burr-daisy												•			•
* <i>Carthamus lanatus</i>	Saffron Thistle	1			1		2	2								
<i>Cassinia arcuata</i>	Sifton Bush						1									
* <i>Centaurea calcitrapa</i>	Star Thistle							1								
* <i>Centaurea solstitialis</i>	St Barnabys Thistle	1														
* <i>Chondrilla juncea</i>	Skeleton Weed	3	2		3								•			
<i>Chrysocephalum apiculatum</i>	Common Everlasting		5										•			•
* <i>Cirsium vulgare</i>	Spear Thistle	2	1	1	3			1	•		•	•				
* <i>Conyza bonariensis</i>	Flaxleaf Fleabane						1	2	•							
* <i>Conyza sumatrensis</i>	Tall Fleabane	2	2	1	2	3	3				•	•			•	
<i>Cotula australis</i>	Carrot Weed							2								

Scientific Name	Common Name	Quadrat Number							Spot Sample							Opp.	
		1	2	3	4	5	6	7	1	2	3	4	5	6	7		
<i>Euchiton involucratus</i>	Common Cudweed						1									•	
<i>Euchiton sphaericus</i>	Star Cudweed		3				1										
* <i>Gamochaeta purpurea</i>	Purple Cudweed	1		3		5	3		•								
* <i>Hypochaeris radicata</i>	Flatweed		2	3	1	4	6	5	•	•						•	
* <i>Lactuca serriola</i>	Prickly Lettuce	2	1		2				•	•							
<i>Pseudognaphalium luteoalbum</i>	Jersey Cudweed											•					
<i>Senecio quadridentatus</i>	Cotton Fireweed									•							
* <i>Silybum marianum</i>	Variegated Thistle																•
* <i>Sonchus asper</i>	Prickly Sowthistle	3			2					•							
* <i>Sonchus oleraceus</i>	Common Sowthistle	1			3				•	•							
* <i>Tolpis barbata</i>	Yellow Hawkweed					1											
* <i>Taraxacum officinale</i>	Dandelion									•							•
* <i>Tragopogon porrifolius</i>	Salsify	1															
<i>Vittadinia gracilis</i>	Woolly New-Holland Daisy												•				•
<i>Vittadinia muelleri</i>	A Fuzzweed			1		4											
Boraginaceae																	
* <i>Echium plantagineum</i>	Paterson's Curse							1									
* <i>Echium vulgare</i>	Vipers Bugloss	4	3		2							•	•				
* <i>Heliotropium amplexicaule</i>	Blue Heliotrope																•
Brassicaceae																	
* <i>Brassica tournefortii</i>	Mediterranean Turnip									•							
* <i>Capsella bursa-pastoris</i>	Shepherd's Purse										•						
* <i>Erophila verna</i> subsp. <i>praecox</i>	Whitlow																
* <i>Hirschfeldia incana</i>	Hairy Brassica	5	1		2				•				•			•	
* <i>Lepidium africanum</i>	Common Peppergrass				1	1											•
Campanulaceae																	
<i>Wahlenbergia communis</i>	Tufted Bluebell	1	2											•			•
<i>Wahlenbergis gracilis</i>	Sprawling Bluebell			1		3	2	3	•	•							
Caprifoliaceae																	
* <i>Lonicera japonica</i>	Japanese Honeysuckle								•								
Caryophyllaceae																	
* <i>Paronychia brasiliiana</i>	Brazilian Whitlow			2		1		1		•		•					•
* <i>Petrorhagia nanteuilii</i>	Proliferous Pink		1				1										
* <i>Polycarpon tetraphyllum</i>	Four-leaved Allseed				2					•							•

Scientific Name	Common Name	Quadrat Number							Spot Sample							Opp.	
		1	2	3	4	5	6	7	1	2	3	4	5	6	7		
* <i>Spergularia rubra</i>	Sandspurry							2			•						
Casuarinaceae																	
<i>Casuarina cristata</i>	Belah											•					
<i>Casuarina cunninghamiana</i>	River Oak				7					•	•	•		•			
Chenopodiaceae																	
* <i>Chenopodium album</i>	Fat Hen	2									•						
<i>Dysphania pumilio</i>	Small Crumbweed				3						•						
<i>Einadia nutans</i> subsp. <i>nutans</i>	Climbing Saltbush																•
<i>Einadia polygonoides</i>	Climbing Saltbush										•	•					
Clusiaceae																	
* <i>Hypericum androsaemum</i>	Tutsan										•						
<i>Hypericum gramineum</i>	Small St John's Wort		1														
* <i>Hypericum perforatum</i>	St Johns Wort							1									•
Convolvulaceae																	
<i>Convolvulus graminetinus</i>	Australian Bindweed		3	1										•			•
Fabaceae - Faboideae																	
* <i>Medicago lupulina</i>	Black Medic	2								•	•						
* <i>Medicago polymorpha</i>	Burr Medic				1												
* <i>Trifolium angustifolium</i>	Narrow-leaved Clover		3						1								•
* <i>Trifolium arvense</i>	Haresfoot Clover	2		1	2												•
* <i>Trifolium dubium</i>	Yellow Suckling Clover	2															
* <i>Trifolium glomeratum</i>	Clustered Clover				1				2								
* <i>Trifolium repens</i>	White Clover			2		3			4	•							•
* <i>Trifolium resupinatum</i>	Shaftal Clover																•
* <i>Trifolium subterraneum</i>	Subterranean Clover	1	1	4		5			5	•	•						•
* <i>Vicia hirsuta</i>	Hairy Vetch	5															
* <i>Vicia sativa</i> subsp. <i>nigra</i>	Narrow-leaved Vetch	4	1		2												
Fabaceae - Mimosoideae																	
<i>Acacia baileyana</i>	Cootamundra Wattle									•		•	•				
<i>Acacia mearnsii</i>	Black Wattle											•					
<i>Acacia pendula</i>	Weeping Myall											•					
<i>Acacia vestita</i>	Weeping Boree												•				
Fagaceae																	
<i>Quercus robur</i>	English Oak									•							

Scientific Name	Common Name	Quadrat Number							Spot Sample							Opp.	
		1	2	3	4	5	6	7	1	2	3	4	5	6	7		
Gentianaceae																	
<i>*Centaurium erythraea</i>	Common Centaury		3	1		1								•			
Geraniaceae																	
<i>*Geranium molle</i>	Cranesbill Geranium				2												
<i>Geranium solanderi</i>	Austral Crane's Bill	1															
Lamiaceae																	
<i>*Marrubium vulgare</i>	White Horehound				2												
<i>*Salvia verbenaca</i>	Vervain		1											•			
<i>Westringia fruticosa</i>	Native Rosemary										•						
Loranthaceae																	
<i>Amyema miquelii</i>	Box Mistletoe													•			
Lythraceae																	
<i>Lythrum hyssopifolia</i>	Hyssop Loosestrife													•			
Malaceae																	
<i>*Cotoneaster</i> sp.	Cotoneaster										•						
<i>*Crataegus monogyna</i>	Hawthorn		2														•
<i>*Photinia x fraseri</i>	Photinia										•						
<i>*Malus pumila</i>	Apple		1														•
Malvaceae																	
<i>*Malva neglecta</i>	Dwarf Mallow													•			
<i>*Malva parviflora</i>	Small-flowered Mallow													•			
<i>*Modiola caroliniana</i>	Red-flowered Mallow				1						•			•			
Myoporaceae																	
<i>Myoporum boninense</i>	Boobiolla													•			
Myrsinaceae																	
<i>*Anagallis arvensis</i>	Scarlet Pimpernel	2		1	1		1				•	•					
Myrtaceae																	
<i>Callistemon salignus</i>	Willow Bottlebrush													•			
<i>Callistemon viminalis</i>	Weeping Bottlebrush										•			•			
<i>Eucalyptus blakelyi</i>	Blakely's Red Gum		4								•						
<i>Eucalyptus bridgesiana</i>	Apple Box		4														
<i>Eucalyptus deanei</i>	Mountain Blue Gum															•	
<i>Eucalyptus camaldulensis</i>	River Gum															•	
<i>Eucalyptus cinerea</i>	Argyle Apple										•	•	•	•		•	•

Scientific Name	Common Name	Quadrat Number							Spot Sample							Opp.	
		1	2	3	4	5	6	7	1	2	3	4	5	6	7		
<i>Eucalyptus cypellocarpa</i>	Monkey Gum											•					
<i>Eucalyptus elata</i>	River Peppermint											•					
<i>Eucalyptus globulus</i>	Tasmanian Blue Gum											•	•		•	•	
<i>Eucalyptus mannifera</i>	Brittle Gum											•	•		•		
<i>Eucalyptus melliodora</i>	Yellow Box											•	•	•	•		
<i>Eucalyptus nicholii</i>	Narrow-leaved Black Peppermint											•	•		•		
<i>Eucalyptus praecox</i>												•			•		
<i>Eucalyptus sideroxylon</i>	Mugga Ironbark											•	•				
<i>Eucalyptus sp.</i>												•					
<i>Eucalyptus viminalis</i>	Ribbon Gum	6										•	•		•		
<i>Melaleuca lanceolata</i>	Black Tea Tree											•					
<i>Melaleuca linariifolia</i>	Flax-leaved Paperbark												•				
Oleaceae																	
* <i>Fraxinus angustifolia</i>	Desert Ash											•					
Onagraceae																	
<i>Epilobium billardierianum</i>	Variable Willow-herb														•		
<i>Epilobium hirtigerum</i>	Hairy Willow-herb	2															
<i>Epilobium sp.</i>	A Willow-herb	1															
Oxalidaceae																	
<i>Oxalis thompsoniae</i>	An Oxalis	3	3	3	3	4	1	2				•			•		•
Papaveraceae																	
* <i>Argemone ochroleuca</i> subsp. <i>ochroleuca</i>	Mexican Poppy												•				
Plantaginaceae																	
* <i>Plantago lanceolata</i>	Lambs Tongues	3	3	5	3	5	3	3				•	•		•		•
Polygonaceae																	
* <i>Acetosella vulgaris</i>	Sorrel		1					1									•
* <i>Polygonum aviculare</i>	Wireweed	1			2			1				•					•
<i>Rumex brownii</i>	Swamp Dock	1					1	2				•			•		
* <i>Rumex crispus</i>	Curled Dock	2			2							•					•
Portulacaceae																	
<i>Portulaca oleracea</i>	Pigweed												•				•
Rosaceae																	
* <i>Rubus anglocandicans</i>	Blackberry	1			2								•				
* <i>Rosa rubiginosa</i>	Sweet Briar	1	1														

Scientific Name	Common Name	Quadrat Number							Spot Sample							Opp.	
		1	2	3	4	5	6	7	1	2	3	4	5	6	7		
<i>*Sanguisorba minor</i> subsp. <i>muricata</i>	Sheep's Burnet		1														•
Rubiaceae																	
<i>Asperula conferta</i>	Common Woodruff	1											•				
Salicaceae																	
<i>*Salix</i> sp.	Willow	2															
Scrophulariaceae																	
<i>*Verbascum virgatum</i>	Twiggy Mullein		1										•				
<i>*Veronica anagallis-aquatica</i>	Blue Water Speedwell	2															
Solanaceae																	
<i>*Datura stramonium</i>	Common Thornapple																•
<i>*Solanum nigrum</i>	Black-berry Nightshade	1								•	•		•				
Sterculiaceae																	
<i>Brachychiton populneus</i>	Kurrajong													•	•		
Verbenaceae																	
<i>*Verbena bonariensis</i>	Purpletop				2								•				
<i>*Verbena rigida</i>	Veined Verbena																•
SUBCLASS LILIIDAE																	
Asparagaceae																	
<i>*Asparagus officinalis</i>	Asparagus	1								•			•			•	
Cyperaceae																	
<i>Carex inversa</i>	Knob Sedge		3														
<i>*Cyperus eragrostis</i>	Umbrella Sedge	2			2		1	2		•						•	
<i>Eleocharis acuta</i>	Common Spike-rush	3															
<i>Schoenus apogon</i>	Common Bog-rush																•
Juncaceae																	
<i>Juncus usitatus</i>	Common Rush	2											•				
Lomandraceae																	
<i>Lomandra filiformis</i> subsp. <i>filiformis</i>	Wattle Mat-rush		3														
Poaceae																	
<i>Agrostis capillaris</i> var. <i>aristata</i>	Browntop Bent					3											
<i>Austrostipa bigeniculata</i>	A Speargrass		7										•				•
<i>Austrostipa scabra</i> subsp. <i>falcata</i>	Speargrass												•			•	•
<i>*Avena sativa</i>	Oats		1										•				
<i>Bothriochloa macra</i>	Red Grass		5	6	1	6	5	6		•						•	

Scientific Name	Common Name	Quadrat Number							Spot Sample							Opp.
		1	2	3	4	5	6	7	1	2	3	4	5	6	7	
<i>*Bromus catharticus</i>	Praire Grass	2		1	5	1			•			•	•		•	
<i>*Bromus hordeaceus</i>	Soft Brome	2	1		2		2	3					•			
<i>Chloris truncata</i>	Windmill Grass			3	3	5	5	5	•	•					•	
<i>Cynodon dactylon</i>	Couch	2		2	2	3	5	6		•		•			•	
<i>*Dactylis glomerata</i>	Cocksfoot	2	2		4					•					•	
<i>Dichanthium sericeum</i>	Queensland Bluegrass		2													
<i>*Digitaria ciliaris</i>	Summer Grass														•	
<i>*Digitaria sanguinalis</i>	Summer Grass									•						
<i>*Echinochloa crus-galli</i>	Barnyard Grass							1								•
<i>*Echinochloa esculenta</i>	Japanese Millet															•
<i>*Eleusine indica</i>	Crowsfoot Grass											•				
<i>*Eleusine tristachya</i>	Goose Grass		1	5	2	3	5	6	•	•			•		•	
<i>Elymus scaber</i>	Wheat Grass						5									
<i>Eragrostis alveiformis</i>	A Lovegrass						5	4							•	
<i>Eragrostis benthamii</i>	A Lovegrass					2			•							
<i>*Eragrostis cilianensis</i>	Stinkgrass				2			1								•
<i>*Eragrostis curvula</i>	African Lovegrass	6	2		5		2	1					•		•	
<i>Eragrostis parviflora</i>	Weeping Lovegrass		2	3	2	3				•			•			•
<i>*Eragrostis pilosa</i>	Soft Lovegrass															•
<i>*Festuca arundinacea</i>	Tall Fescue	3														
<i>*Hordeum leporinum</i>	Barley Grass												•			
<i>Lachnagrostis filiformis</i>	Blown Grass							1				•				
<i>*Lolium perenne</i>	Perennial Ryegrass	1								•						
<i>*Lolium rigidum</i>	Wimmera Ryegrass			1		1										
<i>Microlaena stipoides</i>	Weeping Grass	2													•	
<i>*Nassella neesiana</i>	Chilean Needlegrass			2		1				•						
<i>*Nassella trichotoma</i>	Serrated Tussock		2		2											•
<i>Panicum effusum</i>	Hairy Panic						3									
<i>*Panicum gilvum</i>	Sweet Panic				2										•	•
<i>Panicum obseptum</i>	White Water Panic							5								
<i>Panicum simile</i>	Two-colour Panic		4		2	1							•			
<i>Paspalidium distans</i>	A Paspalidium								•							
<i>*Paspalum dilatatum</i>	Paspalum	3	2	5	3	5	5	3	•	•					•	
<i>Paspalum distichum</i>	Water Couch	3					2									

Scientific Name	Common Name	Quadrat Number							Spot Sample							Opp.
		1	2	3	4	5	6	7	1	2	3	4	5	6	7	
<i>*Pennisetum clandestinum</i>	Kikuyu Grass			3	3	2			•	•					•	
<i>*Phalaris aquatica</i>	Phalaris	3	3		5								•		•	
<i>*Phalaris minor</i>	Lesser Canary Grass	5										•				
<i>*Poa annua</i>	Winter Grass										•					
<i>Rytidosperma bipartitum</i>	A Wallaby Grass			5					•							
<i>Rytidosperma caespitosum</i>	Ringed Wallaby Grass		5	4		5	2		•	•	•	•	•		•	
<i>Rytidosperma fulvum</i>	A Wallaby Grass		3		1	5	2						•		•	
<i>Rytidosperma racemosum</i> var. <i>racemosum</i>	A Wallaby Grass														•	
<i>Rytidosperma richardsonii</i>	Straw Wallaby Grass														•	
<i>Sporobolus creber</i>	Slender Rat's Rail Grass							4							•	
<i>*Vulpia</i> sp.								1								
Typhaceae																
<i>Typha orientalis</i>	Broadleaf Cumbungi											•				
No. Native Species	83															
No. Introduced Species	106															
Total Species	189															

APPENDIX B - Bird Species List

Scientific Name	Common Name	Hawthornden Creek Transect Counts					Totals	Campus Woodlots				
		31-Jan am	31-Jan pm	1-Feb am	8-Feb am	9-Mar am		Golf course	P1	P4	Dam	The Grange
GALLIFORMES												
Phasianidae												
<i>Coturnix pectoralis</i>	Stubble Quail											•
ANSERIFORMES												
Anatidae												
<i>Anas superciliosa</i>	Pacific Black Duck				2		2				•	
<i>Chenonetta jubata</i>	Australian Wood Duck				2		2				•	
PODICIPEDIFORMES												
Podicipedidae												
<i>Tachybaptus novaehollandiae</i>	Australasian Grebe											
COLUMBIFORMES												
Columbidae												
<i>Ocyphaps lophotes</i>	Crested Pigeon					3	3	•				
CAPRIMULGIFORMES												
Podargidae												
<i>Podargus strigoides</i>	Tawny Frogmouth											•
PHALACROCORACIFORMES												
Phalacrocoracidae												
<i>Phalacrocorax melanoleucos</i>	Little Pied Cormorant										•	
CICONIIFORMES												
Ardeidae												
<i>Egretta novaehollandiae</i>	White-faced Heron										•	
FALCONIFORMES												
Falconidae												
<i>Falco berigora</i>	Brown Falcon	1					1					
CHARADRIIFORMES												
Charadriidae												
<i>Vanellus miles</i>	Masked Lapwing	9			3		12		•		•	
PSITTACIFORMES												
Cacatuidae												
<i>Cacatua roseicapilla</i>	Galah	18	90	51	6	2	167		•	•		•
Psittacidae												

Scientific Name	Common Name	Hawthornden Creek Transect Counts					Totals	Campus Woodlots					
		31-Jan am	31-Jan pm	1-Feb am	8-Feb am	9-Mar am		Golf course	P1	P4	Dam	The Grange	Opp.
<i>Alisterus scapularis</i>	King Parrot	3					3	•					
<i>Psephotus haematonotus</i>	Red-rumped Parrot	8		2		6	16	•				•	
<i>Platycercus elegans</i>	Crimson Rosella		2			2	4						
CUCULIFORMES													
Cuculidae													
<i>Chrysococcyx basalis</i>	Horsfield's Bronze-Cuckoo				1		1						
CORACIIFORMES													
Alcedinidae													
<i>Dacelo novaeguineae</i>	Laughing Kookaburra	1					1						
<i>Todiramphus sanctus</i>	Sacred Kingfisher			2			2						
PASSERIFORMES													
Acanthizidae													
<i>Acanthiza chrysorrhoa</i>	Yellow-rumped Thornbill			6	4		10						
<i>Acanthiza lineata</i>	Striated Thornbill				8	6	14						
<i>Acanthiza nana</i>	Yellow Thornbill				9		9						
<i>Gerygone olivacea</i>	White-throated Gerygone	2					2						
<i>Smicromis brevirostris</i>	Weebill	2		2		3	7						
Artamidae													
<i>Cracticus torquatus</i>	Grey Butcher Bird				1	2	3						
<i>Gymnorhina tibicen</i>	Australian Magpie	11	7		4	5	27	•	•		•		
<i>Strepera graculina</i>	Pied Currawong												•
Campephagidae													
<i>Coracina novaehollandiae</i>	Black-faced Cuckoo-shrike		1				1						
Corvidae													
<i>Corvus coronoides</i>	Australian Raven			3	3		6						
Estrildidae													
<i>Neochmia temporalis</i>	Red-browed Finch	3					3						
<i>Taeniopygia bichenovii</i>	Double-barred Finch		2	10		3	15						
Fringilidae													
* <i>Carduelis carduelis</i>	European Goldfinch			6			6						
Maluridae													
<i>Malurus cyaneus</i>	Superb Fairy-wren	7	1	8	16	4	36	•					
Meliphagidae													
<i>Anthochaera carunculata</i>	Red Wattlebird	4	1			6	11	•		•	•		
<i>Lichenostomus chrysops</i>	Yellow-faced Honeyeater	5	11	10	2	9	37						
<i>Lichenostomus penicillatus</i>	White-plumed Honeyeater			2		1	3			•	•	•	

Scientific Name	Common Name	Hawthornden Creek Transect Counts					Totals	Campus Woodlots					
		31-Jan am	31-Jan pm	1-Feb am	8-Feb am	9-Mar am		Golf course	P1	P4	Dam	The Grange	Opp.
<i>Manorina melanocephala</i>	Noisy Minor					1	1	•	•	•	•	•	
Monarchidae													
<i>Grallina cyanoleuca</i>	PeeWee				2	5	7	•		•	•		
<i>Myiagra rubecula</i>	Leaden Flycatcher		1				1						
<i>Rhipidura albiscapa</i>	Grey Fantail	8	4	13	5	5	35			•			
<i>Rhipidura leucophrys</i>	Willie Wagtail										•		
Oriolidae													
<i>Oriolus sagittatus</i>	Olive-backed Oriole							•					
Pachycephalidae													
<i>Colluricincla harmonica</i>	Grey Shrike-thrush									•			
<i>Pachycephala rufiventris</i>	Rufous Whistler	1			3	1	5						
Pardalotidae													
<i>Pardalotus punctatus</i>	Spotted Pardalote	4				3	7						
<i>Pardalotus striatus</i>	Striated Pardalote			1		14	15		•				
Passeridae													
* <i>Passer domesticus</i>	House Sparrow		2	3			5						
Sturnidae													
* <i>Sturnus vulgaris</i>	Common Starling		26				26	•					
Sylviidae													
<i>Cincloramphus mathewsi</i>	Rufous Songlark	2	1	1			4						
<i>Megalurus gramineus</i>	Little Grassbird	3			1	1	5						
Turdidae													
* <i>Turdus merula</i>	Eurasian Blackbird					1	1						
Zosteropidae													
<i>Zosterops lateralis</i>	Silvereye	3	8	4	4		19						
Total counts		95	157	124	76	83	535	-	-	-	-	-	-
Total species	50	19	14	16	18	21	41	10	5	7	11	4	3

* Introduced species