Figure 1. Survey Locations with *Hibbertia* sp. nov. „Menai" at North Menai.

Figure 2. Survey Locations with *Hibbertia* sp. nov. „Menai" at Engadine-Woronora Heights.

Photograph 2. Habitat of *Hibbertia* sp. nov. 'Menai' on the RTA land, Site D(3) at North Menai. Note rather dense growth because of the absence of bushfire for many years. Photographed 4 November 2009.

Photograph 3. A mature flowering specimen of *Hibbertia* sp. nov. 'Menai' growing on site B(1). Photographed 4 November 2009.

Table 1

Results of Field Surveys for **Hibbertia** *sp. nov . 'Menai' in the Sutherland Region*

LOCAL POPULATION **Location** **Sub-Population**	**Survey Date**	**No. plants**	**GPS Location[1]**	**Notes**
NORTH MENAI				
A. Freehold land west of Alfords Point Road, north of Monash Road.				
A1. South of Landcom land	04.11.09	3	0317277 6236028	Sandstone outcrop, not slashed, plants flowering, to 80cm tall.
A2. South of Landcom land	04.11.09	1	0317291 6236058	Disturbed ground, old drainage pond below adjacent freeway.
A3. South of Landcom land	04.11.09	15	0317320 6236034 to 0317347 6236103	Sandstone outcrop, not slashed, plants flowering, to 80cm tall.
A4. South of Landcom land	04.11.09	1	0317282 6236033	Small plant in slashed area.
B. Council strip of land east of Old Illawarra Road, opposite Monash Road.				
B1. South of Monash Road	04.11.09	5	0316685 6235567	Mostly thick shrubs. Also flowering *H. riparia, H. monogyna*.
B2. Northern end of land, near overpass	04.11.09	6	0316909 6235710	On disturbed ground, two mature plants in full flower.
B3. Northwest edge of bushland	04.11.09	1	0316876 6235724	One plant on edge of bushland.
C. Council land west of Old Illawarra Road (Alfords Point Road to west)				
C1. Northern end of council land	04.11.09	59	0317335 6235992 to 0317343 6236009	Some plants over 1m tall, many flowering. Unburnt open woodland. A few plants on RTA road reserve to west. Also flowering *H. riparia*.
D. RTA land west of Old Illawarra Road (Alfords Point Road to west) – land is bounded by a 1.8 m chain wire fence.				
D1. South of Blaxland Drive	04.11.09	42	0317459 6236099 to 0317427 6236077	Many tall shrubs. Also flowering *H. riparia, H. monogyna*. Unburnt open woodland.
D2. North of Blaxland Drive	04.11.09	65	0317409 6236073	Many mature plants. Mostly rather thick with shrubs. *Melaleuca deanei* present, three clumps together.
D3. Northern end of RTA land	04.11.09	50	0317593 6236247 to 0317561 6236216	Mostly on old disturbed ground above Alfords Point Road.

Table 1 cont...

Results of Field Surveys for Hibbertia sp. nov . 'Menai' in the Sutherland Region

LOCAL POPULATION Location Sub-Population	Survey Date	No. plants	GPS Location[1]	Notes
NORTH MENAI cont...				
E. Strip of land (Council?) east and west of ramp off Old Illawarra Road leading to Alfords Point Road, near Lee Place.				
E1. Southern half of eastern side of ramp	04.11.09	77	0316924 6235649 to 0316882 6235612	Some plants growing on cleared edge of road; many small plants present.
E2. Western side of ramp	04.11.09	4	0316927 6235676	Shrubs rather dense. Also flowering *H. riparia.*
J. Land to west and north of Menai High School				
J1. Between high school and tennis court	04.12.09	1	0317606 6235916	Specimen collected.
J2. North of high school	04.12.09	11	0317665 6235848	*Tetratheca neglecta*
K. Northeast corner of Alfords Point Road and Brushwood Drive				
K1. Between two concrete drains	04.12.09	7	0317771 623 6386	*Hibbertia nitida, Tetratheca neglecta;* specimen collected.
No. Locations North Menai: 16	**-**	**348 plants**		
MENAI-BARDEN RIDGE				
H. Timbery Circuit, Barden Ridge				
H1. West of existing subdivision[2]	12.11.09	1	0315757 6233118	*Hibbertia riparia, H.monogyna, Tetratheca neglecta*

Table 1 cont...

Results of Field Surveys for Hibbertia sp. nov . 'Menai' in the Sutherland Region

LOCAL POPULATION Location Sub-Population	Survey Date	No. plants	GPS Location[1]	Notes
MENAI-BARDEN RIDGE cont...				
L. Dalkara Circuit				
L1. West end, Dalkara Crt (roadside)	04.12.09	18	0317172 6233429	-
L2. Central area, Dalkara Crt (roadside)	04.12.09	11	0317314 6233488	*Cassinia cunninghamii*
L3. East end, Dalkara Crt (roadside)	04.12.09	2	0317366 6233500	*Cassinia cunninghamii, Hibbertia nitida*
L4. RTA Corridor, Dalkara Crt (fenced)	04.12.09	21	0317393 6233545 to 0317117 6233428	*Cassinia cunninghamii;* specimen collected. *Hibbertia nitida, Tetratheca neglecta, Hibbertia monogyna*
L5. Gully edge, west end of Dalkara Circuit	04.12.09	10	0317111 6233412	-
No. Locations Menai-Barden Ridge	**6**	**63 plants**		
ENGADINE-WORONORA HEIGHTS				
F. Engadine				
F.1 Caldarra Avenue reserve[2]	12.11.09	46	0317163 6229717	Sandstone ridge; *Leucopogon amplexicaulis, Tetratheca neglecta*
F.2 Croston Road (north end)[2]	12.11.09	6	0318883 6231759	*Hibbertia monogyna, Tetratheca neglecta.*
G. Woronora Heights				
G1. Bundanoon Road[2]	12.11.09	29	0317056 6231590	Edge of road easement; *H.monogyna.*
No. Locations Engadine-Woronora Heights: 3		**81 plants**		

1. GPS given in WGS84 co-ordinates.
2. The plants at these locations require further assessment, although they appear to be the taxon in question.

The results at North Menai indicate that:

- The plants at North Menai extend across several parcels of fragmented bushland in close proximity.
- Most of the land where the taxon occurs is public land of one kind or another.
- The plants in the areas surveyed represent a local population; see **Figure 1**.
- The taxon often grows on the disturbed edges of bushland.
- Most of the sites surveyed have not been burnt for a long time due to the location of the bushland amongst roads and developed land.
- The mallee *Angophora hispida* appears to be a good indicator species for the presence of *Hibbertia* sp. nov. „Menai", at least in the areas so far surveyed at North Menai.
- Many of the plants are mature or semi-mature, judging by their size, with few small plants observed. This is probably because of the rather dense shrubs, the result of an absence of fire for a long time.

The habitat of the taxon in the Sutherland area is woodland/open woodland and heathland. Most of the sites at North Menai have remained unburnt for a long time and the shrubs and sometimes the trees are quite dense. Plants often grow on disturbed ground, where competition from other plants is low and light levels are high. The taxon was found to grow on ridge-tops, usually where there are sandstone outcrops, apparently avoiding the adjacent gullies where forest dominates.

Other Locations in Sutherland

The taxon has been recorded from other locations not surveyed during this investigation; these locations are summarised in **Table 2**. The population on the Landcom land at Monash Road was found to contain about 36 plants in October 2009 (Ecological Australia 2009). These are located across the eastern part of the land. This site is west of sites C and D, as shown in **Figure 1**, and on the opposite side of Alfords Point Road, and north of site A on that map.

This additional information indicates that the taxon occurs in an area of about five kilometres north to south and five kilometres east to west. The currently known extremities of the Sutherland population are Alfords Point, Loftus and Barden Ridge.

Table 2
Other Locations where* Hibbertia *sp. nov. 'Menai' has been recorded

Location	Information Source	Comments
Landcom land, Monash Road	Ecological Australia (2009).	36 plants counted
Maandownie Reserve, Loftus	Australian Plant Society (web site)	90 plants reported.
Bangor-Menai Bypass[1]	Final Determination Australian Plant Society (web site)	 60 plants reported

1.This may be the Dalkara Circuit site surveyed here.

Summary

The surveys in the Sutherland area located a total of 492; a further 36 plants is reported on the Landcom land at Monash road and 90 plants have been counted at Loftus. All sites where the taxon has been found to date are in or adjacent to urban development and quite fragmented.

The known Sutherland populations occur at altitudes ranging from about 50 metres to 120 metres. The average annual rainfall is about 900 mm per year.

4.3 South Coast Regional Population

The taxon has been found to occur on the Toorooroo Plateau, between about Colymea Creek, Yalwal and the Shoalhaven River and on some nearby escarpment locations (K. Mills, pers. obs.). In that region, *Hibbertia* sp. nov 'Menai' is often abundant in open woodland and heathland vegetation. Currently, the plants are known to occur mainly over an area of about 20 square kilometres. The locations where *Hibbertia* sp. apparently belonging to the Menai taxon were observed on the south coast are tabulated in **Table 3**. Note that some of these observations were made in 2008, before it was realised that these plants were the endangered taxon at Sutherland.

The known distribution of the taxon on the South Coast is shown on **Figures 3 and 4**; this map is based on the field surveys by Kevin Mills. The taxon was found to be common throughout the area indicated, occurring in woodlands and heathlands, particularly near broad sandstone surfaces and cliff edges, where the density of trees and large shrubs tends to be lower. The plant avoids forest, where the tree and/or shrub canopy cover is dense.

The South Coast population may well occur in similar habitat to the west and south of the above area, into Morton National Park, Parma Creek Nature Reserve and/or Jerrawangala National Park. Targeted surveys for the taxon are required in those areas to fully appreciate the total extent of the South Coast population. Initial surveys in mid November 2009 found various plants approaching this taxon in the area from HMAS Albatross south to Tomerong Road; the taxonomic status of these specimens if yet to be determined.

The results of the south coast surveys indicate that;

- The taxon is common to very common across a broad area of sandstone country.
- The taxon is common in Colymea State Conservation Area, and all known occurrences are on public land.
- The environment in terms of rainfall, altitude, soils and vegetation is very similar to the Sutherland region.
- The south coast population is under no significant threat.

Summary
The taxon was found to be very common on the sandstone plateau west of the Colymea Creek Valley and to a lesser extent to the east. The population must number in the tens of thousands. At this stage it is assumed that the south coast population is the same taxon as the one found in the Sutherland region. The occurrence of the known population to the west of Nowra ranges from 150 metres to 330 metres in altitude. The average rainfall in the area is about 900 mm per year.

Table 3
Results of Field Surveys for Hibbertia sp. nov . 'Menai' in the Shoalhaven District

Population Location	Survey Date	No. plants	GPS Location[1]	Altitude	Notes
TOOROOROO PLATEAU					
1. Hylands Lookout	02.11.09	occasional	0265676 6123392	330m	Specimens collected (2).
2. Toorooroo plateau, south side	02.11.09	100+	0266594 6129389	265m	Specimens collected (2).
3. South of number 2	02.11.09	200+	0266652 6129141	265m	
4. East of number 2	02.11.09	100s	0266722 6129430	265m	
5. Beside Deans Gap Road	02.11.09	10+	0266517 6129726	255m	
6. Beside Yalwal Road	02.11.09	Occasional	0266950 6130756	250m	
7. Beside Yalwal Road	02.11.09	20+	0266950 6130756	260m	Specimen collected .
8. Beside Yalwal Road	02.11.09	10+	0266409 6131171	280m	
9. Beside Yalwal Road	02.11.09	Occasional	0265985 6131740	290m	
10. Beside Yalwal Road	02.11.09	Occasional	0264697 6133168	318m	
11. Beside Yalwal Road	02.11.09	Occasional	0264283 6133473	315m	
12. East of Barringella Creek valley	02.11.09	Occasional	0269261 6134150	190m	Specimen collected.
13. East of Barringella Creek valley	02.11.09	Occasional	0269155 6134595	190m	
14. East of Matson Pass	10.05.08	common	0263909 6134701	300m	
15. North of Chimney Stack Road	10.05.08	uncommon	0264754 6132646	310m	
16. Above Chimney Stack Rock	10.05.08	uncommon	0264700 6132250	310m	
17. West of Barringella Creek valley	29.06.08	-	0266538 6132611	270m	
18. West of Barringella Creek valley	29.06.08	100s	0266743 6133697	270m	
19. South of Grady Point	23.08.08	abundant	0265321 6133698	285m	
20. Near Wattle Track	02.05.09	-	0265520 6133875	210m	
21. North of Waxflower Trail	12.07.09	few	0268408 6133025	220m	
22. West of Christmas Bush Trail	12.07.09	few	0267741 6131932	220m	
23. Link Trail, Colymea SCA	24.12.07	common	0270087 6131763	185m	
24. Link Trail, Colymea SCA	24.01.08	common	0270340 6131799	165m	
25. Christmas Bush Trail, Colymea SCA	12.01.08	common	0269721 6131704	185m	
26. Christmas Bush Trail, Colymea SCA	04.01.08	common	0268951 6131585	165m	
27. Christmas Bush Trail, Colymea SCA	12.01.08	common	0270436 6132540	150m	
28. Link Trail, Colymea SCA	18.01.08	common	0270522 6131792	160m	
29. Northern arm, Wattle Trail	17.01.08	common	0268745 6130305	215m	

Table 3 cont...

Results of Field Surveys for Hibbertia sp. nov . 'Menai' in the Shoalhaven District

Population Location	Survey Date	No. plants	GPS Location[1]	Altitude	Notes
30. Link rail, Colymea SCA	20.01.08	common	0270371 6131713	160m	
31. Christmas Bush Trail, Colymea SCA	20.01.08	abundant	0269028 6131750	205m	
32. Link Trail, Colymea SCA	20.01.08	common	0270379 6131952	170m	
33. North of HMAS Albatross	21.12.09	common	0273522 6131470	110m	Specimen collected.
34. South of Yerriyong Trig	21.12.09	occasional	0269364 6122857	230m	Specimen collected.
35. Christmas Bush Trail, Colymea SCA	21.12.09	occasional	0268235 6131752	225m	Specimen collected.
36. South of Hylands Lookout	21.12.09	common	0265597 6123320	320m	
37. North of Hylands Lookout	21.12.09	common	0265783 6123487	320m	
38. North of Turpentine Road junction	21.12.09	occasional	0268415 6121015	240m	Specimen collected.
39. Deans Gap Road	05.01.10	occasional	0266116 6127890	305m	Specimen collected.
40. Deans Gap Road	05.01.10	occasional	0266246 6128191	285m	
41. Deans Gap Road	05.01.10	occasional	0266409 6128309	290m	
42. Deans Gap Road	05.01.10	occasional	0266856 6129264	280m	
43. Deans Gap Road	05.01.10	occasional	0266838 6130512	270m	
44. Yalwal Road	05.01.10	occasional	0269632 6134032	190m	

1. GPS given in WGS84 co-ordinates.

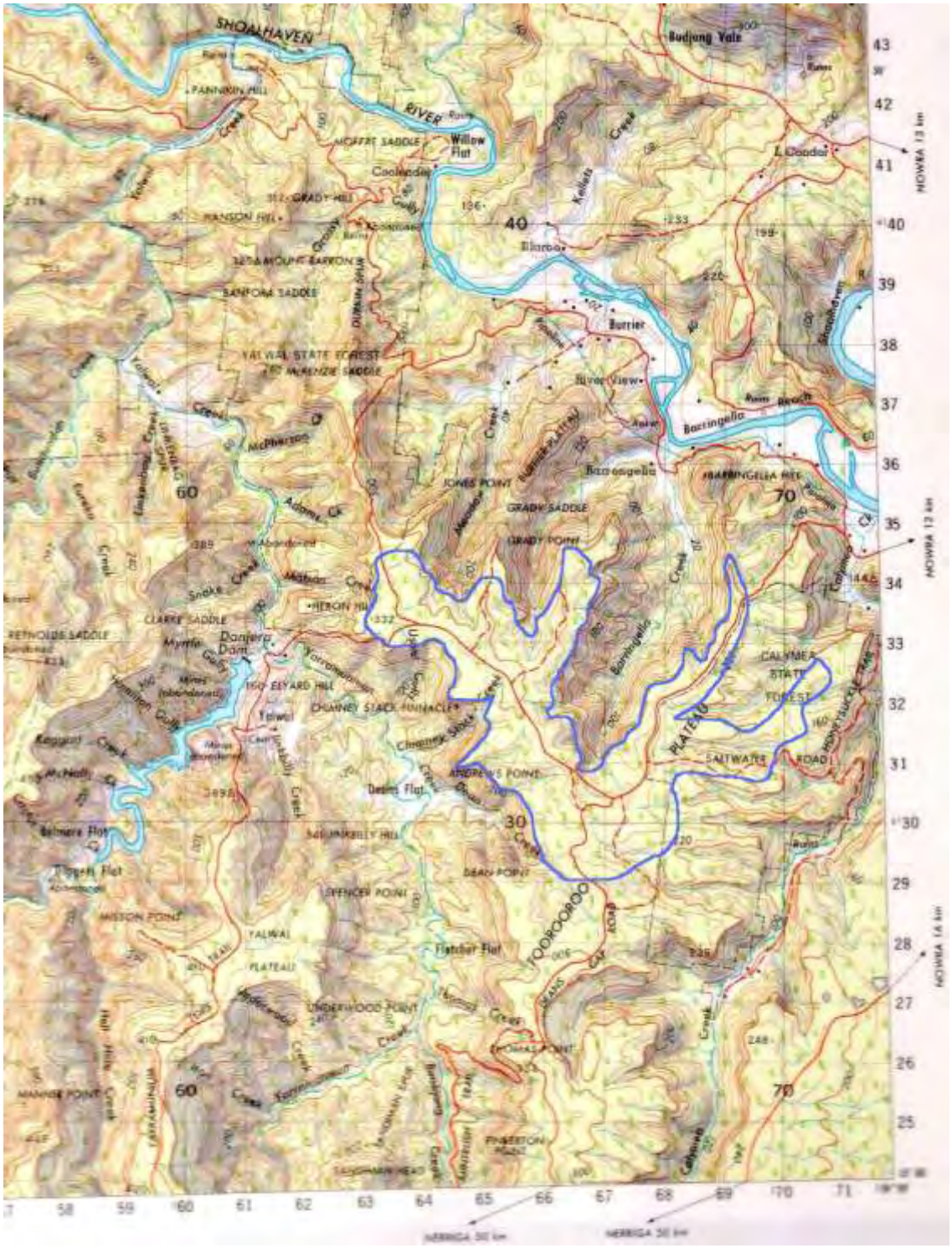


Figure 3. Known Distribution of *Hibbertia* sp. nov. 'Menai' on Toorooroo Plateau, South Coast. Note: grid squares are 1 km by 1 km. Figure 4 adjoins to the south.

Figure 4. Known Distribution of *Hibbertia* sp. nov. 'Menai' near Deans Gap Road, South Coast. Note: grid squares are 1 km by 1 km. Figure 3 adjoins to the north.

4.4 Conservation Status

As noted above, the taxon is listed as endangered in NSW. Under the *Threatened Species Conservation Act 1995*, Clause 10 of the Act states that:
"a species is eligible to be listed as an "endangered species" if, in the opinion of the Scientific Committee:
(a) it is facing a very high risk of extinction in New South Wales in the near future, as determined in accordance with criteria prescribed by the regulations, and
(b) it is not eligible to be listed as a critically endangered species."

Hibbertia sp. nov 'Menai' occurs in Colymea State Conservation Area on the South Coast, where it is abundant. The remainder of the known South Coast population occurs on vacant Crown land that is very unlikely to ever be developed. As noted above, the taxon may extend into other adjacent conservation reserves. The South Coast population is considered to be secure and under no significant threat.

In the Sutherland area, the known extant populations are located primarily on public land, mainly council land. The southern Sydney population is not known to occur in a formal conservation reserve. Although on land that is generally unlikely to be developed, the Sutherland populations are threatened by weed competition, bushfire hazard reduction activities, road maintenance and vandalism. Lack of fire may be a long term threat.

Photograph 4. *Hibbertia* sp. nov 'Menai' from the South Coast population (Colymea State Conservation Area). Photographed 20 January 2008.

5 Conclusion

The taxon *Hibbertia* sp. nov. 'Menai' is little known. It is generally distinct from other taxa in the *H. riparia* group, particularly as regards hair types and their density on the leaves, as well as leaf colour and length. However, both at Sutherland and on the South Coast, there are plants that appear to be neither typical *H. riparia* nor the Menai taxon. Further investigation of specimens from both populations, including genetic studies, will hopefully throw further light on the true stratus of the taxa involved in this complex.

When listing *Hibbertia* sp. nov 'Menai' as "endangered" in late 2007, the NSW Scientific Committee was of the opinion that "it is facing a very high risk of extinction in New South Wales in the near future". Based on the current knowledge of the distribution and abundance of the taxon on the South Coast, this is clearly not the case. On the South Coast, the taxon is known to occur across a broad sandstone plateau, with very little disturbance to its primarily woodland and heathland vegetation. There is little threat to the taxon in that area, where it is abundant across a large area of public land, and where it is common in a conservation reserve.

The results of the recent surveys in the Sutherland region indicate that the taxon may be threatened, but it is not likely to go extinct in the immediate future. Most of its original habitat, i.e. the tops of the ridges, however, is now covered in urban development. The taxon is locally common in a few locations, primarily on public land, although the bushland where it occurs is quite fragmented.

The challenge in the Sutherland region is to manage these bushland remnants to conserve this and other rare plants in the long term. Lack of bushfire in some remnants may be a significant threat to the taxon in the long term, as dense vegetation may eventually result in the loss of the taxon from these sites. It is noted that nearly all of the bushland across the Toorooroo Plateau on the South Coast was severely burnt in the 2001/2002 bushfires, and that the taxon is abundant there today.

This is a preliminary investigation of the taxon *Hibbertia* sp. nov. 'Menai' as currently understood across its known range. There is still much work to be done to fully understand the distribution of the taxon and its taxonomic relationships within the *H. riparia* - *H. stricta* complex.

6 References

Ecological Australia (2009). Threatened Flora Surveys, *Hibbertia* sp. 'Menai', *Tetratheca neglecta*. Prepared for Landcom, November.

NSW Flora Online (2009). *Hibbertia* sp. nov. 'Menai'. Royal Botanic Garden, Sydney.

NSW Scientific Committee (2007). Final Determination: *Hibbertia sp.* nov. 'Menai' as an endangered species. The Committee, Hurstville, August.

APPENDIX 1
Hibbertia *sp. nov. 'Menai' - Endangered Species Listing*

The Scientific Committee, established by the Threatened Species Conservation Act, has made a Final Determination to list the shrub *Hibbertia* sp. nov. 'Menai' A.T. Fairley 15 Dec 2004 as an ENDANGERED SPECIES in Part 1 of Schedule 1 of the Act. Listing of endangered species is provided for by Part 2 of the Act.

The Scientific Committee has found that:

1. *Hibbertia* sp. nov. 'Menai' (family Dilleniaceae) is a small shrub 0.8 - 1.3 m in height and up to 70 cm wide, usually of strict upright habit, and densely covered with hairs on the branchlets, sepals, carpels, and (less densely) leaves, the hairs lacking a basal tubercle and reduced-stellate on type, with two or three stiff strongly ascending to erect arms (or rarely simple), the hairs and arms sometimes tending antrorsely directed. Branchlets are pale orange-brown, angular near the tips, with ridges produced downwards from the base of each leaf. Leaves are alternate, linear, 7 - 15 mm long, 0.5 - 0.8 mm wide, with the margin entire and recurved; the adaxial (upper) surface is slightly sunken along the midrib, venation not otherwise visible; the abaxial (lower) surface has the midvein up to 1.5 times as broad as the 'rolled' margins and somewhat sunken between them, with a deep distinct groove along either side; the leaves are unevenly spaced and often appearing somewhat whorled; each leaf sits on a cupped protuberance from the stem. Flowers are solitary, mostly on short lateral branchlets and terminal (but sometimes appearing axillary), sessile or very shortly pedicellate (pedicel up to 0.5 mm long). Sepals are hairy outside except near margin, glabrous inside, narrowly ovate, 4.5 - 7 mm long, 1.5 - 2.5 mm wide, the two 'outer' sepals slightly narrower than the other three; margin entire; apex with a short to long point; outer surface sometimes slightly ridged along the midline, papery, green to margin on the two 'outer' sepals, or with a distinct pale margin 0.5 mm wide on the other three. Petals are obovate, 4 - 6.5 mm long, c. 3 mm wide, yellow, with midvein pale orange-coloured. Stamens are 6 - 8, inserted to one side of the carpels; filaments 0.5 - 0.7 mm long; anthers 2 - 3 mm long. Carpels 2, 0.8 - 1 mm long, densely hairy (as for other parts); styles laterally inserted, c. 3 mm long.

2. *Hibbertia* sp. nov. 'Menai' is most similar and probably most closely related to *H. stricta* R.Br. *sensu stricto*. Both taxa have in recent years, with some other suspected undescribed taxa, been regarded as part of the species complex around *H. riparia* (R.Br. ex DC.) Hoogl. (e.g. Harden and Everett 2000: p 302). Taxonomic work (H. Toelken, South Australian Herbarium, pers. comm.) is resolving this complex, and validates the taxonomic distinctiveness of *Hibbertia* sp. nov. 'Menai'. *H. stricta* R.Br. *sens. strict*. differs from the 'Menai' taxon in having a more prominent and proportionately wider midvein on the lower (abaxial) surface of the leaf, completely filling the space between the revolute leaf margins and often overtopping them, and in having branches, leaves and sepals with smaller multi-angulate reduced-stellate hairs, these usually simple or with two (very rarely three) very short arms, the hairs and arms, strongly antrorse to weakly spreading, and only weakly emergent from a basal tubercle (sometimes the arms scarcely or not emergent, and the leaf upper surface effectively hairless); the hairs are in almost all cases less densely distributed on the leaf surface than in the Menai taxon. *H. stricta sens. str.* occurs in more maritime situations, being known from the north shore of Port Jackson ('Quarantine Ground', JH Maiden, 1889), the eastern suburbs of Sydney, the Jervis Bay area, from north of Milton to Ulladulla, Snapper Point, and extending inland near Batemans Bay to near Currowan Creek. There are also disjunct single specimens apparently assignable to *H. stricta sens. str*. from the NSW far South Coast (Womboyn/Genoa River, MEL35941) and from

'Diamond Head' (E. Duncan 29 Apr. 1968, CBG 023942) - possibly the locality of that name on the mid-North Coast.

3. *Hibbertia* sp. nov. 'Menai' flowers from July to about December. It appears to propagate by seed, with no evidence to date of vegetative reproduction or regeneration. Its longevity, seed biology, and most aspects of its ecology are unknown, although in common with most species of *Hibbertia* it is probably pollinated primarily by bees. Recruitment appears to be continuing in at least one site in Menai that is very disturbed by road verge construction and maintenance (R.O. Makinson pers. comm.), with young plants flowering at an estimated two years of age and others at the site with an estimated age of 6-8 years.

4. *Hibbertia* sp. nov. 'Menai' is known to occur in two metapopulations, one in the southern outskirts of Sydney, and one near Nowra on the mid-South Coast of NSW. The *Southern Sydney metapopulation* occurs on both sides of the Woronora River gorge. A northern sub-population (96 plants known at 20 January 2006: L. Hedges, Menai Wildflower Group, pers. comm.) occurs in the Menai-Bangor area, and in the adjacent suburbs of Alfords Point (Mill Creek catchment) and Illawong (Still Creek catchment). The southern sub-population (c. 90 plants known at 20 Jan. 2006, L. Hedges pers. comm., M. Bradhurst pers. comm.) is in Maandowie Reserve, Loftus, a local government reserve. The *South Coast metapopulation* is less well known, but herbarium specimen records show it occurring just to the west and south-west of Nowra, with most of the six collections made prior to 1970.

5. Habitat of the *Southern Sydney metapopulation* is broadly dry sclerophyll forest and woodland. Dominant tree species at various sites include *Corymbia gummifera*, *Angophora costata*, *Eucalyptus resinifera*, *E. piperita* and *Allocasuarina littoralis*. Associated shrub and ground layer species recorded at various sites include *Acacia linifolia*, *Acacia myrtifolia*, *Acacia suaveolens*, *Actinotus helianthi*, *Actinotus minor*, *Astroloma* sp., *Banksia spinulosa*, *Bauera rubioides*, *Caustis flexuosa*, *Dodonaea triquetra*, *Gonocarpus* sp., *Grevillea sericea* subsp. *sericea*, *Grevillea buxifolia* subsp. *buxifolia*, *Grevillea mucronulata*, *Hardenbergia violacea*, *Lasiopetalum ferrugineum*, *Leptospermum* sp., *Lomandra longifolia*, *Platysace lanceolata* and *Xanthosia pilosa.* This metapopulation appears to occur mainly on upper slopes and above the Woronora River gorge escarpment, at or near the interface between the Lucas Heights soil landscape and Hawkesbury sandstone. Habitat of the *South Coast metapopulation* is poorly recorded, but appears to be dry sclerophyll forest or woodland associations in sandy soils over sandstone, with one record from gravelly clay soil.

6. The very recent recognition of *Hibbertia* sp. nov. 'Menai' as a distinct taxon makes difficult a reconstruction of past distribution and any decline, the few herbarium records being the only firm information source and these lacking much population data. However, scarcity of past collections suggests that the taxon has always been fairly uncommon and restricted in distribution. The scale of urban development in recent decades in both metapopulation areas, and the surviving occurrences in the Menai/Bangor area alongside recently constructed roadways and housing estates, suggests that there has been significant recent destruction of suitable habitat and a high probability of significant recent declines in both numbers of plants and areas of occupancy. Several of the surviving sites in the Menai/Bangor area are in small disturbed bushland remnants with very low numbers of plants, and are threatened by weeds, road verge maintenance work (potentially including weed spraying), trampling, changed fire regime, and changed drainage patterns. Tenures for these sites are yet to be fully determined but are apparently mainly a mix of Road Transport Authority and Council easements. Pressures operating on the Loftus sub-population (mostly or wholly in a Council reserve) are yet to be

evaluated. Similar urbanisation pressures may be operating on the South Coast metapopulation; most of the six confirmed collections were made close to the Nowra urban area before the major westward expansion of that town from the 1970s. Susceptibility of the species to pathogens is not known. The species is not confirmed as occurring in any conservation reserve; although one herbarium record for the South Coast metapopulation (I. Beeton 23 Aug. 1969, CBG 043381) gives a possibly erroneous location as 'Morton National Park'.

7. The Scientific Committee is of the opinion that *Hibbertia* sp. nov. 'Menai' is not eligible to be listed as a critically endangered species.

8. *Hibbertia* sp. nov. 'Menai' A.T. Fairley 15 Dec 2004 is eligible to be listed as an endangered species as, in the opinion of the Scientific Committee, it is facing a very high risk of extinction in New South Wales in the near future as determined in accordance with the following criteria as prescribed by the Threatened Species Conservation Regulation 2002:

Clause 15
The geographic distribution of the species is estimated or inferred to be:
(b) highly restricted
and:
(d) a projected or continuing decline is observed, estimated or inferred in:
(i) an index of abundance appropriate to the taxon, and
(ii) geographic distribution and habitat quality
(e) the following two conditions apply:
(i) the population or habitat is observed or inferred to be severely fragmented;
(ii) all or nearly all mature individuals are observed or inferred to occur within a small number of populations or locations

Clause 16
The estimated total number of mature individuals of the species is:
(b) low,
and:
(d) a projected or continuing decline is observed, estimated or inferred in:
(i) an index of abundance appropriate to the taxon, and
(ii) geographic distribution and habitat quality
(e) the following two conditions apply:

(i) the population or habitat is observed or inferred to be severely fragmented;
(ii) all or nearly all mature individuals are observed or inferred to occur within a small number of populations or locations

Professor Lesley Hughes
Chairperson
Scientific Committee
Proposed Gazettal date: 10/08/07
Exhibition period: 10/08/07 - 28/09/07

Reference:
Harden GJ and Everett J (2000) 28. Dilleniaceae. In 'Flora of New South Wales vol. 1', revised edition (ed. GJ Harden) (University of New South Wales Press: Sydney).

APPENDIX 2
***Unsuccessful Surveys for* Hibbertia *sp. nov. 'Menai'* in Sutherland**

LOCALITY **Site Location**	**Survey Date**	**GPS Location**[1]	**Notes** (threatened, rare or restricted plant species, other *Hibbertia* species)
LOFTUS-ENGADINE			
Kingswood Road reserve	12.11.09	0317986 6230985	*H.riparia; Leucopogon amplexicaulis.*
Marlee Road reserve	12.11.09	0318395 6231047	*Tetratheca neglecta.*
Kingswood Road (far east end)	12.11.09	0318790 6231267	-
Forbes Creek Reserve (west side)	12.11.09	0316577 6230408	-
Kelton Place (ridge north side)	12.11.09	0317006 6231437	*H.nitida, H. monogyna.*
Bundanoon Road (east side, south)	12..11.09	0317090 6231569	*H.riparia, H. monogyna; Melaleuca deanei* (3 clumps together), *Tetratheca neglecta.*
Bundanoon Road (east side, north)	12..11.09	0317162 6231652	*H.riparia, H. monogyna; Melaleuca deanei* (1 large plant), *Tetratheca neglecta*, *Eucalyptus squamosa.*
Warrangaree drive (north end)	12.11.09	0318626 6232918	*H. monogyna.*
BARDEN RIDGE-MENAI			
Above Angophora Place	04.12.09	0317653 6236525	*Hibbertia nitida*
Near Oval, Coachwood Road	04.12.09	0317499 6236910	-
Off Royal Oak Road	04.12.09	0316947 6236586	*Hibbertia nitida*
Off Lavender Drive	04.12.09	0317074 6236974	-
South west of Menai High School	04.12.09	0317353 6235720	-
End of Walsh Close	04.12.09	0318407 6235328	*Hibbertia monogyna, Tetratheca neglecta,*
Dulin Circuit	04.12.09	0317535 6233575	-
East end of Barden Road	04.12.09	0316878 6233330	-
Menai Conservation Park	04.11.09	0316782 6234831	*H.riparia*, *Tetratheca neglecta, Melaleuca deanei.* Half of reserve recently burnt; not all of remainder was searched.
Timbery Circuit (east side)	12.11.09	0315960 6233066	*H.riparia*; *Tetratheca neglecta.*
Ella Avenue (south side)	12.11.09	0315895 6232835	*Tetratheca neglecta*.
North of playing fields/golf course	12.11.09	0314950 6233262	*Tetratheca neglecta*, *Eucalyptus squamosa; H.nitida, H. monogyna.*

HEATHCOTE ROAD			
0.7 km west of Old Illawarra Road	12.11.09	0312119 6230361	*Acacia bynoeana*, *Eucalyptus squamosa; H.riparia.*
3.8 km west of Old Illawarra Road	12.11.09	0312359 6233076	*Eucalyptus squamosa.*
7.3 km west of Old Illawarra Road	12.11.09	0314799 6235676	*H. monogyna; Tetratheca neglecta*.
7.3 km west of Old Illawarra Road	12.11.09	0315142 6235739	*Eucalyptus squamosa.*

1. GPS given in WGS84 co-ordinates.

Appendix E – Eco Logical Australia, North Nowra Link Road – Revocation and Offsets Assessment

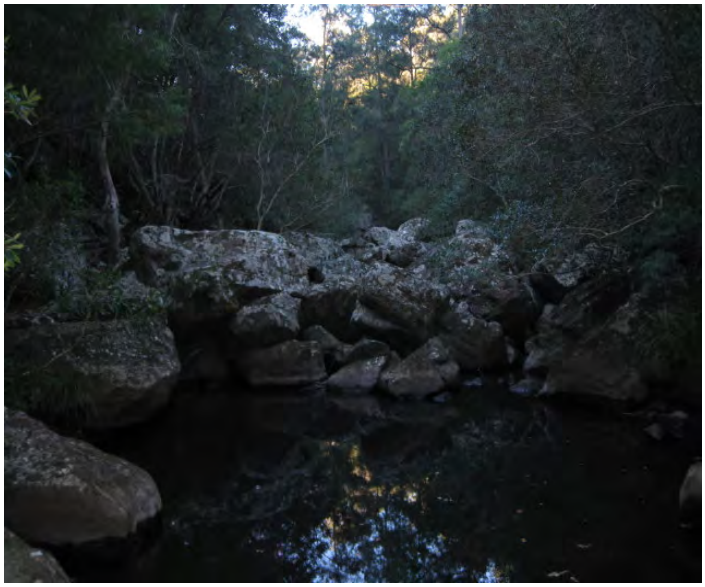
NORTH NOWRA LINK ROAD

Revocation & Offsets Assessment

Prepared for
Shoalhaven City Council

June 2010



NORTH NOWRA LINK ROAD

REVOCATION & OFFSETS ASSESSMENT

PREPARED FOR	**Shoalhaven City Council**
PROJECT NO	**10CANFED-0011**
DATE	**June 2010**

DOCUMENT TRACKING

ITEM	DETAIL
Project Name	North Nowra Link Road – Revocation and Offsets Assessment
Project Number	10CANFED - 0011
File location	Canberra 10CANFED - 0011
Prepared by	DF
Approved by	Tom Kaveney
Status	FINAL
Version Number	4.0
Last saved on	22 June 2010

ACKNOWLEDGEMENTS

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Contents

List of Figures

List of Tables

1 Introduction

Eco Logical Australia Pty Ltd (ELA) was engaged by Shoalhaven City Council to prepare a "*Revocation and Biodiversity Offsets Report*" (this report) for the proposed North Nowra Link Road. The North Nowra Link Road is proposed to connect Pitt Street to Nerang Road to alleviate traffic congestion in the north Nowra / Bomaderry area (Central Route Option). The proposed link road will traverse parts of Bomaderry Creek Regional Park which is reserved under the *National Parks and Wildlife Act 1974* (NPW Act). In order for the road to traverse through the Park a small area of the Park land will need to be revoked from the Park under the NPW Act.

To compensate for the revocation of land, Shoalhaven City Council has committed to providing 50 hectares of adjacent land for inclusion into the Bomaderry Creek Regional Park.

This report will help inform an application for revocation of land from the Regional Park for the construction of the North Nowra Link Road. This report will also help inform the environmental assessment of the road proposal under Part 3A of the NSW *Environment Planning and Assessment Act 1979* (EP&A Act) and Part 9 of the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). To help inform these processes a comprehensive assessment of the biodiversity values of the proposed 50 hectare compensatory land has been undertaken, including an analysis of the flora and fauna conservation benefits associated with the inclusion of the land within the Bomaderry Creek Regional Park and how environmental protection will positively add to the biodiversity values of the Bomaderry Creek region.

1.1 BACKGROUND

Shoalhaven City Council is proposing the construction of a new link road ('North Nowra Link Road') to alleviate significant traffic congestion in the North Nowra/Bomaderry area. The proposed road is part of the strategic planning of the Shoalhaven City Council for Nowra City. The proposed North Nowra Link Road is a single lane, two way road. The road reserve corridor will be 30 metres wide for the majority of its length, narrowing to 20 metres wide in areas of ecological significance where required.

The compensatory 50 ha conservation offset land currently owned by Shoalhaven City Council will be dedicated to DECCW and included within Bomaderry Creek Regional Park. The offset land will expand the current regional park from 82 hectares to 132 hectares, an increase of 61 per cent.

The Bomaderry Creek Regional Park has high biodiversity values and contains suitable habitat for a number of threatened flora and fauna species. In particular, the proposed link road may impact two threatened species, *Zieria baeuerlenii* (Bomaderry Zieria) and *Eucalyptus langleyi* (Albatross Mallee), of which the regional park provides critical habitat. The dedication of 50 hectares of Council land to the regional park so that the whole area can be managed by DECCW is aimed at achieving conservation protection and management of significant ecological areas and threatened species.

1.2 REVOCATION OF LAND POLICY

The revocation of lands reserved or dedicated under the NPW Act is required in this instance as the proposed development is a non-permissible activity within the NPWS owned land of Bomaderry Creek Regional Park. Under the NPWS Revocation of Land Policy (2002) the Minister must be satisfied that proposed compensatory land is of equal or greater conservation value both in terms of natural and cultural heritage than the land that is proposed to be revoked. In particular, where NPWS seeks compensation several factors need consideration when negotiating compensation, these include:

a) Compensatory land should be of greater size than the area of land being revoked;
b) It is desirable to match the area, type and quality of habitat, and cultural heritage on land being revoked with the area of land proposed as compensation where possible;
c) It is desirable that land to be transferred as compensation is close to the area being revoked and is adjacent to the relevant reserve; and
d) Information gathered on lands to be revoked and on proposed compensatory land should include:
    a. Biodiversity: e.g. species present, including populations and community presence, and habitat types.
    b. An assessment of habitat quality, habitat connectivity, and adjoining habitat uses.
    c. The home range and territories of target species.
    d. Rarity of species.
    e. Landform; and cultural heritage values.

1.3 OFFSET LAND

The offset land for the proposed North Nowra Link Road is immediately adjacent to the Bomaderry Creek Regional Park. The land is located in the North Nowra and Bomaderry region of the Shoalhaven Local Government Area. The proposed offset land is located on the northern side of the Shoalhaven River and to the west of the Princes Highway and is intersected by Bomaderry Creek, which runs from the north to the south-east of the offset land. The offset land occurs within three parcels, of 4 hectares, 18 hectares and 28 hectares, and is located to the north, east and south of the Bomaderry Creek Regional Park. The offset land is located on both sides of the Bomaderry Creek gorge and includes a substantial length of the gorge.

Figure 1 shows the location of the offset land. The offset land has been broken down into 10 separate land parcels to aid assessment and evaluation of the offset land values.

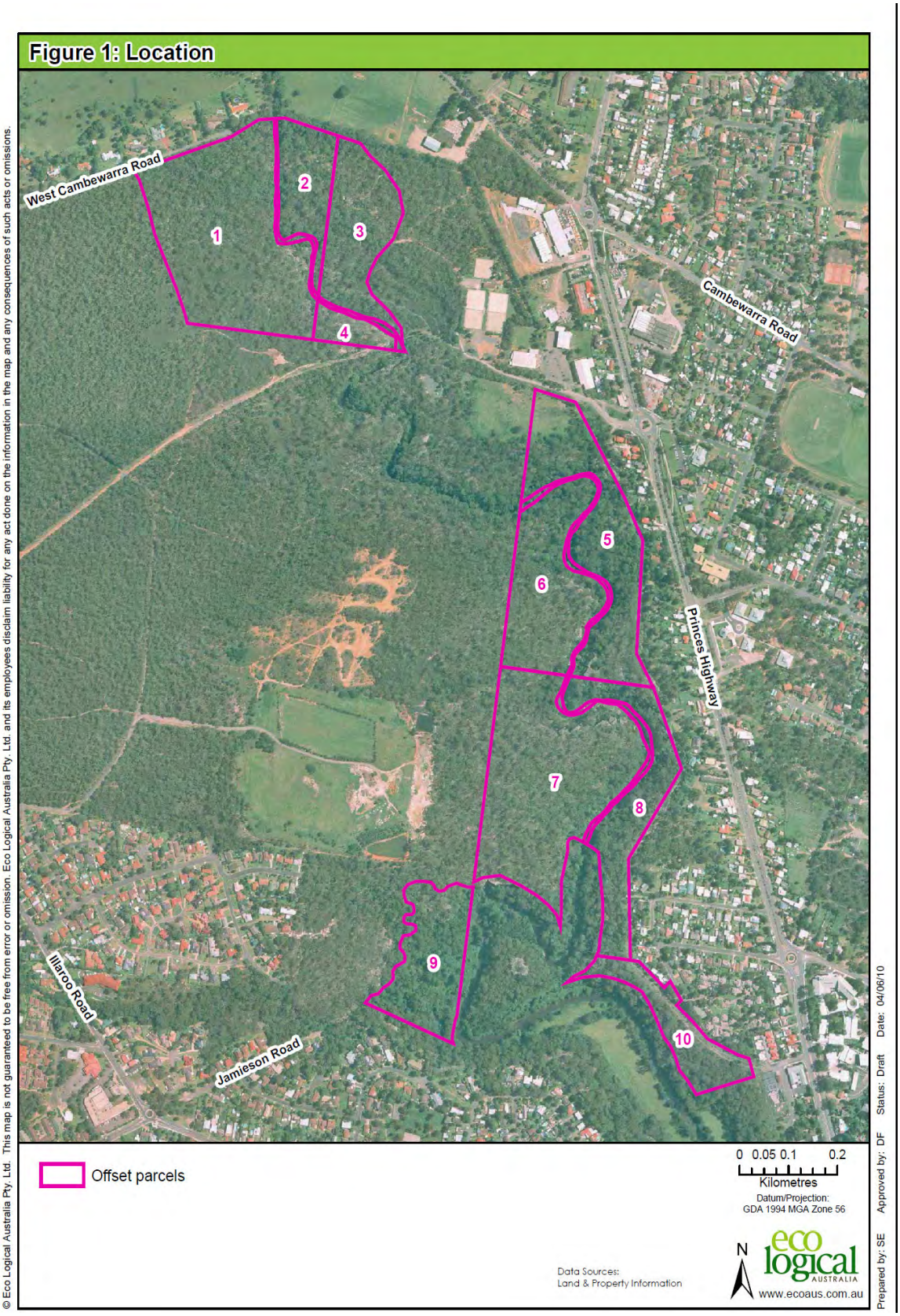

Figure 1: Location of offset land and individual offset parcels

2 Methods

2.1 DATA AND LITERATURE REVIEW

A review of relevant information was undertaken prior to the commencement of field studies. Databases and other sources were interrogated to generate a list of species and vegetation communities that have been recorded within and nearby the offset land and included:

a) reviewing available literature including relevant flora and fauna studies, topographic maps, aerial photographs and site plans;

b) searching the Atlas of NSW Wildlife for records of threatened flora and threatened fauna species in the offset land; and

c) using the Commonwealth Protected Matters Search Tool to search for records of matters of national environmental significance in the offset land.

The data gathered during the field studies and from the review of literature was analysed and interpreted to facilitate the biodiversity assessment of the proposed 50 ha offset area.

2.2 FIELD SURVEYS

A 2-day field survey was undertaken in May 2010 across the proposed offset land. A random meander flora survey was undertaken across the offset land to document the vegetation communities and broadly verify the type, location and extent of vegetation communities present. The vegetation communities observed were compared with existing mapping and vegetation community descriptions documented by KMA (1998). Where possible, the offset land was surveyed in reference to offset parcel boundaries and observations of the vegetation condition and extent of disturbances were noted. Disturbances of weed invasion, erosion, clearing, presence of access tracks, infrastructure, run-off, and proximity of development were noted.

The vegetation quality within the offset area was assigned a condition rating of low, moderate, or high and was based on the rating definitions outlined in Table 1.

Table 1: Vegetation quality ratings

Condition Rating	Description
Low	The vegetation consists only of exotic species, has been substantially modified from its original state, or has been extensively cleared, and provides little or no fauna habitat.
Moderate	A high proportion of native species and native cover persist in the canopy stratum, but the understorey vegetation consists of both native and exotic species. Some fauna habitat is available.
High	The vegetation comprises a high level of floristic and structural diversity and has significance as fauna habitat, especially threatened species. The community supports some old growth forest characteristics.

2.3 HABITAT ANALYSIS

A survey of threatened species habitat was undertaken during the field survey. Observations were conducted for habitats or resources of relevance for those threatened flora and fauna species known from the general region or species which might be anticipated to occur given the vegetation communities and habitats present. The habitat analysis was undertaken to prepare an inventory of threatened species with potential to occur within each offset parcel. Observations of the following resources were recorded:

- presence and density of hollow-bearing trees
- potential feed trees
- foraging resources such as high nectar producing plants
- rocky outcrops
- areas of shallow soils over sandstone
- moss covered sandstone
- cliff faces (caves / crevices) and plateaus
- dense riparian vegetation
- swampy / boggy areas
- heathy understorey sheltering resources

3 Results

3.1 VEGETATION COMMUNITIES

The vegetation communities occurring in the offset land are summarised below, in Table 2, followed by a brief and general description of each community. The vegetation communities were verified in the field against existing floristic mapping (KMA 1998). For this assessment, the floristic mapping adequately depicts the general boundaries of the vegetation communities observed within the offset land; however, ecotonal transitions between vegetation communities occur within the offset land and are not mapped. Specifically, there appears to be some overlap between Scribbly Gum – Red Bloodwood Woodland and Grey Gum – Stringybark Forest / Woodland, primarily within offset parcel 1.

Figure 2 shows the occurrence of vegetation communities within the offset land, as mapped by KMA (1998).

Table 2: Plant Communities occurring in the offset land

Community	Dominant Species	Occurrence
Coachwood / Ironwood Warm Temperate Rainforest	*Ceratopetalum apetalum* *Backhousia myrtifolia*	In the base of the gorge, along the banks of the creek.
Spotted Gum – Blackbutt Forest	*Corymbia maculata* *Eucalyptus pilularis*	On the upper slopes of the gorge.
Grey Gum – Stringybark Forest / Woodland	*Eucalyptus punctata* *Eucalyptus agglomerata*	On the plateau and on gentle slopes above the gorge, usually on rocky ground.
Scribbly Gum – Bloodwood Woodland	*Eucalyptus sclerophylla* *Corymbia gummifera* *Eucalyptus consideniana*	On the plateau.
Kunzea Shrubland	*Kunzea ambigua* *Leptospermum sejunctum*	On the plateau on broad rock outcrops
Sandstone Sedgeland	*Melaleuca thymifolia* *Viminaria juncea* Leptospermum spp.	On the plateau, on shallow, moist soils covering broad areas of bedrock.

Coachwood / Ironwood Warm Temperate Rainforest

Coachwood / Ironwood Warm Temperate Rainforest occurs on deep, moist and partial alluvial soils in the gorge of Bomaderry Creek or along associated gullies. A dense canopy and sub-canopy over an open understorey typifies this vegetation community.

Spotted Gum – Blackbutt Forest

Spotted Gum – Blackbutt Forest occurs on deep, moist soil below the cliff of Bomaderry Creek, but it can be recorded above the cliff line in a few places. Above the cliff line, this community exhibits a

shorter canopy stratum and a healthier understorey typical of drier soils. Turpentine is often an associated species within the sub-canopy of this community.

Grey Gum – Stringybark Forest / Woodland

Grey Gum – Stringybark Forest / Woodland occurs on the rocky eastern and western edges of the Bomaderry Creek gorge. It is the most prevalent vegetation community within the offset area. At times, Scribbly Gum, Red Bloodwood, and to a lesser extent Black Sheoak, are recorded within the canopy stratum of this vegetation community. *Banksia, Acacia, Kunzea, Leptospermum,* and *Hakea* generally comprise the heathy understorey of this community.

Scribbly Gum – Bloodwood Woodland

Scribbly Gum – Bloodwood Woodland is located only within offset parcel 1. This community is most prevalent across the plateau further west of Bomaderry Creek outside the offset land. Black Sheoak is often an associated species within the sub-canopy of this community. *Banksia, Acacia, Kunzea, Leptospermum* and *Hakea* generally comprise the heathy understorey of this community.

Kunzea Shrubland

Kunzea Shrubland is not as prevalent as other forest vegetation communities within the offset land and generally occurs within the western side of Bomaderry Creekline. The vegetation community is found within the Grey Gum – Stringybark Forest/Woodland, as discrete patches on rock outcrops.

Sandstone Sedgeland

Sedgeland occurs occasionally on the plateau, on poorly drained sites with shallow soils over the sandstone bedrock. This community occurs within offset parcel 1 where broad sandstone surfaces are close to the surface.

3.1 THREATENED FLORA / FAUNA SPECIES

Species from the EPBC Protected Matters Search Tool and Atlas of NSW Wildlife databases, as well as records from previous studies were combined to produce a list of national and state threatened species that may possibly occur within the offset land (see Table 3 and Table 4).

A total of 22 listed threatened species, three migratory species and one conservation significant species were identified from the searches or literature review. Thirteen of these species are known to occur within the offset land. The other 13 species have the potential to occur within the offset land based on their known habitat preferences and the habitats available within the offset parcels. Habitat descriptions, distribution, and home ranges (if known) of these species are provided in the below tables.

Figure 3 identifies known threatened flora locations and Figure 4 identifies known threatened fauna locations.

Table 3: Threatened or conservation significant flora species known or with the potential to occur in the offset land

Scientific Name	EPBC Act	TSC Act	Habitat	Distribution	Likelihood within Offset Area
Cryptostylis hunteriana Leafless Tongue Orchid	V	V	This orchid is known from a range of vegetation communities including swamp-heath and woodland. The larger populations typically occur in woodland dominated by Scribbly Gum, Silvertop Ash, Red Bloodwood and Black Sheoak; where it appears to prefer open areas in the understorey of this community.	The Leafless Tongue Orchid has been recorded from as far north as Gibraltar Range National Park south into Victoria around the coast as far as Orbost. It is known historically from a number of localities on the NSW south coast and has been observed in recent years at many sites between Batemans Bay and Nowra (although it is uncommon at all sites). Also recorded at Nelson Bay, Wyee, Washpool National Park, Ku-Ring-Gai Chase National Park, Ben Boyd National Park.	Potential – suitable habitat available
Eucalyptus langleyi Albatross Mallee	V	V*	This species occurs within poor sandy sites and in mallee shrubland on poorly-drained, shallow, sandy soils on sandstone	The main occurrence of the Albatross Mallee is to the south-west of Nowra as far as Yarramunmun Creek. It is also found to a limited extent north of the Shoalhaven River in the vicinity of Bomaderry Creek.	Known in offset area
Genoplesium baueri Bauer's Midge Orchid	-	V	The Bauer's Midge orchid is a terrestrial orchid that grows to approximately 6-15cm in height. The species grows in sparse sclerophyll forest and moss gardens over sandstone.	The species has been recorded from locations between Ulladulla and Port Stephens. Surveys undertaken by NSW Parks and Wildlife in February 2010, within the Bomaderry Creek Regional Park recorded 7 clusters containing 14 individual specimens within the vicinity of the central route corridor.	Potential - known in Bomaderry Creek Regional Park
Triplarina nowraensis Nowra Heath Myrtle	E	E	Nowra Heath Myrtle occurs on poorly drained, gently sloping sandstone shelves or along creek lines underlain by Nowra Sandstone. The sites are often either treeless or have a very open tree canopy due to the impeded drainage.	There are five known populations of Nowra Heath Myrtle. Three of these form a cluster to the immediate west of Nowra. A fourth, much smaller population is found 18km south-west of Nowra in the Boolijong Creek Valley. The fifth population is located north of the Shoalhaven River on the plateau above Bundanoon.	Potential – suitable habitat available
Zieria baeuerlenii Bomaderry Zieria	E	E	*Zieria baeuerlenii* most often occurs in dry sclerophyll forest and woodland but is also found in low scrub associations. Common associated forest and woodland species are *Eucalyptus punctata, E. agglomerata*, *Corymbia gummifera* and *C. maculata* and *Syncarpia glomulifera* with a shrub understory including *Kunzea ambigua*, Bomaderry Zieria is also found with *Kunzea ambigua* dry scrub and on exposed rocky sites with *Leptospermum sejunctum.* The species is growing on well-drained, skeletal, grey, sandy loam soils, derived from Nowra Sandstone.	*Zieria baeuerlenii* occurs in only one location north-west of Nowra. The population occurs in a total of 57 colonies in six discrete clusters. These clusters are confined within a 0.5 km x 1.0 km area of the bushland, and are found on both sides of Bomaderry Creek	Known in offset area
Conservation Significant Species					
Acacia subtilinervis	-	-	Heath, woodland and forest on shallow soils over sandstone.	From the NSW central coast south to the Upper Snowy River in Victoria.	
Leptospermum sejunctum	-	-	This species grows in dry sclerophyll forest on shallow sandy soil over sandstone.	This species is confined to the Nowra district, but not uncommon to this area.	Known in offset area

* The NSW Scientific Committee, established by the Threatened Species Conservation Act 1995 (TSC Act), has made a Preliminary Determination to support a proposal to list a population of the tree *Eucalyptus Langleyi*, north of the Shoalhaven river in the Shoalhaven local government area as an Endangered Population in Part 2 of Schedule 1 of the TSC Act.

Table 4: Threatened fauna species known or with the potential to occur in the offset land

Scientific Name	EPBC Act	TSC Act	Habitat	Distribution	Likelihood within Offset Area
Amphibians					
Heleioporus australiacus Giant Burrowing Frog	V	V	This species forages in woodlands, wet heath, dry and wet sclerophyll forest and is associated with semi-permanent to ephemeral sand or rock based streams where the soil is soft and sandy so that burrows can be constructed	The Giant Burrowing Frog is distributed in south eastern NSW and Victoria, and appears to exist as two distinct populations: a northern population largely confined to the sandstone geology of the Sydney Basin and extending as far south as Ulladulla, and a southern population occurring from north of Narooma through to Walhalla, Victoria.	Record in offset area*
Diurnal Birds					
Callocephalon fimbriatum Gang-gang Cockatoo	-	V	During summer, the species utilises dense, tall, wet forests of mountains and gullies and alpine woodlands. In winter they occur at lower altitudes in drier more open forests and woodlands, particularly box-ironbark assemblages. They sometimes inhabit woodland, farms and suburbs in autumn/winter.	The Gang-gang Cockatoo is distributed from southern Victoria through south- and central-eastern New South Wales. In New South Wales, the Gang-gang Cockatoo is distributed from the south-east coast to the Hunter region, and inland to the Central Tablelands and south-west slopes. It occurs regularly in the Australian Capital Territory. It is rare at the extremities of its range, with isolated records known from as far north as Coffs Harbour and as far west as Mudgee.	Known in offset area
Calyptorhynchus lathami Glossy Black-Cockatoo	-	V	This Cockatoo is associated with a variety of forest types containing Allocasuarina species, usually reflecting the poor nutrient status of underlying soils. Intact drier forest types with less rugged landscapes are preferred.	The species is uncommon although widespread throughout suitable forest and woodland habitats, from the central Queensland coast to East Gippsland in Victoria, and inland to the southern tablelands and central western plains of NSW, with a small population in the Riverina. An isolated population exists on Kangaroo Island, South Australia.	Known in offset area
Lophoictinia isura Square-tailed Kite	-	V	In coastal areas, this species is associated with tropical and temperate forests and woodlands on fertile soils with an abundance of passerine birds. It can be recorded inland along timbered watercourses In NSW it is commonly associated with ridge or gully forests dominated by Woollybutt (*Eucalyptus logifloria*), Spotted Gum (*E. maculata*), or Peppermint Gum (*E. elata, E. smithii*).	The Square-tailed Kite ranges along coastal and subcoastal areas from south-western to northern Australia, Queensland, NSW and Victoria. In NSW, scattered records of the species throughout the state indicate that the species is a regular resident in the north, north-east and along the major west-flowing river systems. It is a summer breeding migrant to the south-east, including the NSW south coast.	Known in offset area
Nocturnal Birds					
Ninox strenua Powerful Owl	-	V	Powerful Owls are associated with a wide range of wet and dry forest types with a high density of prey, such as arboreal mammals, large birds and flying foxes. Large trees with hollows at least 0.5m deep are required for shelter and breeding.	The Powerful Owl is endemic to eastern and south-eastern Australia, mainly on the coastal side of the Great Dividing Range from Mackay to south-western Victoria. In NSW, it is widely distributed throughout the eastern forests from the coast inland to tablelands, with scattered, mostly historical records on the	Known in offset area

Scientific Name	EPBC Act	TSC Act	Habitat	Distribution	Likelihood within Offset Area
				western slopes and plains. The species is now uncommon throughout its range where it occurs at low densities. The species has a home range of 400-1450 ha.	
Tyto novaehollandiae Masked Owl	-	V	The Masked Owl is associated with forest with sparse, open, understorey, typically dry sclerophyll forest and woodland and especially the ecotone between wet and dry forest, and non forest habitat. It is known to utilise forest margins and isolated stands of trees within agricultural land and heavily disturbed forest where its prey of small and medium sized mammals can be readily obtained.	The species extends from the coast where it is most abundant to the western plains. Overall records for this species fall within approximately 90% of NSW, excluding the most arid north-western corner. There is no seasonal variation in its distribution The species has a home range of 500 - 1000 ha.	Known in offset area
Tyto tenebricosa Sooty Owl	-	V	Sooty Owls are associated with tall wet old growth forest on fertile soil with a dense understorey and emergent tall Eucalyptus species. Pairs roost in the daytime amongst dense vegetation, in tree hollows and sometimes in caves. The Sooty Owl is typically associated with an abundant and diverse supply of prey items and a selection of large tree hollows.	The species occupies the easternmost one-eighth of NSW, occurring on the coast, coastal escarpment and eastern tablelands. There is no seasonal variation in its distribution.	Known in offset area
Mammals (excluding bats)					
Dasyurus maculates Spotted-tailed Quoll	E	V	The Spotted-tailed Quoll inhabits a range of forest communities including wet and dry sclerophyll forests, coastal heathlands and rainforests, more frequently recorded near the ecotones of closed and open forest. This species requires habitat features such as maternal den sites, an abundance of food (birds and small mammals) and large areas of relatively intact vegetation to forage in.	The Spotted-tailed Quoll is now found on the east coast of NSW, Tasmania, eastern Victoria and north-eastern Queensland. Only in Tasmania is it still considered common. The species has a home range of up to 750 ha for females and 3500 ha for males.	Potential – suitable habitat available
Petaurus australis Yellow-bellied Glider	-	V	This species is restricted to tall mature forests, preferring productive tall open sclerophyll forests with a mosaic of tree species including some that flower in winter. Large hollows within mature trees are required for shelter, nesting and breeding.	The Yellow-bellied Glider is found along the eastern coast to the western slopes of the Great Dividing Range, from southern Queensland to Victoria. The species has a home range from 30 to 65 ha.	Known in offset area
Mammals (bats)					
Chalinolobus dwyeri Large-eared Pied Bat	V	V	The Large-eared Pied Bat has been recorded in a variety of habitats, including dry sclerophyll forests, woodland, sub-alpine woodland, edges of rainforests and wet sclerophyll forests. This species roosts in caves, rock overhangs and disused mine shafts and as such is usually associated with rock outcrops and cliff faces.	This species is found mainly in areas with extensive cliffs and caves, from Rockhampton in Queensland south to Bungonia in the NSW Southern Highlands. It is generally rare with a very patchy distribution in NSW.	Potential – suitable habitat available

Scientific Name	EPBC Act	TSC Act	Habitat	Distribution	Likelihood within Offset Area
Myotis macropus Large-footed Myotis	-	V	This bat roosts predominantly in caves but will also use tree hollows and man-made structures and is associated with a wide range of habitats as long as water is nearby.	The Large-footed Myotis is found in the coastal band from the north-west of Australia, across the top-end and south to western Victoria. It is rarely found more than 100 km inland, except along major rivers.	Known in offset area
Pteropus poliocephalus Grey-headed Flying-Fox	V	V	The Grey-headed Flying-fox inhabits a wide range of habitats including rainforest, mangroves, and paperbark forests. Camps are often located in gullies, typically close to water, in vegetation with a dense canopy.	Grey-headed Flying-foxes are found within 200 km of the eastern coast of Australia, from Bundaberg in Queensland to Melbourne in Victoria. This species is known to travel long distances (ie generally within 20 km but sometimes 50 km) between roosts and foraging areas.	Known in offset area

* There is a record in 1992 of a possible audible observation of the Giant Burrowing Frog

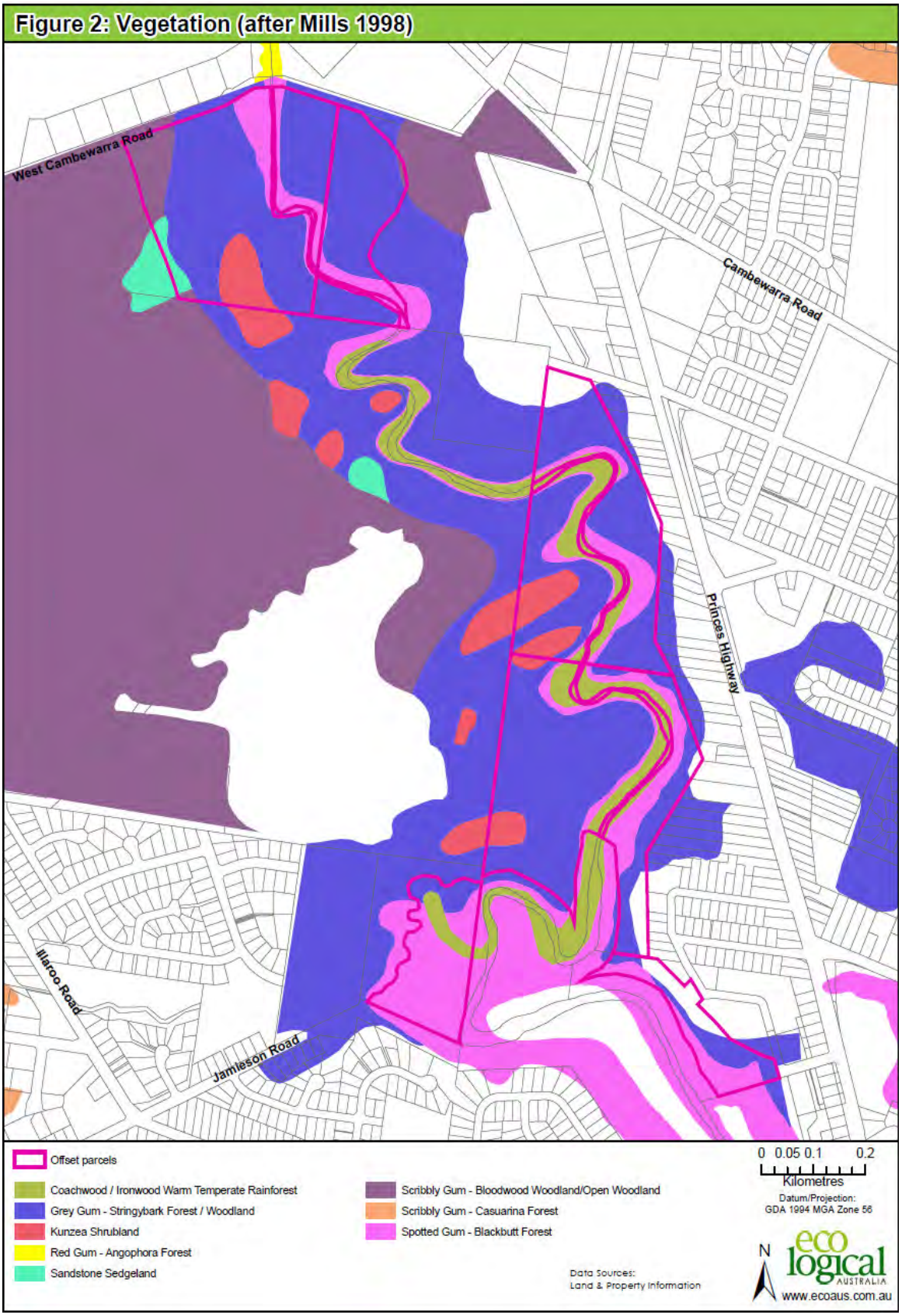

Figure 2: Vegetation communities within the offset land, as mapped by KMA (1998)

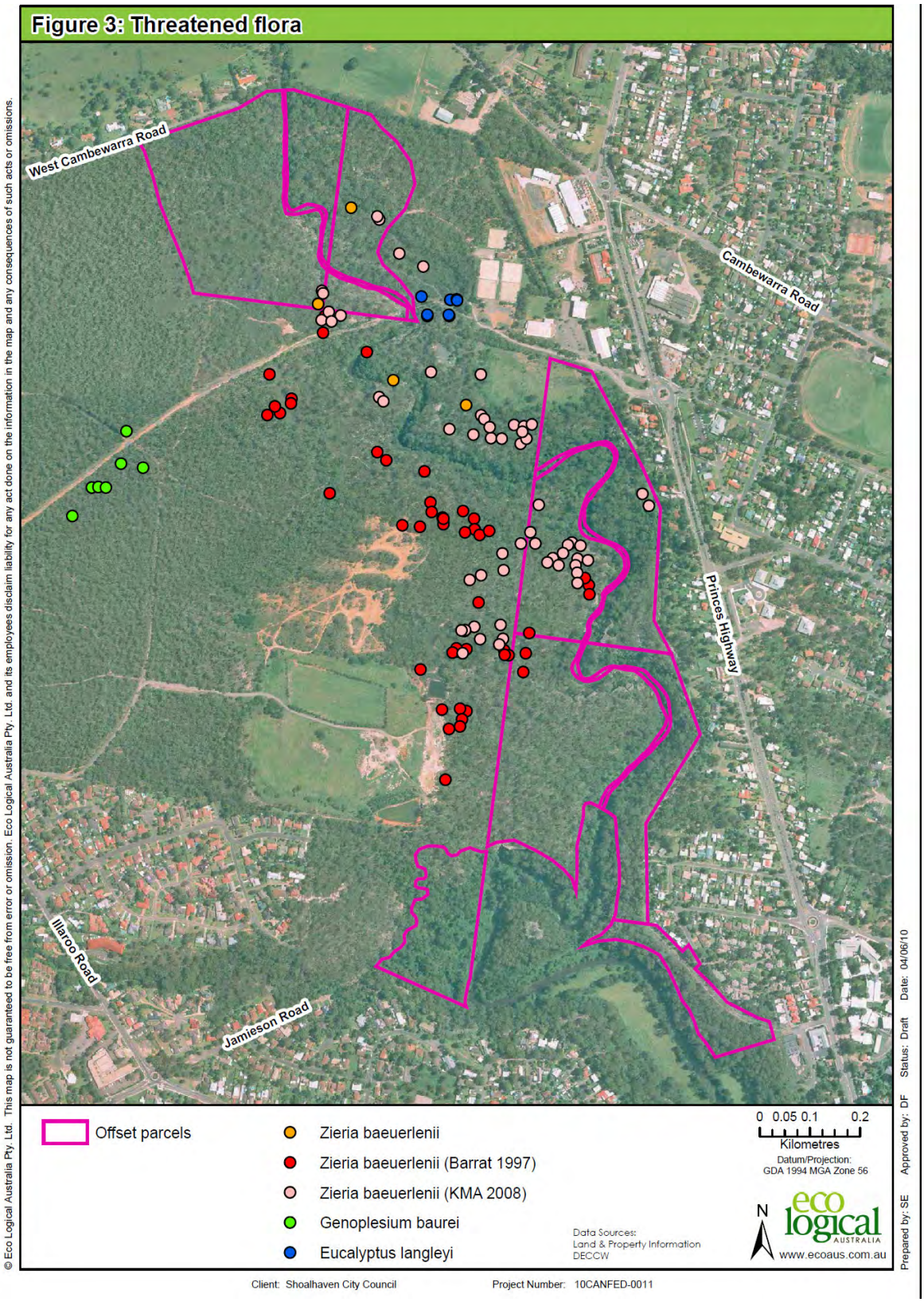

Figure 3: Known threatened flora locations

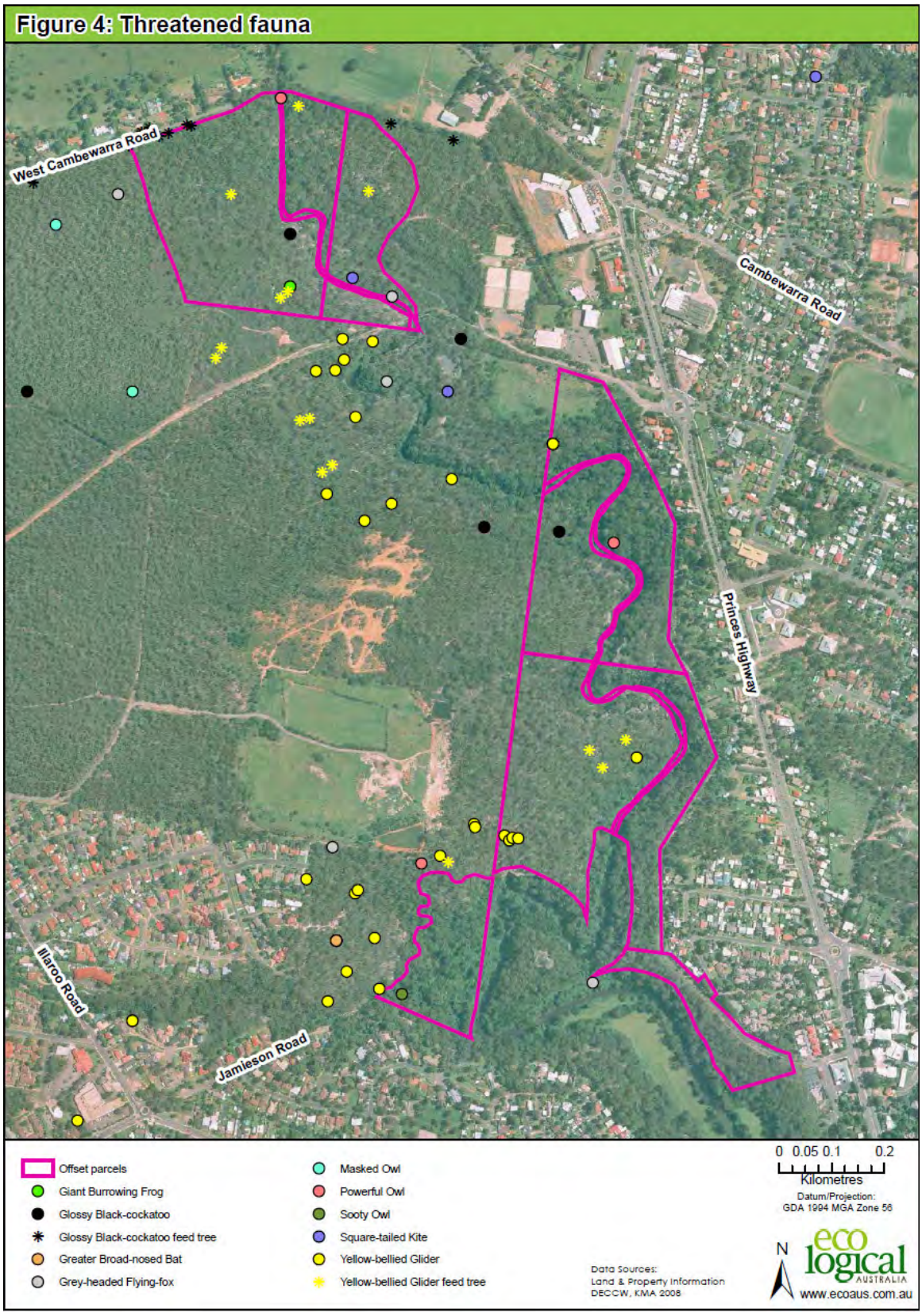

Figure 4: Known threatened fauna locations

3.2 IDENTIFIED FLORA / FAUNA HABITATS WITHIN OFFSET AREA

Several flora and fauna habitats were identified within the offset land. Table 4 identifies the habitat identified and species which are associated with the habitat type. Section 5 further details the habitat types observed within each offset parcel.

Table 4: Flora and fauna habitats within the offset land

HABITAT TYPE	DESCRIPTION	ASSOCIATED FLORA / FAUNA SPECIES
Bomaderry Creek (parts of Bomaderry Creek pass through deep gorges)	Bomaderry Creek falls within most offset parcels, except for offset parcels 9 and 10. The creek flows in a north-south trajectory and is a tributary to the Shoalhaven River.	Yellow-bellied Gliders, Powerful Owl, Sooty Owl, Grey-headed Flying-fox, Large-footed Myotis (known); Masked Owl, Nowra Heath Myrtle (potential)
Cliff faces (caves / rock crevices)	Cliff faces line the edge of gullies and Bomaderry Creek.	Microchiropteran bats, large forest owls, Spotted-tailed Quoll, Rosenberg's Goanna (potential)
Rocky outcrops (supporting sandy soils)	Associated with the plateau above Bomaderry Creek.	Bomaderry Ziera, *Acacia subtilinervis, Leptospermum sejunctum* (known); Rosenberg's Goanna (potential)
Sandstone with shallow sandy soils	Associated with the plateau above Bomaderry Creek.	*Acacia subtilinervis, Leptospermum sejunctum,* Albatross Mallee (known); Bauer's Midge Orchid, Leafless Tongue Orchid, Nowra Heath Myrtle (potential)
Swampy / boggy areas	Depressions within drainage lines and sandstone outcrops. Associated with the plateau above Bomaderry Creek.	Giant Burrowing Frog (potential)
Feed trees • Grey Gum • Spotted Gum • Red Bloodwood • Black Sheoak	Feed trees are scattered throughout vegetation communities.	Yellow-bellied Glider, Grey-headed Flying-fox, Glossy Black-cockatoo (known)
Hollow-bearing Trees	Hollow-bearing trees are scattered throughout vegetation communities. Larger hollows were generally found in mature trees nearby Bomaderry Creek.	Yellow-bellied Glider, Powerful Owl, Masked Owl, Sooty Owl, Gang-gang Cockatoo, Glossy Black-cockatoo, Microchiropteran Bats.
Dense riparian vegetation	Found along Bomaderry Creek and gullies.	Powerful Owl, Sooty Owl, Large-footed Myotis (known); Masked Owl (potential)
Heathy understorey (nectar producing shrubs)	Generally found within Grey Gum – Stringybark Forest / Woodland and is associated with shallow sandy soils on top of the plateau above Bomaderry Creek.	Leafless Tongue Orchid, Nowra Heath Myrtle (potential)
Moss over sandstone	Associated with shallow sandy soils on top of the plateau above Bomaderry Creek.	Spring Tiny Orchid, Bauer's Midge Orchid (potential)

4 Biodiversity Assessment

4.1 VEGETATION QUALITY

The quality of the vegetation communities within the offset land ranges from low to high, with much of the area being of high quality. Offset parcels 1, 2, 3, 4, 6, and 7 were generally rated as high quality, despite some insignificant disturbances associated with walking and vehicle tracks, the weir, and minor weed invasion. These offset parcels commonly supported undisturbed forest or woodland which provide significant habitat for flora and fauna, including threatened species. In areas of high quality, a mosaic of tree ages were recorded and the floristic and structural components of the vegetation communities were representative of undisturbed forest, with some old growth characteristics observed (i.e. large hollow-bearing trees).

Most of the vegetation within offset parcels 5 and 8 was also rated as high quality, however the presence of exotic species was more notable in some areas of these parcels. Weed disturbances were associated with edge effect and were predominantly confined along boundary edges nearby residential homes or cleared areas. Generally, the vegetation quality away from the offset boundaries and nearby Bomaderry Creek supported high quality vegetation in which large hollow-bearing trees and dense sub-canopy vegetation provides important habitat for fauna. Very little evidence of weed invasion was observed in these areas.

Offset parcels 9 and 10 were considered more disturbed compared to other offset parcels. In particular, much of the understorey within offset parcel 9 was invaded by weeds especially nearby creeklines and gullies. The eastern edge of offset parcel 10 is low in quality and has been cleared for a powerline easement. The close proximity of residential homes has contributed to disturbances of weed invasion through garden escapes, trampling through increased foot traffic and rubbish dumping. The neighbouring land surrounding offset parcels 9 and 10 is substantially disturbed in places and appears to influence the disturbance levels observed in these areas. However, despite disturbances within the understorey and ground layer stratums, the canopy in these parcels is characteristic of other areas within the offset land in which a mosaic of tree ages were observed including large hollow-bearing trees.

Figure 5 displays the vegetation quality observed across the offset land.

4.2 ADJOINING LANDUSES AND DISTURBANCES

Adjoining Landuses

Bomaderry Creek Regional Park was established under the *National Parks and Wildlife Act 1974* and is managed by the South Coast Region of the National Parks and Wildlife Service of NSW. The park currently covers an area of 82 hectares. The proposed offset land abuts the park to the north, east and south. The Bomaderry Creek Regional Park has high biodiversity values and supports known habitat for a number of threatened flora and fauna species.

Urban development associated with Nowra and Bomaderry townships surround both Bomaderry Creek Regional Park and the offset land. Primarily, the offset land is neighboured by residential development to the east nearby Princes Highway, to the north nearby West Cambewarra Road, and to the south nearby Illaroo Road. Parts of the lots offered for conservation offset are zoned residential. Council intends rezoning all lands to be dedicated to Environmental Protection Zone and be gazetted as DECCW tenure (ELA 2010).

Land to the west of the offset land at parcels 1-4 is owned and managed by the Shoalhaven City Council and includes cleared areas, stockpile sites and native vegetation.

Disturbances

Disturbances of weed invasion, vehicle tracks, walking tracks, dumped rubbish, powerline easements, urban development, clearing, evidence of rock-climbing and minor erosion were observed within or nearby the offset land (Figure 5).

The density and extent of weed invasion varied in relation to proximity to nearby disturbance. Weed invasion was most prevalent at the interface of offset parcel boundaries and urban development or nearby some creeklines and swampy areas. In particular, weeds were noted within the understorey of offset parcel 9, the most northern tip of offset parcel 5 and the eastern boundary of offset parcels 5, 8, and 10. The presence of a powerline easement and residential homes compromise the eastern edge of offset parcels 5, 8, and 10. Garden escapes from neighbouring residential properties were observed more commonly along this eastern boundary compared to other parts of the offset land. In general, weeds were generally confined to the fringe of clearings and did not penetrate the native forest beyond its outer edge, except for offset parcel 9 in which weeds were prevalent within much of the understorey,

The understorey of offset parcel 9 was substantially disturbed by weeds within its southern half. The weeds were associated with damp and wet areas of creeklines and swampy areas. Weeds were scattered within the northern half of the parcel but did not dominate the understorey in this area.

Vehicle tracks were noted along the powerline easement and within offset parcels 2, 3, and 4. Vehicle tracks are most notable within offset parcel 3, however they were confined to a concentrated area where other small disturbances were observed in the nearby vicinity (i.e. fenced enclosure and dumped car body).

Walking tracks were noted throughout the offset land, the most prevalent being Bomaderry Creek Walking Track which traverses offset parcels 5, 6, 7, 8, and 10. Trail signs and markers are located along the walking path for Bomaderry Creek Track. Other minor walking tracks were identified within all other parcels (Figure 5).

A lookout, toilet amenities, and carpark are located within offset parcel 3 and are used by visitors to the Bomaderry Creek region. These areas are in relatively good condition with little evidence of weed invasion surrounding the infrastructure.

The cliff edge located on the western boundary of offset parcel 9 is used by the public for rock climbing. Walking tracks have been created in the near vicinity by climbers traversing the area to access the cliff. Scattered rubbish and discarded debris were located nearby tracks and within the understorey of offset parcel 9 and are a reflection of increased foot traffic in this area.

Very little evidence of erosion was observed within the offset land during the field survey. Minor erosion is associated with run-off down gullies from the plateau or cliff edges that drain towards Bomaderry

Creek. However, erosion is negligible within the offset land and is not considered a detrimental disturbance.

4.3 HABITAT CONNECTIVITY

Strong habitat connectivity is achieved when combining the offset area with Bomaderry Creek Regional Park as the vegetation is contiguous with the park along its eastern, northern, and southern edges. The offset area contributes an additional 50 ha to Bomaderry Creek Regional Park and expands the park from 82 ha to 132 ha.

In addition, the offset parcels include a substantial part of Bomaderry Creek which encompass both sides of the gorge and their dedication to the park will expand protection of this riparian corridor. The vegetation present along most of Bomaderry Creek was considered high quality and supports fauna movement along the length of this corridor and is likely to be used by some fauna species for visitation, foraging, and breeding. Offset parcels 1 - 4 also support high quality vegetation and inclusion of these parcels to the northern boundary of the park will protect habitat connectivity in this area and facilitate fauna movement.

No signs of significant fragmentation or large cleared areas were identified within the offset area. Fauna movement is possible throughout the offset area and within Bomaderry Creek Regional Park. The vegetation within the offset parcel has high connectivity value in an urban area in which little other native vegetation persists.

4.4 THREATENED FLORA AND FAUNA SPECIES ASSESSMENT

Table 5: Assessment of the significance of the offset land to threatened flora species

Scientific Name	EPBC Act	TSC Act	Significance of Offset Land to Species
Cryptostylis hunteriana Leafless Tongue Orchid	V	V	Potential Leafless Tongue Orchid habitat occurs within the offset area within areas of shallow sandy soil over sandstone and within Scribbly Gum – Bloodwood Woodland.
Eucalyptus langleyi Albatross Mallee	V	V	Albatross Mallee records are known within the area and have been located within offset parcel 3 on the eastern side of Bomaderry Creek. The offset land supports habitat for this species and it is likely it could inhabit other areas.
Genoplesium baueri Bauer's Midge Orchid	-	V	Bauer's Midge Orchid has been recorded within Bomaderry Creek Regional Park and the Atlas of NSW Wildlife has records of the species within approximately 1km of the offset land, suggesting that the species could occur within the offset land given that appropriate habitat is available.
Triplarina nowraensis Nowra Heath Myrtle	E	E	Potential Nowra Heath Myrtle habitat occurs within the offset area on the plateau in areas of shallow sandy soils on sandstone or moss gardens.
Zieria baeuerlenii Bomaderry Zieria	E	E	Bomaderry Zieria is recorded throughout the offset land (Barrat 1997; KMA 2008). The inclusion of the offset land within Bomaderry Creek Regional Park will better conserve Bomaderry Zieria populations within a protected area. Of the known populations, 97% would be included within Bomaderry Creek Regional Park, of which only 60% is currently protected. The area of identified critical habitat protected within the park would increase to 88%, from the current 51% (KMA 1998).
Acacia subtilinervis	-	-	The offset area contains habitat for the rare *Acacia subtilinervis,* mainly in association with rock outcrops, heath and shrubland.

Scientific Name	EPBC Act	TSC Act	Significance of Offset Land to Species
Leptospermum sejunctum	-	-	The offset area supports known habitat for the rare *Leptospermum sejunctum*. In particular, *Leptospermum sejunctum* is recorded within the plateaus of the offset land and was commonly recorded within offset parcels 1, 4, 6 and 7.

Table 6: Assessment of the significance of the offset land to threatened fauna species

Scientific Name	EPBC Act	TSC Act	Significance of Offset Land to Species
Heleioporus australiacus Giant Burrowing Frog	V	V	A single possible call of the Giant Burrowing Frog was heard (Garry Daly, DECC 2009c) and potential breeding habitat was identified by McCotter (1995) within offset parcel 1. Other areas of potential breeding habitat have been identified within offset parcel 6.
Callocephalon fimbriatum Gang-gang Cockatoo	-	V	The Gang-gang Cockatoo is known to occur within the offset area and is likely to be a regular visitor to the area. The Atlas of NSW Wildlife has records of the species throughout the Bomaderry Creek Region suggesting that the species would utilise foraging habitat regularly within the offset area. Suitable nesting habitat also occurs in the offset area.
Calyptorhynchus lathami Glossy Black-Cockatoo	-	V	Known feeding habitat for the Glossy Black-cockatoo occurs within the offset area, predominantly within the northern half of the offset area (Atlas of NSW Wildlife). Suitable nesting habitat also occurs in the offset area.
Lophoictinia isura Square-tailed Kite	-	V	The Square-tailed Kite has been sighted within offset parcel 3 and is most likely to forage over much of the offset land (Atlas of NSW Wildlife). Possible nesting habitat also occurs in the offset area.
Ninox strenua Powerful Owl	-	V	The Powerful Owl has been recorded within offset parcel 2 and west of the offset land by ELA (2010). Two individuals were also recorded roosting together within offset parcel 5 during the field survey. The inclusion of the offset land would protect good quality riparian habitat for this owl species. The offset land contains suitable foraging, roosting and nesting habitat for the species.
Tyto novaehollandiae Masked Owl	-	V	The Masked Owl is known from Bomaderry Creek region and was recorded to the west of offset parcel 1 (ELA 2010). While no specific records are identified within the offset land, this species would most likely forage within the offset land. The offset land contains suitable foraging, roosting and nesting habitat for the species.
Tyto tenebricosa Sooty Owl	-	V	The Atlas of NSW Wildlife has records of the Sooty Owl nearby offset parcel 9. While no specific records are identified within the offset land, this species may forage over much of the offset land. The inclusion of the offset land would protect good quality riparian habitat for this owl species, including suitable roosting and possibly nesting resources.
Dasyurus maculatus Spotted-tailed Quoll	E	V	Potential Spotted-tailed Quoll habitat occurs within the offset area. In particular, the caves and crevices associated with the cliffs of Bomaderry Creek provide potential den sites.
Petaurus australis Yellow-bellied Glider	-	V	The offset land supports known Yellow-bellied Glider habitat along Bomaderry Creek gorge and surrounding areas (Atlas of NSW Wildlife; ELA 2010). Currently, only about one third of the known Yellow-bellied Glider habitat is included in the existing park and the addition of the offset area to the park would secure this habitat entirely within the park (KMA 1998). Yellow-bellied Glider feed trees were recorded during the field survey and were commonly observed west of the gorge.
Chalinolobus dwyeri Large-eared Pied Bat	V	V	Suitable Large-eared Pied Bat foraging habitat occurs throughout the offset area and potential roosting habitat occurs in rock cavities within the gorge.
Myotis macropus	-	V	The species was previously recorded in the gorge at the southern end of the offset land (Parnaby 1996) near offset parcel 9. Bomaderry Creek provides suitable foraging

Scientific Name	EPBC Act	TSC Act	Significance of Offset Land to Species
Large-footed Myotis			habitat for this species and nearby caves and tree hollows provide suitable roosting sites. Most of the creek habitat on Bomaderry Creek is outside the existing park. The offset area would include this habitat into the park.
Pteropus poliocephalus Grey-headed Flying-Fox	V	V	This species is known to roost in the gorge near the southern parts of the offset land. Suitable foraging habitat occurs over much of the offset land where nectar producing trees such as eucalypts occur.

4.5 LANDFORMS & CULTURAL VALUES

The Bomaderry Creek Regional Park has high biodiversity values and contains suitable habitat for a number of threatened flora and fauna species. The Park is also of significant importance for its natural heritage, Aboriginal spiritual connection and contemporary European heritage in reference to the former dam that serviced Bomaderry for many years (ELA 2010).

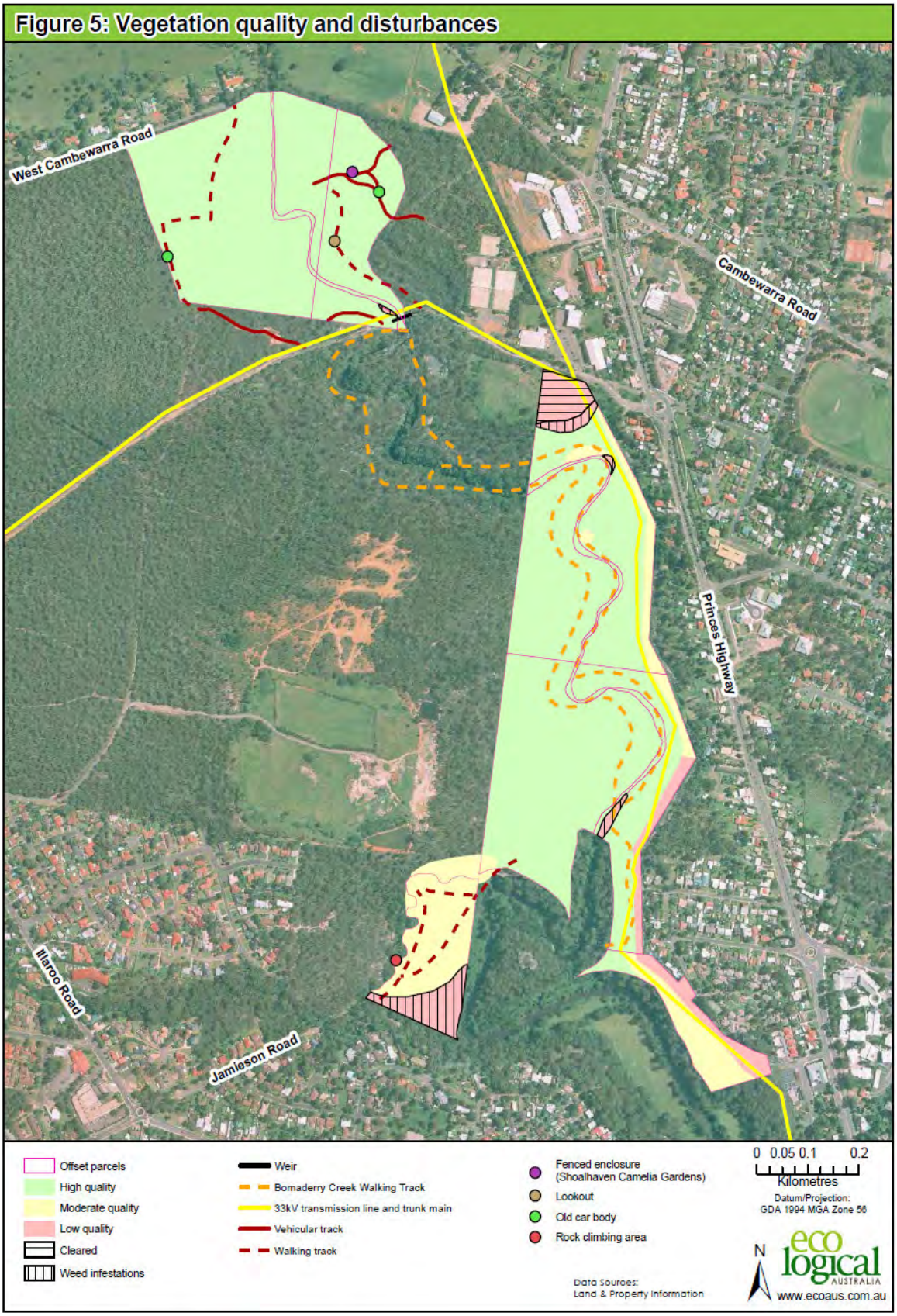

Figure 5: Vegetation quality and disturbances identified within each offset land parcel

5 Individual Offset Parcel Descriptions

Offset parcel Number 1

Hectares: 10.15

Vegetation communities: Grey Gum – Stringybark Forest, Spotted Gum – Blackbutt Forest, Sandstone Sedgeland, and Kunzea Shrubland

Vegetation quality: High

Disturbances: Vehicle tracks and walking tracks were observed. Some scattered weeds are associated with the tracks, but appear confined to these immediate disturbances. Weeds are generally absent from this offset parcel.

Habitat types: Rocky outcrops, sandstone with shallow sandy soils, swampy / boggy areas, Yellow-bellied Glider, Grey-headed Flying-fox, and Glossy Black-cockatoo feed trees, hollow-bearing trees supporting large hollows, heath understorey, and moss over sandstone.

Overall value of land: Offset parcel 1 supports significant high quality habitat for threatened fauna and flora, especially known foraging areas for the Yellow-bellied Glider and Glossy Black-cockatoo and Bomaderry Zieria habitat. Potential Giant Burrowing Frog breeding habitat has been identified within this parcel. Due to the low disturbance levels and the presence of high quality vegetation this parcel will be a valuable inclusion within Bomaderry Creek Regional Park.

Offset parcel Number 2

Hectares: 2.6

Vegetation communities: Spotted Gum – Blackbutt Forest and Grey Gum – Stringybark Forest.

Vegetation quality: High

Disturbances: Some walking tracks were observed. The understorey is moderately disturbed nearby Yellow-bellied Glider feed trees in the north, however this has only resulted in reduced ground-cover. A small number of weeds were observed in this parcel and no significant areas of weed invasion.

Connectivity to good quality vegetation:

Habitat types: Bomaderry Creek, Rocky outcrops, sandstone with shallow sandy soils, Yellow-bellied Glider, Grey-headed Flying-fox, and Glossy-black Cockatoo feed trees, hollow-bearing trees supporting large hollows, heath understorey, and moss over sandstone.

Overall value of land: Offset parcel 2 supports significant high quality habitat for threatened fauna and flora, especially known foraging areas for the Yellow-bellied Glider and Glossy Black-cockatoo and Bomaderry Zieria habitat. Due to the low disturbance levels and the presence of high quality vegetation this parcel will be a valuable inclusion within Bomaderry Creek Regional Park.

Offset parcel Number 3

Hectares: 4.1

Vegetation communities: Spotted Gum – Blackbutt Forest and Grey Gum – Stringybark Forest.

Vegetation quality: High

Disturbances: Vehicle tracks and walking tracks were observed and are concentrated within a centre section of this offset parcel. Some scattered weeds are associated with the tracks, but appear confined to these immediate disturbances. Weeds are generally absent from this offset parcel. The Bomaderry Creek Lookout and tourist amenities are included within this offset parcel. However, this infrastructure has not contributed negatively to the surrounding vegetation.

Habitat types: Bomaderry Creek, Rocky outcrops, sandstone with shallow sandy soils, Yellow-bellied Glider, Grey-headed Flying-fox, and Glossy Black-cockatoo feed trees, hollow-bearing trees supporting large hollows, heath understorey, and moss over sandstone.

Overall value of land: Offset parcel 3 supports significant high quality habitat for threatened fauna and flora, especially for Bomaderry Zieria and Albatross Mallee habitat. The Bomaderry Creek Lookout is also included within this parcel and provides an avenue to educate park visitors on the high biodiversity value of the area. Due to the low disturbance levels and the presence of high quality vegetation this parcel will be a valuable inclusion within Bomaderry Creek Regional Park.

Offset parcel Number 4

Hectares: 0.9

Vegetation communities: Spotted Gum – Blackbutt Forest and Grey Gum – Stringybark Forest.

Vegetation quality: High

Disturbances: Vehicle tracks and walking tracks were observed. Some scattered weeds are associated with the tracks, but appear confined to these immediate disturbances. Weeds are generally absent from this offset parcel. The Bomaderry Creek weir is nearby this offset parcel and some weed invasion has been noted in this general area. In particular, a patch of Lantana was recorded north of the weir.

Habitat types: Bomaderry Creek, Rocky outcrops, sandstone with shallow sandy soils, Yellow-bellied Glider, Grey-headed Flying-fox, and Glossy Black-cockatoo feed trees, hollow-bearing trees supporting large hollows, heath understorey, and moss over sandstone.

Overall value of land: Offset parcel 4 supports significant high quality habitat for threatened fauna and flora, especially for Bomaderry Zieria. Some disturbance was noted within the area, but generally overall disturbance levels were considered low. This parcel will be a valuable inclusion within Bomaderry Creek Regional Park as it includes Bomaderry Creek and supports high quality vegetation.

Offset parcel Number 5

Hectares: 6.3

Vegetation communities: Spotted Gum – Blackbutt Forest, Grey Gum – Stringybark Forest and Coachwood / Ironwood Warm Temperate Rainforest

Vegetation quality: Predominantly high, with moderate quality vegetation observed on the eastern edge and low quality on the northern tip.

Disturbances: The northern tip of this offset parcel is cleared and substantial weed invasion is prevalent around the edge of this cleared area. The weeds penetrate the neighbouring bushland to the south for approximately 10 m and then cease. Similarly, weeds were observed along the eastern edge of this parcel nearby the powerline easement and residential homes; however they do not penetrate beyond the immediate edge of the native bush. Some scattered weeds were observed within the offset parcel; however most of the area is generally weed free. Bomaderry Creek Walking Track traverses this offset parcel.

Habitat types: Bomaderry Creek, rock pools, cliff faces, Yellow-bellied Glider and Grey-headed Flying-fox feed trees, hollow-bearing trees supporting large hollows, and dense riparian vegetation.

Overall value of land: Offset parcel 5 supports significant high quality habitat for threatened fauna and flora, especially for threatened owl and bat species, and potential migratory species. The dense riparian vegetation is considered high quality and supports large hollow-bearing trees. Some disturbances were noted but generally overall disturbance levels were considered low. This parcel will be a valuable inclusion within Bomaderry Creek Regional Park as it includes Bomaderry Creek and supports high quality vegetation. This parcel also secures land that acts as a vegetative buffer to nearby residential housing.

Offset parcel Number 6

Hectares: 5.3

Vegetation communities: Spotted Gum – Blackbutt Forest, Grey Gum – Stringybark Forest, Coachwood / Ironwood Warm Temperate Rainforest, and Kunzea Shrubland

Vegetation quality: High

Disturbances: Very few disturbances were observed within this offset parcel, except for Bomaderry Creek Walking Track.

Habitat types: Bomaderry Creek, rock pools, cliff faces, Yellow-bellied Glider and Grey-headed Flying-fox feed trees, hollow-bearing trees supporting large hollows, dense riparian vegetation, sandstone with shallow sandy soils, heathy understorey, and moss over sandstone.

Overall value of land: Offset parcel 6 supports significant high quality habitat for threatened fauna and flora, especially known foraging areas for the Yellow-bellied Glider and Glossy Black-cockatoo. The dense riparian vegetation is considered high quality and supports large hollow-bearing trees which are potentially used by threatened owls. The cliffs also provide potential roosting sites for bat species. This parcel will be a valuable inclusion within Bomaderry Creek Regional Park as it includes Bomaderry Creek, supports high quality vegetation.

Offset parcel Number 7

Hectares: 9.9

Vegetation communities: Spotted Gum – Blackbutt Forest, Grey Gum – Stringybark Forest, Coachwood / Ironwood Warm Temperate Rainforest, and Kunzea Shrubland.

Vegetation quality: High

Disturbances: Very few disturbances were observed within this offset parcel, except for Bomaderry Creek Walking Track.

Habitat types: Bomaderry Creek, rock pools, cliff faces, Yellow-bellied Glider and Grey-headed Flying-fox feed trees, hollow-bearing trees supporting large hollows, dense riparian vegetation, sandstone with shallow sandy soils, heathy understorey, and moss over sandstone.

Overall value of land: As for parcel 6.

Offset parcel Number 8

Hectares: 4.2

Vegetation communities: Spotted Gum – Blackbutt Forest, Grey Gum – Stringybark Forest, and Coachwood / Ironwood Warm Temperate Rainforest.

Vegetation quality: Predominantly high, with moderate quality and low quality recorded on the eastern edge.

Disturbances: Weeds were observed along the eastern edge of this parcel nearby the powerline easement and residential homes; however they do not penetrate beyond the immediate edge of the native bush. Some scattered weeds were observed within the offset parcel; however most of the area is generally weed free. Bomaderry Creek Walking Track traverses this offset parcel.

Habitat types: Bomaderry Creek, rock pools, cliff faces, Yellow-bellied Glider and Grey-headed Flying-fox feed trees, hollow-bearing trees supporting large hollows, and dense riparian vegetation.

Overall value of land: As for parcel 5.

Offset parcel Number 9

Hectares: 4.0

Vegetation communities: Spotted Gum – Blackbutt Forest, Grey Gum – Stringybark Forest, and Coachwood / Ironwood Warm Temperate Rainforest.

Vegetation quality: Predominantly moderate quality with low quality recorded on the eastern edge and a small area of high quality recorded to the west.

Disturbances: The understorey vegetation of this offset parcel is invaded with weeds within its southern half. Weeds are noted within the northern half, however they are not as prevalent in this area. A significant invasion of Lantana dominates the creekline in this parcel and much of the native understorey has been substantially modified. Additionally, walking tracks were observed and evidence of rock climbing was noted on the cliff that borders the western boundary. Rubbish and scattered debris

were located within this parcel which is most likely a result of public visitation, although some rubbish may flow down the creek.

Habitat types: Minor creekline, cliff faces, rocky outcrops, swampy / boggy areas, dense riparian vegetation, Yellow-bellied Glider and Grey-headed Flying-fox feed trees, and a minor amount of heath understorey and sandstone with shallow sandy soils at the northern boundary.

Overall value of land: Offset parcel 9 varies in its biodiversity value. Dense riparian habitat is found within gullies which provide habitat for threatened owls, and possibly the Sooty Owl. The weed infested creeklines and gullies have reduced native diversity within this parcel and will require active management. The use of the cliff line for rock-climbing by the public will be a management issue requiring consideration. However, this parcel is valuable as vegetative buffer that protects Bomaderry Creek from neighbouring urban development. This parcel may also buffer important riparian habitat that is used by threatened species within the creekline to the east.

Offset parcel Number 10

Hectares: 2.6

Vegetation communities: Spotted Gum – Blackbutt Forest and Grey Gum – Stringybark Forest.

Vegetation quality: Predominantly moderate quality with the southern section recorded as low quality.

Disturbances: Weeds were observed along the eastern edge of this parcel nearby the powerline easement and residential homes and have penetrated the native bushland in areas. Approximately, a 30m corridor has been cleared for the installation of the powerline easement. The vegetation within this area is subject to repeated slashing to allow access. Bomaderry Creek Walking Track traverses this offset parcel.

Habitat types: Rocky outcrops, cliff faces, Yellow-bellied Glider and Grey-headed Flying-fox feed trees, and hollow-bearing trees supporting large hollows.

Overall value of land: Offset parcel 10 provides limited biodiversity value due to clearing associated with the powerline easement. In particular, this parcel is valuable as vegetative buffer that protects Bomaderry Creek from neighbouring urban development in the east and the canopy stratum provides connectivity to better-quality habitat.

6 Conclusion

In light of the above assessment, the inclusion of the 50 ha offset area within Bomaderry Creek Regional Park would be considered very positive from a biodiversity conservation perspective. Several biodiversity conservation gains would be made through the dedication of the offset land within the park and include:

- the protection of high quality vegetation that supports forest vegetation of varying ages, therefore securing both old-growth forest components and young forest within the reserve system;
- the protection of significant threatened flora and fauna habitat;
- the inclusion of both sides of Bomaderry Creek within the park; and
- a higher level of environmental protection for the general Bomaderry Creek region.

The inclusion of the offset land will also provide several benefits in terms of park management which include:

- a substantial increase in the size of the park;
- the inclusion of all existing recreational facilities, e.g. Bomaderry Creek Walking Track and other park infrastructure. This will result in the whole Bomaderry Creek area being managed as an integrated management unit; and
- the whole area would come under a single management body (ie. DECCW) with expertise in conservation estate management. This will help to simplify a range of management issues within the regional park, including
    - bushfire regimes;
    - regulation of public access through appropriately marked and patrolled areas;
    - restrict access and other threats to sensitive biodiversity areas within the park;
    - focus and coordinate rehabilitation works in areas of greatest need and benefit; and
    - increase opportunities and consistency of public education about the biodiversity values of the regional park.

7 References

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Appendix F – Director General's Requirements (DGRs)

NSW GOVERNMENT
Department of Planning

Contact: Mark Turner
Phone: (02) 9228 6351
Fax: (02) 9228 6555
Email: mark.turner@planning.nsw.gov.au

Our ref: S06/00841

Mr Russell Pigg
General Manager
Shoalhaven City Council
PO Box 42
NOWRA NSW 2541

Dear Mr Pigg

Director General's Requirements for the Environmental Assessment of Proposed North Nowra Link Road Concept Plan (MP 07_0037)

Reference is made to your correspondence dated 1 April 2009 reconsulting on Director-Generals requirements for the proposed North Nowra Link Road Concept Plan, which lapsed on 16 April 2009.

I have attached a copy of the Director-General's requirements (DGRs) for the environmental assessment of the project. These requirements have been prepared following the Planning Focus Meeting held on Tuesday, 13 March 2007 and in consultation with the relevant government agencies.

It should be noted that the Director-General's requirements have been prepared based on the information provided to date. Under section 75F(3) of the Act, the Director-General may alter or supplement these requirements if necessary and in light of any additional information that may be provided prior to the proponent seeking approval for the project.

I would appreciate it if you could contact the Department at least two weeks before you propose to submit the Environmental Assessment for the project to determine:

- the fees applicable to the application;
- relevant land owner notification requirements;
- consultation and public exhibition arrangements that will apply;
- options available in publishing the Environmental Assessment via the Internet; and
- number and format (hard-copy or CD-ROM) of the Environmental Assessment that will be required.

Prior to exhibiting the Environmental Assessment, the Department will review the document to determine if it adequately addresses the DGRs. The Department may consult with other relevant government agencies in making this decision. If the Director-General considers that the Environmental Assessment does not adequately address the DGRs, the Director-General may require the proponent to revise the Environmental Assessment to address the matters notified to the proponent. Following this review period the Environmental Assessment will be made publicly available for a minimum period of 30 days.

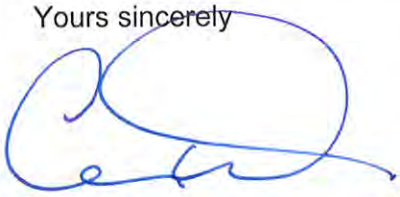
If your proposal includes any actions that could have a significant impact on matters of National Environmental Significance, it will require an additional approval under the Commonwealth *Environment Protection Biodiversity Conservation Act 1999* (EPBC Act). This approval would be in addition to any approvals required under NSW legislation and it is your responsibility to contact the Department of Environment Water, Heritage and the Arts to determine if an approval under the EPBC Act is required for your proposal (6274 1111 or http://www.environment.gov.au).

Please note that the Commonwealth Government has accredited the NSW environmental assessment process for assessing impacts on matters of National Environmental Significance. As a result, if it is determined that an approval is required under the EPBC Act, please contact the Department immediately as supplementary Director-General's requirements will need to be issued.

It is highlighted that the all three route options for the concept plan are located within the Bomaderry Creek Regional Park. The process to revoke land reserved or dedicated under the *National Parks and Wildlife Act 1974* would be required for the project (if approved) in accordance with the *NPWS Revocation of Land Policy* (NPWS, July 2002) in addition to the concept plan approval being sought under Part 3A of the *Environmental Planning and Assessment Act 1979.* Council may choose to address this issue within the Environmental Assessment for the concept plan or pursue a separate process with the Department of Environment and Climate Change (the former Department of Environment and Conservation). Nonetheless, Council is advised to contact the Department of Environment and Climate Change immediately to further discuss the requirements and the possible timing for undertaking this process.

If you have any enquiries about these requirements, please contact Mark Turner, Environmental Planning Officer, Major Infrastructure Assessments on 02 9228 6351 or via email (mark.turner@planning.nsw.gov.au).

Yours sincerely



3.5.09

Chris Wilson
Executive Director
As delegate for the Director-General

Director-General's Requirements

Section 75F of the *Environmental Planning and Assessment Act 1979*

Application number	07_0037
Project	The North Nowra Link Road Concept Plan, being the assessment of three route options for the link road in North Nowra/Bomaderry in the Shoalhaven local government area.
Location	The northern option (West Cambewarra Road), the central option (Pitt Street to Narang Road) and southern option (Illaroo Road to West Bunderra Street).
Proponent	Shoalhaven City Council
Date issued	3 May 2009
Expiry date	3 May 2011
General requirements	The Environmental Assessment must be prepared to a high technical and scientific standard and must include: • an executive summary; • a description of the proposal, including construction, operation, staging and the components which may be subject to subsequent approval(s); • the alignment and corridor width (including ancillary infrastructure) of the nominated route options; • an assessment of the environmental impacts of the proposal, with particular focus on the key assessment requirements specified below; • justification for undertaking the proposal with consideration of the benefits and impacts of the proposal; • a draft Statement of Commitments detailing measures for environmental mitigation, management and monitoring for the proposal; and • certification by the author of the Environment Assessment that the information contained in the Assessment is neither false nor misleading.
Key issues	The Environmental Assessment must include assessment of the three nominated route options on the following key issues: • **Strategic Justification** - the Environmental Assessment must include a strategic assessment of the need and location for the proposed Link Road (and alignments) in relation to the strategic direction of the locality and region, with consideration to the *South Coast Regional Strategy* (2007) and the *Nowra/Bomaderry Structure Plan*. The Environmental Assessment must also include a strategic planning consideration of the Link Road and an analysis of the suitability of the proposed alignments with respect to potential land use conflicts with existing and future surrounding land uses. Particular focus is to be given the potential conflict with the Bomaderry Creek Regional Park, including the strategic justification for the location of the route options within the Regional Park boundary. • **Biodiversity** – the Environmental Assessment must include a detailed flora and fauna impact assessment in accordance with the DEC's *Guidelines for Threatened Species Assessment* (draft). This assessment must clearly identify and consider any direct and indirect impacts on critical habitats, threatened species, populations or ecological communities listed under both State and Commonwealth legislation recorded along the nominated routes and surrounding area, such as *Zieria baeuerlenii* and *Eucalyptus langleyi*. The Environmental Assessment must also consider the potential impacts of the route options on the conservation values and integrity of the Bomaderry Creek Regional Park, particularly as a result of fragmentation impacts and edge effects. Measures to avoid or mitigate impacts associated with the option(s) must be identified with an assessment of the feasibility, effectiveness and reliability of these proposed measures.

	• **Road and Traffic** – the Environmental Assessment must clearly identify the current road network performance and limitations and include a detailed impact assessment of the three route options on the road network performance and efficiencies. This assessment must have consideration to the potential growth in traffic volumes that may occur as a result of the proposed urban release areas identified in the Nowra/Bomaderry Structure Plan. • **Noise Impacts** – the Environmental Assessment must include a noise impact assessment for the three route options, conducted in accordance with *Environmental Criteria for Road Traffic Noise* (EPA 1999). The Environmental Assessment must clearly outline the noise mitigation measures to mitigate the potential impacts on receptors as result of road traffic noise. • **Urban Design** – the Environmental Assessment must include an assessment of the visual impacts of the three proposed route options. • **Aboriginal Heritage** – the Environmental Assessment must include an assessment of aboriginal heritage along the three nominated options undertaken, including the Bomaderry Creek Gorge. This assessment is to have consideration to the draft Part 3A *Guidelines for Aboriginal Cultural Heritage Impact Assessment and Community Consultation* (DEC 2005). • **Soil and Water** – the Environmental Assessment must include an assessment of the potential impacts of the proposed route option(s) on local flooding behaviour, the Bomaderry Creek riparian corridor and the disturbance of contaminated soil. • **Socio-Economic** – the Environmental Assessment must have consideration to the socio-economic impacts of the route options, including any potential impacts on recreational values of the Bomaderry Creek Regional Park. • **General Environmental Risk Analysis** – notwithstanding the above key assessment requirements, the Environmental Assessment must include an environmental risk analysis to identify potential environmental impacts associated with the project (construction and operation), proposed mitigation measures and potentially significant residual environmental impacts after the application of proposed mitigation measures. Where additional key environmental impacts are identified through this environmental risk analysis, an appropriately detailed impact assessment of these additional key environmental impacts must be included in the Environmental Assessment.
Consultation	You should undertake an appropriate and justified level of consultation with relevant parties during the preparation of the EA, including: • local, State or Commonwealth government authorities and service providers; and • the public (including community groups, affected landowners) - document all community consultation undertaken or discuss the proposed strategy for undertaking community consultation. This should include any contingencies for addressing any issues arising from the community consultation and an effective communications strategy. The consultation process and the issues raised should be described in the Environmental Assessment.

Appendix G – Kevin Mills & Associates 2008 Report

FINAL FLORA & FAUNA ASSESSMENT
NORTH NOWRA LINK ROAD
ENVIRONMENTAL ASSESSMENT
CITY OF SHOALHAVEN

a report prepared by

KEVIN MILLS & ASSOCIATES
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for

SHOALHAVEN CITY COUNCIL
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July 2008
06/11/04

Kevin Mills & Associates Pty Limited ACN 003 441 610
as trustee for Kevin Mills & Associates Trust

Cover Photograph:
Part of the Central route option, looking west towards Illaroo Road; the water tower in the far distance is at the junction of Illaroo Road and Pitt Street. Note the cleared transmission line easement, the existing transmission line and the parallel pipeline are within the proposed 30m road easement.

CONTENTS

EXECUTIVE SUMMARY

This report forms part of the Environmental Assessment being prepared by Shoalhaven City Council for a new road located at North Nowra. The road, known as the North Nowra Link Road, traverses an undeveloped area between the Princes highway in the east and Illaroo Road in the west. The length of the road would be about 1.7 to 1.8 kilometres. Three options are being investigated, known as the Northern, Central and Southern Options.

The purpose of this report is to identify and assess the flora and fauna issues associated with each of the three route options and provide a comparison of the three routes based on the most significant flora and fauna issues.

The key flora and fauna issues associated with each route are identified, described and assessed and compared between the three route options. These key issues include the presence of endangered, vulnerable and rare plants and animals, occurrence of natural vegetation, general habitat values and the impact on the Bomaderry Creek Regional Park.

The conclusion of the report is that the Southern route would impact very significantly upon the gorge of Bomaderry Creek, as it traverses a section of gorge with no existing disturbance. This area supports stands of tall forest and rainforest, with riparian and escarpment habitats utilised by threatened animals.

The report further concludes that the impact of the Northern and Central route options is similar in many respects; this includes the area of bushland cleared and the impact on Bomaderry Creek. The major difference is that the Central route traverses the core of the bushland, whereas the Northern route is located on the edge of the bushland. Thus the Central route would bisect the Bomaderry Creek Regional Park and the habitats of several threatened species, including the Yellow-bellied Glider, *Zieria baeuerlenii* and, should it be present, the Giant Burrowing Frog. The Central route also results in the removal of two specimens of the vulnerable mallee *Eucalyptus langleyi* and is very close to a population of the endangered shrub *Zieria baeuerlenii.*

An assessment under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* suggests that at least one route, the Central option, should be referred to the Minister for the Environment as it may be a controlled action due to the removal of the above listed eucalypt species.

The report summarises the mitigation measures that would be required to address the potential impact upon flora and fauna for each route.

* * * * *

1 INTRODUCTION

1.1 Background

This report provides an assessment of the flora and fauna associated with three road route options for the North Nowra Link Road being proposed by Shoalhaven City Council. All three options traverse the bushland around Bomaderry Creek at North Nowra and involve a crossing of this creek; see **Figure 1**. The project area is that area traversed by the three road routes.

This report forms part of Shoalhaven City Council's environmental assessment for the proposed road under Part 3A of the *Environmental Planning & Assessment Act, 1979*. The role of this report is to assist in the identification of a preferred route. The current report responds to those flora and fauna matters listed in the Director-General's Requirements.

Background information on the important flora and fauna species and communities that occur in the Bomaderry Creek area is documented in previous reports (e.g. Kevin Mills & Associates 2006, 2007). Previous survey effort in the area around Bomaderry Creek has been extensive; this is summarised in the report of Kevin Mills & Associates (2006). Little has changed in the area in the intervening years and although many threatened species and communities have been listed under the *Threatened Species Conservation Act 1995* since that time, listings relevant to the Bomaderry Creek area that were made are readily assessed through the recent surveys (i.e. Gang-gang Cockatoo and Grey-headed Flying-fox).

The recent field surveys and assessment over a period of several days together with the previous survey results provide an adequate basis upon which to assess and compare the road route options. The detailed draft flora and fauna study previously prepared by Kevin Mills & Associates (2006) provides considerable information and this is included in this report where appropriate. The current report is essentially a summary of the total available information, and should be read together with the accompanying Council documents.

Figure 1. Route Options for the North Nowra Link Road.

1.2 Location and Character of the Project Area

The project area is located at North Nowra, between the Princes Highway in the east and Illaroo Road in the west. Three options are investigated here, referred to as the Northern (West Cambewarra Road) Option, Central (Pitt Street–Narang Road) Option and the Southern (Illaroo Road–West Bunberra Street) Option. Further information on each route is provided in Section 2.

The area traversed by the routes is mainly public land of one sort or another. This public land is the Bomaderry Creek Regional Park, managed by the NSW National Parks and Wildlife Service, land owned by Shoalhaven City Council or vacant Crown land. The majority of the area is naturally vegetated, primarily with woodland and heathland, with stands of forest in the Bomaderry Creek gorge. All routes require clearing some natural vegetation.

1.3 Director-General's Requirements

The Requirements for the assessment from the Director-General of the NSW Department of Planning were issued on 16 April 2007. These Requirements for flora and fauna are set out under the heading biodiversity; see below. The key issues raised in the Requirements, including the responses from the other government authorities, where they relate to flora and fauna, are addressed in detail in this report.

"Biodiversity – the Environmental Assessment must include a detailed flora and fauna impact assessment in accordance with the DEC's *Guidelines for Threatened Species Assessment* (draft). This assessment must clearly identify and consider any direct and indirect impacts on critical habitats, threatened species, populations or ecological communities listed under both State and Commonwealth legislation recorded along the nominated routes and surrounding area, such as *Zieria baeuerlenii* and *Eucalyptus langleyi*. The Environmental Assessment must also consider the potential impacts of the route options on the conservation values and integrity of the Bomaderry Creek Regional Park, particularly as a result of fragmentation impacts and edge effects. Measures to avoid or mitigate impacts associated with the option(s) must be identified with an assessment of the feasibility, effectiveness and reliability of these proposed measures."

A guide to where the Director-General's Requirements are dealt with in this report is provided in **Table 1**.

1.4 Guidelines for Threatened Species Assessment

Guidelines that identify matters relevant to the assessment of potential impact on threatened species, populations or ecological communities of proposed development under Part 3A of the *Environmental Planning and Assessment Act 1979* (NSW) have been prepared by the Department of Environment and Conservation (now Department of Environment and Climate Change) and the Department of Primary Industries (DEC July 2005).

The *Guidelines for Threatened Species Assessment* identify the following objectives in regard to conserving threatened species, etc.:

1 "Maintain or improve biodiversity values (i.e. there is no net impact on threatened species or native vegetation).
2 Conserve biological diversity and promote ecologically sustainable development.
3 Protect areas of high conservation value (including areas of critical habitat).
4 Prevent the extinction of threatened species.
5 Protect the long-term viability of local populations of a species, population nor ecological community.
6 Protect aspects of the environment that are matters of national environmental significance."

Table 1 ***Guide to Director-General's Requirements***		
Requirement		*Section of Flora and Fauna Assessment*
Assessment in accordance with *Guidelines for Threatened Species Assessment* for Part 3A Matters (DEC July 2005)		Section 1.4 and Section 9
Direct and indirect impact upon	critical habitat	Section 5.4 and Section 8.5
	threatened species – plants (such as *Zieria baeuerlenii* and *Eucalyptus langleyi*)	State (TSC Act 1995) Section 5.1.1 and Section 8.2 Table 7 Appendix 3 Commonwealth (EPBC Act 1999) Section 7 Appendix 3
	threatened species - animals	State (TSC Act 1995) Section 5.1.3 and Section 8.3 Table 8 Appendix 5 Commonwealth (EPBC Act 1999) Section 7 Appendix 5
	endangered populations	Section 5.3
	endangered ecological communities	State (TSC Act 1995) Section 5.2.1 and Section 8.4 Commonwealth (EPBC Act 1999) Section 7
Impacts on Bomaderry Creek Regional Park, including fragmentation and edge effects.		Section 6 and Section 10
Measures to avoid and/or mitigate impacts.		Section 9 Table 10

Note that matters of national environmental significance (NES) are those matters listed under the *Environment Protection and Biodiversity Conversation Act 1999* (Commonwealth); these matters are not listed under state legislation.

The *Guidelines* outline a broad five-step process for assessing impacts on threatened species. Note that 'threatened species' refers here to species, populations and communities listed as threatened under the *Threatened Species Conservation Act 1995* (NSW) or the *Fisheries Management Act 1994* (NSW).

1.5 Definitions

In this report, the following meanings have been ascribed to the listed words and expressions.

Council means the Council of the City of Shoalhaven.

dch means tree trunk diameter at chest height (i.e. about 1.5 metres), a measure of the size of a tree.

DECC means the NSW Department of Environment and Climate Change, until recently the Department of Environment and Conservation (DEC).

Director-General's Requirements are the requirements provided by the Director-General of the NSW Department of Planning for this project dated 16 April 2007.

endangered ecological community has the same meaning as in the *Threatened Species Conservation Act 1995* (NSW) or the *EPBC Act 1999* (Commonwealth).

endangered population has the same meaning as in the *TSC Act 1995* (NSW).

endangered species has the same meaning as in the *Threatened Species Conservation Act 1995* (NSW) or the *EPBC Act 1999* (Commonwealth).

EPBC Act means the *Environment Protection and Biodiversity Conservation Act, 1999* (Commonwealth).

EP&A Act means the *Environmental Planning and Assessment Act 1979* (NSW).

exotic grassland a grassland in which more than 75% of species and cover are introduced.

forest usually a treed community with more than 30% canopy cover.

endemic species are species occurring naturally only in the area specified.

grassland vegetation dominated by grasses and forbs (herbaceous plants other than grasses, sedges and rushes), with less than 10% tree and shrub cover.

indigenous species are species occurring naturally in the area specified.

locality means the area within five (5) kilometres of the project area.

NPWS means the National Parks and Wildlife Service of New South Wales.

project area means the areas identified in Section 1 of this report.

region means the Sydney Basin Bio-Region, extending from the Hunter Valley in the north to Batemans Bay in the south and west to Lithgow, unless the reference is specifically to the Shoalhaven Region.

ROTAP means a rare or threatened Australian plant species, as defined by Briggs and Leigh (1996).

Regional Park means the Bomaderry Creek Regional Park, managed by the NSW NPWS.

threatened species has the same meaning as in the *Threatened Species Conservation Act 1995* (NSW) or the *EPBC Act 1999* (Commonwealth).

TSC Act means the *Threatened Species Conservation Act 1995* (NSW).

vulnerable species has the same meaning as in the *Threatened Species Conservation Act 1995* (NSW) or the *EPBC Act 1999* (Commonwealth).

Wildlife Atlas means the Atlas of NSW Wildlife maintained by the NSW National Parks and Wildlife Service, Sydney and accessible through their web site.

woodland a plant community in which widely spaced and usually deep crowned trees dominate; usually a treed community with less than 30% canopy cover.

***** an asterisk after or before a species name denotes a plant or animal that has been introduced to the area and that does not naturally occur there.

1.6 Previous Studies

This report has made extensive use of previous studies undertaken in the area around Bomaderry Creek. Flora and fauna studies have been carried out in this area since at least 1990 and over that period a considerable amount of information has been gathered on the biota of the area. In particular, those species of threatened or rare flora and fauna have been identified and their habitats delineated. As there has been little change in the habitats in the area since those earlier studies were undertaken, the results obtained then are just as relevant today. Note that new surveys were undertaken along the route options covered in this document, with particular attention given to the two northern route options.

2 ROUTE OPTIONS

This study is concerned with three route options; the following terms being used to identify each one. The aerial photograph at **Figure 1** shows the alignment of the three options.

1. Northern - West Cambewarra Road Option;
2. Central - Pitt Street - Narang Road Option;
3. Southern - Illaroo Road - West Bunberra Street Option.

Table 2 provides a summary of the various options in terms of length, the area of land required and ownership of the land traversed.

The route options range in length from approximately 1,760 metres (Northern and Central options) to 1,820 metres (Southern option) and require the use of 5.20 to 5.46 hectares of land. All of the routes cross privately owned land and land owned by Shoalhaven City Council. All options also cross part of the Bomaderry Creek Regional Park, a conservation reserve managed by the NSW National Parks and Wildlife Services.

Table 2 *Summary of Route Options*					
	Approximate Length of Routes on each Land Tenure				
Route Option	**Crown Land**	**Regional Park**	**Private**	**Council[1]**	**Total Length**
Northern	nil	330 m	110 m	1,320 m	1,760 m
Central	645 m	740 m	nil	375 m	1,760 m
Southern	1,010 m	60 m	240 m	510 m	1,820 m
1. Includes existing road reserves.					

For the purposes of this study, the study area for each route was established as a 60 metre wide corridor centred on the centre line of the road route; the centre line was pegged on the ground and surveyed by Council. The resultant chainage maps, with the 60 metre wide corridors marked up, were used during this study to locate relevant flora and fauna features; see attached maps for the Northern and Central routes.

3 THE FLORA

3.1 Vegetation Survey Methods

The aim of the vegetation survey was to describe the floristic composition, structure and condition of the natural vegetation in the project area, describe, assess and map the distribution of the threatened species in the area and to prepare a map showing the distribution of the vegetation communities. A vegetation map for this area already exists, this was prepared by Kevin Mills & Associates (1992); another map, modified from the one by Kevin Mills & Associates, was prepared by Barratt (1993). The boundaries of the vegetation communities previously delineated by us were re-checked within the project area; this was done by carefully traversing the area on foot and marking the boundaries onto a large scale colour aerial photograph (scale 1:4,000). This map is now on Council's GIS. A modified vegetation map was prepared later. Each plant community was given an identification code. A system of codes was devised by the consultant several years ago, to standardise vegetation classification in the Shoalhaven local government area. Refer to "Vegetation Survey Methods and Natural Vegetation Types in the Coastal Parts of the City of Shoalhaven, New South Wales" (Mills 1998).

In the most recent survey, the plant communities recognised along the Northern and Southern routes were marked onto a detailed survey plan in the field, and maps subsequently prepared.

Australian vegetation classification systems are usually based on the name(s) of the dominant species (the floristic association) in the tallest stratum and an expression of the growth form, height and cover of the vegetation (the structural formation). The classification system of Walker and Hopkins (1990) is an example. In keeping with this practice, the names of the plant communities in this report are based on (i) the common name(s) of the dominant species in the tallest stratum and (ii) the structure of the community, although there may be occasional departures from this system.

A floristic audit was undertaken during the traverses of the Northern and Southern routes, for the purpose of identifying as many as possible of the native plant species present. The resulting list of plant species is reasonably comprehensive, but unlikely to be definitive.

The plant survey included a search for species listed on the *Threatened Species Conservation Act 1995.* Information on the distribution of threatened flora is available from various botanical texts and from the NSW Wildlife Atlas maintained by the National Parks and Wildlife Service. Additional species regarded as rare in Australia are documented by Briggs and Leigh (1996);

these species, known as ROTAP species, were also the subject of survey. The consultant also maintains a regional database of records of threatened plant species. Because of personal experience and the availability of such resources, the consultant is familiar with the threatened species in the area and the habitats in which they occur.

Most of the plant species names in this report are the current names published by the National Herbarium of New South Wales in the *Flora of New South Wales* (Harden 1992 to 2002). The taxonomic names are supplemented by common names obtained from various sources, such as the *Flora* (op. cit.) and *Australian Plant Genera* by Baines (1981) and, for weeds, Richardson, Richardson and Shepherd (2006).

3.2 Plant Species

The Bomaderry Creek area has high plant species diversity, reflecting the presence of sandstone soils that usually support a high diversity of plant species, and the gorge that supports very different moist forest vegetation. A total of 204 native plant species have been recorded there by various people; see **Table 3**. Additionally, 44 introduced plant species (weeds) have been recorded in the area. **Appendix 1** provides a list of the plant species recorded along the two northern route options during the recent surveys (2007/2008). The plant species were recorded within a 60 metre wide corridor centred on the centre line of the road routes, as surveyed by Council and pegged on the ground at the time of the surveys. The Southern route was not surveyed in such detail because it has been ruled out as a possibility due to a very high adverse impact on the gorge environment.

Table 3
Number of Plant Species recorded in the Bomaderry Creek Area

Broad Habitat	Indigenous Plant Species	Introduced Plant Species	Total Species
Gorge	73	29	102
Grey Gum Forest/Woodland	138	30	168
Kunzea Shrubland	24	-	24
Scribbly Gum Woodland	91	10	101
Total	204	44	248

3.3 Plant Communities

The plant communities occurring in the Bomaderry Creek area have been summarised below, in **Table 4**, followed by a general description of each community. The occurrence of these communities along the two northern road route options is shown on the accompanying maps.

Coachwood Warm Temperate Rainforest
CER-WRF
Ceratopetalum apetalum - Backhousia myrtifolia

Occurrence
Coachwood Warm Temperate Rainforest occurs on deep, moist and partially alluvial soils in the gorge of Bomaderry Creek, where it is protected from fire. The main occurrence is along the base of the gorge, downstream from a point about 50 metres below the crossing by the Central route. Lower in the gorge, subtropical rainforest elements occur within the community.

Description
The rainforest reaches a height of about 20 metres and has a closed canopy. This "simple" rainforest is dominated by Coachwood *Ceratopetalum apetalum* and contains just a few other tree species, such as Ironwood *Backhousia myrtifolia*, Sweet Pittosporum *Pittosporum undulatum* and Sandpaper Fig *Ficus coronata*. Water Gum *Tristaniopsis laurina* and River Oak *Casuarina cunninghamiana* occur along the creek. On dry slopes, *Backhousia myrtifolia* dominates the rainforest and emergent eucalypts are common, especially Southern Blue Gum *Eucalyptus saligna/Eucalyptus botryoides*.

Table 4
Plant Communities occurring in the Bomaderry Creek Area

Community	Dominant Species	Occurrence / Route Option(s)
Coachwood Warm Temperate Rainforest	*Ceratopetalum apetalum* *Backhousia myrtifolia*	In the base of the gorge, along the banks of the creek. Only on the Southern route.
Spotted Gum - Turpentine Tall Forest	*Corymbia maculata* *Eucalyptus saligna/ Eucalyptus botryoides* *Syncarpia glomulifera*	On the upper slopes of the gorge, just below the cliffline. Occurs on all three routes.
Grey Gum - Stringybark Forest/Woodland	*Eucalyptus punctata* *Eucalyptus agglomerata*	On gentle slopes above the gorge, usually on rocky ground. Occurs on all route options.
Community	**Dominant Species**	**Occurrence / Route Option(s)**
Scribbly Gum - Casuarina Forest/Woodland	*Eucalyptus sclerophylla* *Allocasuarina littoralis* *Corymbia gummifera*	Across the plateau on all route options.
Scribbly Gum - Bloodwood Woodland	*Eucalyptus sclerophylla* *Corymbia gummifera* *Eucalyptus consideniana*	Across the plateau on all route options.
Kunzea Shrubland	*Kunzea ambigua* *Leptospermum sejunctum*	On broad rock outcrops above the gorge. On the Central route option.
Sandstone Sedgeland	*Melaleuca thymifolia* *Viminaria juncea*	On the plateau, on shallow, moist soils covering broad areas of bedrock.
	Leptospermum spp.	Near to the Central route option.

The understorey contains rainforest species and species that are common in moist eucalypt forest. The characteristic ground layer species in the gorge include Gristle Fern *Blechnum cartilagineum*, Spiny-headed Mat-rush *Lomandra longifolia*, Common Maidenhair Fern *Adiantum aethiopicum*, Soft Bracken *Calochlaena dubia*, Rock Felt Fern *Pyrrosia rupestris*, Yellow Rock Orchid *Liparis reflexa* and Hard Water Fern *Blechnum wattsii*. The weeds among the rocks in the channel include Wandering Jew *Tradescantia albiflora* and Mist Flower *Ageratina riparia*.

Occurrence on Route Options
Occurs on the Southern route and just below the Central route. Some plants from the community occur along the whole length of the riparian zone of Bomaderry Creek, so these species can be found on the Central and Northern routes, but there is no rainforest structure.

Spotted Gum - Turpentine Tall Forest
MAC-SYN
Corymbia maculata - Eucalyptus saligna/Eucalyptus botryoides - Syncarpia glomulifera

Occurrence
Spotted Gum - Turpentine Tall Forest occurs on deep, moist soils below the cliff line. It also extends above the cliff in a few places, albeit with shorter growing trees and a drier understorey.

Description
This community is dominated by Spotted Gum *Corymbia maculata*. The associated tree species are Turpentine *Syncarpia glomulifera* and Southern Blue Gum *Eucalyptus saligna/Eucalyptus botryoides*. Other tree species are present, rainforest tree species such as Sandpaper Fig *Ficus coronata*, Port Jackson Fig *Ficus rubiginosa* and Sweet Pittosporum *Pittosporum undulatum*, and creekside tree species such as Water Gum *Tristaniopsis laurina* and Coachwood *Ceratopetalum apetalum*. A few River Oaks *Casuarina cunninghamiana* also occur in the gorge.

The understorey is quite open in many places, mainly because there is so much rock outcropping. The characteristic understorey species include Soft Bracken *Calochlaena dubia*, Rough-fruited Pittosporum *Pittosporum revolutum*, Blueberry Ash *Elaeocarpus reticulatus*, Common Milk Vine *Marsdenia rostrata*, Bearded Tylophora *Tylophora barbata*, Large Mock-olive *Notelaea venosa*, Blakeley's Bush-pea *Pultenaea blakeleyi* and Gristle Fern *Blechnum cartilagineum*.

Occurrence on Route Options
This forest occurs on all options, but is best developed in the wide gorge around the Southern option; on the other routes the community is mainly growing on sandstone and is of a lower stature.

Grey Gum - Stringybark Forest / Woodland
PUN-AGG
Eucalyptus punctata - Eucalyptus agglomerata

Occurrence
Grey Gum - Stringybark Forest/Woodland occurs on the rocky eastern and western edges of Bomaderry Creek gorge. It is quite distinct from the Spotted Gum Tall Forest below the cliff line, but merges more gradually with the Scribbly Gum woodland to the west of the gorge. Kunzea Shrubland occurs within this community, in discrete patches on rock outcrops; see below.

Description
Grey Gum *Eucalyptus punctata* is the dominant tree species in most places. The other trees present include Blue-leaved Stringybark *Eucalyptus agglomerata*, Spotted Gum *Corymbia maculata* and Red Bloodwood *Corymbia gummifera*. Spotted Gum *Corymbia maculata* is common in small depressions off the main gorge, while Scribbly Gum *Eucalyptus sclerophylla* becomes common on the upslope side.

The understorey, which is rather open, contains species characteristic of rocky ground, e.g. White Kunzea *Kunzea ambigua*, Nowra Teatree *Leptospermum sejunctum*, Mat-rush *Lomandra confertifolia*, Shrubby Platysace *Platysace lanceolatus*, Cockspur Flower *Plectranthus graveolens* and the endangered plant Bomaderry Creek Zieria *Zieria baeuerlenii*.

Occurrence on Route Options
This community occurs on all routes, growing on the edge of the gorge to the east and west of the creek.

Scribbly Gum - Casuarina Forest / Woodland
SCL-CAS
Eucalyptus sclerophylla - Allocasuarina littoralis - Corymbia gummifera

Occurrence
Scribbly Gum - Casuarina Forest/Woodland is similar to and closely associated with the Scribbly Gum - Bloodwood Woodland described below. Both communities occur on the plateau and the demarcation between the two communities is not always distinct. The Scribbly Gum - Casuarina Forest/Woodland contains taller and denser trees, the structure tends towards forest, Black She-oak *Allocasuarina littoralis* is present and is often a dominant small tree, while the understorey is less heathy. It is probably growing on deeper soils than the following woodland.

Description
This community is dominated by Scribbly Gum *Eucalyptus sclerophylla*, Black She-oak *Allocasuarina littoralis* and Red Bloodwood *Corymbia gummifera*. Black She-oak forms dense stands in some places, but this would vary with fire history. Old Man Banksia *Banksia serrata*, a medium-sized tree species, is common in some places.

The understorey is characterised by shrubs such as Mountain Devil *Lambertia formosa*, Finger Hakea *Hakea dactyloides*, Paperbark Teatree *Leptospermum trinervium*, Conesticks *Petrophile pedunculata* and Soft Geebung *Persoonia mollis.* It is not particularly diverse, probably because the tree canopy is fairly dense.

Occurrence on Route Options:
This community occurs mainly in the north-western part of the Bomaderry Creek bushland; it is on the western parts of the Northern and Central routes.

Scribbly Gum - Bloodwood Woodland
SCL-GUM
Eucalyptus sclerophylla - Corymbia gummifera - Eucalyptus consideniana

Occurrence
Scribbly Gum - Bloodwood Woodland occurs across the plateau. It is more common and has a wider distribution than any other community in the Bomaderry Creek area.

Description
This community is dominated by Scribbly Gum *Eucalyptus sclerophylla* and Red Bloodwood *Corymbia gummifera*. The associated tree species are Stringybark *Eucalyptus imitans* and Yertchuk *Eucalyptus consideniana*. Medium-sized trees of Old Man Banksia *Banksia serrata* and Black She-oak *Allocasuarina littoralis* occur here and there.

The understorey is heathy and rich with shrub species such as Broad-leaved Geebung *Persoonia levis*, Mountain Devil *Lambertia formosa*, Swamp Banksia *Banksia paludosa*, Stalked Conestick *Petrophile pedunculata*, Finger Hakea *Hakea dactyloides*, Paperbark Teatree *Leptospermum trinervium*, Wreath Bush-pea *Pultenaea tuberculata* and Heath Phyllota *Phyllota phyllicoides.* The common ground cover species include Twisted Mat-rush *Lomandra obliqua*, Speargrass *Stipa* sp., Holly Lomatia *Lomatia ilicifolia*, Curly Wig *Caustis flexuosa* and Wiry Panic *Entolasia stricta*.

Occurrence on Route Options
This is the most common plant community on all three routes, extending across most of the area west of the gorge.

Kunzea Shrubland
KUN-SHR
Kunzea ambigua - Leptospermum sejunctum

Occurrence: Kunzea Shrubland occurs on the rocky eastern and western edges of Bomaderry Creek gorge. It occurs within the Grey Gum - Stringybark Forest/Woodland, as discrete patches on rock outcrops.

Description: This community is dominated by large shrubs of White Kunzea *Kunzea ambigua* and Nowra Teatree *Leptospermum sejunctum*. Other species that typically occur on rock outcrops also occur in this community, for example Coral Heath *Epacris micropylla*, Mulga Fern *Cheilanthes sieberi*, Creeping Raspwort *Gonocarpus micranthus* and Scale-rush *Lepyrodia scariosa*; however, floristic diversity is low because the shrubland grows on rather bare rock outcrops.

Occurrence on Route Options

This community occurs on a broad rock outcrop on the Central route, just west of the gorge, extending to the north.

Sandstone Sedgeland
SST-SDG

Occurrence: Sedgeland occurs here and there on the plateau, on poorly drained sites with shallow soils over the sandstone bedrock.

Description: This community, which varies from a sedgeland to shrubland, is dominated by species that prefer swampy to moist soil conditions. The common shrub species include Thyme Honey-myrtle *Melaleuca thymifolia*, Narrow-leaved Paperbark *Melaleuca linariifolia*, Yellow Teatree *Leptospermum polygalifolium*, Golden Spray *Viminaria juncea* and Prickly-leaved Teatree *Leptospermum juniperinum*. The common characteristic smaller species include Coral Heath *Epacris microphylla*, Scale-rush *Lepyrodia scariosa*, Creeping Raspwort *Gonocarpus macranthus*, Rocket Goodenia *Goodenia bellidifolia* and the sedge *Ptilothrix deusta*.

Occurrence on Route Options
This community occurs mainly to the west of the gorge where broad sandstone surfaces are close to the surface; the community is close to but not on the Central route.

Summary of Plant Communities Impacted
The extent of each plant community that is likely to be impacted by each route option is set out in **Table 5**; these areas have been determined from the vegetation maps accompanying this report.

Table 5
Plant Communities Impacted by the Route Options

Community	Northern Route	Central Route	Southern Route
Coachwood Warm Temperate Rainforest	-	-	Present
Spotted Gum–Turpentine Tall Forest	1.0 ha	0.08 ha	Present
Grey Gum–Stringybark Forest/Woodland	0.06 ha	0.08 ha	Present
Scribbly Gum–Casuarina Forest/Woodland	1.2 ha	0.13 ha	Present
Scribbly Gum–Bloodwood Woodland	-	1.3 ha	Present
Kunzea Shrubland	-	0.05 ha	-
Sandstone Sedgeland	-	-	-
Total	2.2 ha	1.5 ha	2.7 ha

'-' means not present on route option.

4 THE FAUNA

4.1 Fauna Survey Methods

Intensive fauna surveys were undertaken previously in the project area between November 1998 and February 1999, although most of the survey work was undertaken in January 1999. The study concentrated on mammals, birds, reptiles and frogs. The general survey methods, which included daytime searches, spotlight surveys at night, call playback sessions and a bat survey, are discussed below. Other surveys have been undertaken since that time, but these were not as intensive. The earlier results are considered to be valid as little environmental change has occurred in the area, as confirmed by resent surveys.

Habitats
Daytime surveys were undertaken to identify the range of fauna habitats in and adjacent to the project area. The diversity of habitats was noted and the value of these habitats was

assessed, based on what is currently known about the life cycle requirements of native fauna species.

Mammals

Daytime Searches

Daytime searches for mammals were undertaken, although this method is mostly only useful for the detection of larger species such as the macropods. The daytime surveys also included a search for the indications of the presence of mammals, such as scats and dung, diggings, tracks and burrows; see Triggs (1996). The whole project area and the nearby Bomaderry Creek bushland were searched for these signs of mammal activity throughout the study period.

Nocturnal Searches

Nocturnal surveys were undertaken with a high-powered spotlight to locate nocturnal mammals, especially arboreal species such as possums and gliders. The consultant also listened for animal calls. All of the project area was searched by these methods on each nocturnal survey. Call playback tapes were used to illicit responses from Yellow-bellied Gliders.

Survey of Bats

A bat survey was undertaken on several evenings in January and February 1999 to identify the microchiropteran bats on the site; Titley Anabat II ultrasonic detectors were utilised. The recorded signals were later analysed using a Titley ANABAT II Zero Crossing Analysis Interface Module linked to a computer.

Birds

Daytime Observations

The bird surveys were composed of (i) general observations during all field work in the study area and (ii) timed searches and bird counts in all habitats in the project area. Twelve counts were conducted; each count was one hour in duration. The counts were undertaken in the morning or late in the afternoon when, with the exception of the nocturnal species, birds are generally most active. On each occasion, the count was conducted along transects through every habitat type in the project area. The birds were either directly observed or were identified by interpretation of their call.

Night time Observations

Night time surveys were undertaken to identify any nocturnal bird species present in the project area. The nocturnal birds surveys were conducted at the same time as the spotlighting for mammals. Call playback sessions were undertaken to illicit responses from the Powerful Owl and Sooty Owl.

Reptiles

Daytime Searches

Searches were undertaken in potential habitat niches and refuges, such as under logs, rocks and debris. Suitable basking sites were also targeted, such as in full sun on bare earth and beside water. Incidental observations were made during other field work.

Frogs

Daytime Searches

Daytime searches were undertaken for frogs in suitable hiding places and a few species were heard calling during the daytime.

Nightime Surveys

Nightime frog surveys were also undertaken. Frogs were sought with a spotlight, mainly in moist locations. The characteristic calls of the male frogs also enabled identification of the species present.

Nomenclature

The fauna species names in this report are based on Strahan (1995) for mammals, Churchill (1998) for bats, Christidis and Boles (1994) for birds and Cogger (1992) for amphibians and reptiles.

Summary of fauna Survey Effort
A summary of fauna survey effort in the study area during 1999 is provided in **Table 6**; it should also be appreciated that the consultant, and several other people whose reports are noted elsewhere in this document, have spent a considerable amount of time in the Bomaderry Creek bushland since 1989. Information about the intensive 1999 fauna surveys in and near the project area is provided in **Figure 2**.

4.2 Habitats

The habitat types in the Bomaderry Creek area are, of course, closely associated with the plant communities described in Section 3.3. The habitat occurs within three main environments, namely: (i) plateau woodland and forest, mainly with a heathy understorey; (ii) the gorge, with extensive rocky areas, and rainforest and ponds; and (iii) cleared land, with weedy patches and large areas of bare ground. These habitats have been described below, and occur on all three route options.

i. Plateau Woodland and Forest
Woodland with a heathy understorey is the most common type of habitat in the Bomaderry Creek area. The density and height of the heathland varies from place to place, depending largely on the fire history. The trees are generally not particularly large; however, large Scribbly Gums occur here and there, and the woodland then tends towards forest. The stands of Black She-oak are a feature of the forest near Illaroo Road.

Shrubland occurs in patches within the woodland, in dry conditions on expansive rock outcrops. The shrubland habitat can be quite dense, and reaches a height of about four metres. Only occasional trees are present. The underlying soils are often shallow and dry, but can be quite moist where they are deeper, because of seepage across the subterranean rock surface.

Table 6
Summary of Fauna Survey Effort in the Project Area

Group/Method	Date	Time	Hours	Notes
Arboreal Mammals (spotlighting)	27.01.99	08.30-11.00	2.5 hrs	Spotlighting was undertaken intensively within the project area; all surveys extended outside the subject site to the north and south.
	09.02.99	08.10-10.40	2.5 hrs	
	17.02.99	09.17-11.20	2.0 hrs	
	23.02.99	08.15-09.17	1.0 hr	
	23.02.99	10.07-10.37	0.5 hrs	
	02.03.99	08.00-10.45	2.75 hrs	
Bats	27.01.99	08.30-10.00 (2 recorders)	3.0 hrs	Bat survey sites were mainly in the subject site, other sites were in then gorge to the south of the subject site.
	09.02.99	08.10-10.40 (2 recorders)	2.5 hrs	
	17.02.99	08.30-11.00 (2 recorders)	4.5 hrs	
	23.02.99	08.08-10.08 (2 recorders)	2.0 hrs	
	02.02.99	8.00-9.15	45 mins	
	02.02.99	9.45-10.30	45 mins	
Frogs	09.02.99	08.10-10.40	2.5 hrs	This only lists specific surveys on wet nights; frog surveys were carried out on all visits. All spotlighting surveys included areas of potential Giant Burrowing Frog habitat.
Owl Playback	17.02.99	08.30-09.00	1.0 hr	
	23.02.99	08.30-09.00	0.5 hrs	

Habitat Searches (diurnal)	27.01.99	-	4.0 hrs	Times listed are diurnal searches for fauna, e.g. owl roost sites. Incidental time spent doing other field work where fauna was also recorded is not included.
	09.02.99	-	1.25 hrs	
	18.02.99	-	2.0 hrs	
	23.02.99	-	1.5 hrs	
	02.03.99	-	1.5 hrs	

ii. The Gorge

The habitats in the gorge consist of rock outcrops, some cliff-lined and extensive, tall forest with large trees, closed forest (rainforest) and the creek, itself, with its rocky bottom and pools of water. The rock outcrops and tall dense forest are the most prominent features; these features contrast markedly with the woodland in the surrounding area. Bomaderry Creek is a permanent stream. The permanent pools are up to several metres deep and are linked by rocky rapids.

Forest occurs in the gorge and on the adjoining slopes. Spotted Gum and Grey Gum are the main tree species. The largest trees, which are more than 30 metres tall, occur on deep alluvial soils. The trees along the upper edge of the gorge are smaller, because the conditions are drier and rockier. The forest in the gorge is rather dense and contains rainforest, at least in the lower part of the gorge.

iii. Cleared Land

The vegetation within the electricity transmission line easement along the Central route is cleared routinely for asset maintenance; as a result, the habitat in this area consists of bare ground and regenerating natives. The old gravel quarry near Illaroo Road, also along the Central route, is becoming covered by regenerating Black She-oaks. There has been extensive clearing in the vicinity of Narang Road; this area is now covered by weeds and regenerating native plants, including a few patches of trees.

4.3 Fauna Species Recorded in the Bomaderry Creek Area

Twenty-one (21) native mammal species have been recorded in the Bomaderry Creek area; these consist of six (6) terrestrial mammal species, four (4) arboreal mammals, ten (10) bat species and one (1) aquatic mammal, the Platypus. Four introduced mammals species have also been recorded in the area. These species have been listed in **Appendix 2**. Note that the lists are compiled from all available sources, primarily between about 1995 and 2008.

The Swamp Wallaby *Wallabia bicolor* is probably the most common large terrestrial mammal in the Bomaderry Creek area. The Short-beaked Echidna *Tachyglossus aculeatus* is probably common at certain times of year. The Eastern Grey Kangaroo *Macropus giganteus* and Common Wombat *Vombatus ursinus* are less common. Dogs, cats, foxes and rabbits are probably all common in the area.

Four arboreal mammal species have been recorded during nocturnal surveys in this area; i.e. the Sugar Glider *Petaurus breviceps*, Common Ringtail Possum *Pseudocheirus peregrinus*, Common Brushtail Possum *Trichosurus vulpecula* and Yellow-bellied Glider *Petaurus australis*.

Arboreal mammals are uncommon in the Bomaderry Creek area, probably because most of the bushland is on nutrient-poor sandstone soils. Most of the arboreal mammals were found in forest, in and near the gorge. Of the nine sightings of arboreal mammals during a survey in 1999, all but one were in the Grey Gum and Spotted Gum communities near the gorge; only one arboreal mammal was observed in woodland. Low numbers of arboreal species from the woodland is consistent with the results of many other surveys throughout the district.

Ten (10) bat species have been recorded at in the Bomaderry Creek area; i.e. the Grey-headed flying-fox *Pteropus poliocephalus* and nine small insectivorous bat species. Eighty-three (83) bird species have been recorded in the Bomaderry Creek area, including four introduced species; see Appendix 2.

Seventeen (17) reptile species and 11 frog species have been recorded in the Bomaderry Creek area, as listed in **Appendix 2**.

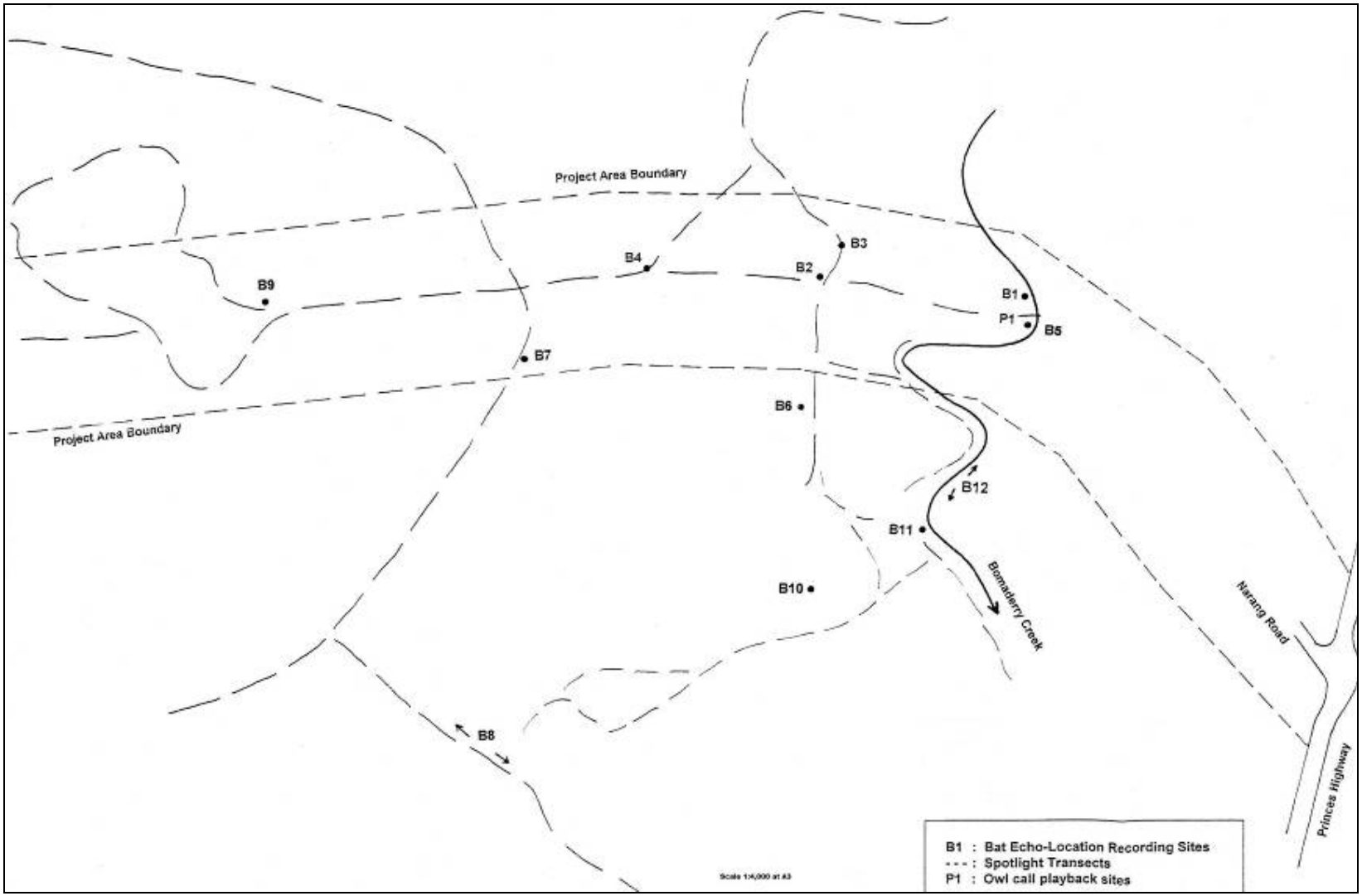

Figure 2. Fauna Survey Information.

5 CONSERVATION VALUES

5.1 Threatened Species

5.1.1 Threatened Flora

Two threatened plant species are known to occur in the Bomaderry Creek area, mainly around the edge of the gorge. These species have been listed below, in **Table 7**. More information on the threatened plant species has been provided in **Appendix 3**. More information on the two threatened plants at Bomaderry Creek, *Zieria bauerlenii* and *Eucalyptus langleyi* is provided below.

Zieria baeuerlenii
The distribution of *Zieria baeuerlenii* in the area is shown on **Figure 5**, some of which are near the Central route option. The closest individual plant is 13 metres north of the road centre line, to the west of the gorge; see attached plan. The NPWS report entitled "Recommendation for the Identification of Critical Habitat for the Bomaderry Zieria" contains a good summary of what is known about this species (NPWS 2002).

Eucalyptus langleyi
At Bomaderry Creek two plants occur on the centre line of the Central road route, while other plants occur from 25 metres to about 100 metres to the north of the centre line, mostly well outside the area affected by the construction of the road. Some plants also occur to the south of the picnic area on the southern side of the route.

5.1.2 Rare Plant Species

In addition to the above threatened plant species, three rare species are known in the area; these are rare or threatened Australian plants (ROTAP) identified by Briggs and Leigh (1996). These species are listed in **Table 7** and discussed in **Appendix 3**. Appendix 4 explains the conservation codes used by Briggs and Leigh (1996).

5.1.3 Threatened Fauna

Seven or possibly eight threatened fauna species have been recorded in the Bomaderry Creek area; some are possibly resident, while most are occasional visitors; see **Table 8**. The species of most concern are those that are resident within the area, as is the habitat that is significant to these species that would be impacted by the proposed road. A species profile for each relevant threatened animal species is provided in **Appendix 5.**

The following summary assists in the assessment of the potential impact on threatened species of fauna. Notes on each relevant threatened fauna species at Bomaderry Creek are provide below.

Itinerant visitors	Possible resident species	Resident species
Grey-headed Flying-fox Gang-gang Cockatoo Glossy Black-Cockatoo Masked Owl Square-tailed Kite	Large-footed Myotis Giant Burrowing Frog	Yellow-bellied Glider

Resident Species
Yellow-bellied Glider
The Yellow-bellied Glider occurs in the forests around the gorge, as shown on **Figure 3.** Past surveys heard the species in the forest near the gorge to the south of the Central route. It was considered at the time that the area supported at least two family groups. The main area of identified habitat is shown on **Figure 3**. This habitat occurs on all routes, with the northern route on its northern edge and the other routes traversing the core area of habitat.

Possible resident Species

Giant Burrowing Frog

The occurrence of this frog in the area is problematical. Other than one possible call heard in 1992, the species has not been found at Bomaderry Creek. The Central route traverses the area containing suitable moist sandstone habitat.

Large-footed Myotis

The Myotis was recorded in the gorge in pervious bat surveys; see **Figure 4.** The main habitat features of importance are the pools along the creek and, possibly, the caves where roosting could occur.

Itinerant visitors

Grey-headed Flying-fox

Likely to be a regular summer visitor to the forests in the area. The forests would be a small part of a very large foraging area utilised by the bats. A summer camp may be present in the lower gorge where rainforest occurs, but this has not been confirmed.

Gang-gang Cockatoo

Likely to be a regular visitor to the forests in the area, particularly in winter when the birds range widely.

Glossy Black-Cockatoo

This cockatoo forages in the area where stands of *Allocasuarina littoralis* are found; i.e. primarily in the north-western part of the Bomaderry Creek bushland. The foraging habitat has been mapped along the Northern and Central routes; see attached maps.

Masked Owl

The masked Owl occurs widely in the region, and has a large foraging territory. It has been recorded in the area once and may occasionally visit the bushland.

Square-tailed Kite

The kite is a regular summer breeding visitor to the Nowra – Jervis Bay area. the Bomaderry Creek bushland is part of its very large foraging area covering many thousands of hectares.

5.2 Plant Communities

5.2.1 Endangered Ecological Communities

The low altitude Coachwood Rainforest growing in the Bomaderry Creek gorge is a warm temperate rainforest (Mills & Jakeman 1995); this rainforest is specifically excluded from the endangered ecological community known as Lowland Rainforest. Small stands of rainforest in the lower gorge could, however, meet the criteria for Lowland Rainforest because of the presence of more subtropical species and the higher diversity of plant species. This rainforest only occurs on the Southern route option.

5.2.2 Other Communities

The plant communities around Bomaderry Creek are generally common and widespread in the region. The most restricted is the low altitude Coachwood Rainforest in the gorge; this is regarded as having regional conservation significance, although it is not listed as endangered as it does not meet the criteria for Lowland Rainforest, as discussed above.

5.3 Endangered Populations

Endangered populations are declared under the *Threatened Species Conservation Act 1995* (NSW). There are no such populations in or near the Bomaderry Creek area.

Table 7
Botanically Significant Plant Species in the Bomaderry Creek Area

Species	Family	Habit	Status	Occurrence on Route Options[1]		
				Northern	Central	Southern
Threatened Species						
Eucalyptus langleyi	Myrtaceae	Mallee	vulnerable	-	yes	-
Zieria baeuerlenii	Rutaceae	Shrub	endangered	-	very close	-
ROTAP Species						
Acacia subtilinervis	Fabaceae	Shrub	3RCa[2]	-	yes	-
Leptospermum sejunctum	Myrtaceae	Shrub	2K	-	yes	-
Rulingia hermanniifolia	Sterculiaceae	Shrub	3RCa	-	yes	-

1. '-' means not present.
2. Conservation classification after Briggs & Leigh (1996); see Appendix 4.

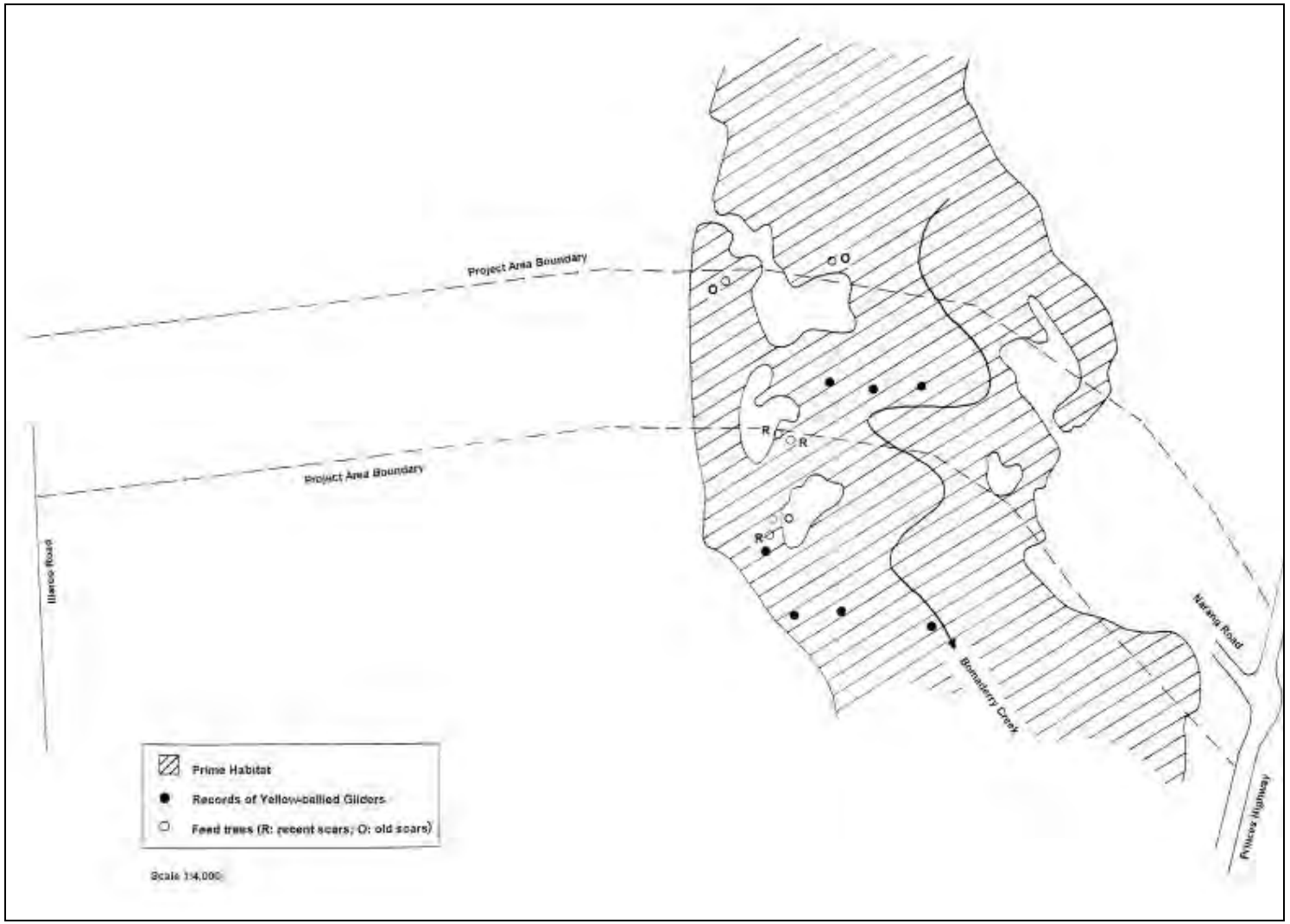

Figure 3. The Extent of Yellow-bellied Glider Habitat.
(This extends to the south and north along Bomaderry Creek.)

Table 8
Threatened Fauna Species records in the Bomaderry Creek Area

Species	Date(s)	Location / Habitat / Route Option(s)	Reference
Mammals			
Grey-headed Flying-fox	1990s	Throughout the region in summer, specific sites are used for camps. Likely to forage in all treed habitats of the Bomaderry Creek area. Foraging habitat occurs along all route options while the gorge forest on the Southern route option has potential as a camp site.	K. Mills
Large-footed Myotis	Jan-Feb 1996 02.03.1999	Recorded at nine of ten sites along the creek in 1996; present in 1999. Pools provide foraging habitat while the adjacent caves may provide roosting opportunities. Habitat occurs on the Central and Southern route options. See Figure 4.	Parnaby (1996) K. Mills
Yellow-bellied Glider	May 1992 Jan-Feb 1999	In the tall forest along the gorge, regularly recorded during nocturnal surveys along Bomaderry Creek gorge. Evidence of feeding can be seen on the Grey Gum trees near the gorge. Probably denning in the tall Spotted Gums in the gorge. Habitat is mainly on the Central and Southern route options. See Figure 3.	Symbiosis (1992) K. Mills
Birds			
Gang-gang Cockatoo	Occasional	In forest generally; widespread and moderately common through the region. There is probably an element of migration during winter when birds visit the coastal lowlands. Habitat occurs along all three route options.	K. Mills
Glossy Black-Cockatoo	1995, 1999 2007	Chewed casuarina cones were found from Pitt Street to West Cambewarra Road and along the Northern and Central route options during all surveys. See attached maps.	K. Mills
Masked Owl	1996	"Bomaderry Creek" is the only location information, exact location unknown. Could occur throughout the forested parts of all three route options.	IBOC Newsletter No.192
Square-tailed Kite	27.01.99 03.10.07	Flying low over woodland on both occasions. Regularly visits the Nowra area in summer when it breeds in the area. A relatively small amount of foraging habitat occurs along each route option compared to the very large territory of this species.	K. Mills K. Mills
Frogs			
Giant Burrowing Frog	May 1992	North of the transmission line. G. Daly and A. York heard a single call by a frog they thought could have been a Giant Burrowing Frog. Record has apparently never been substantiated, despite numerous surveys in the area.	Mitchell McCotter (1993)

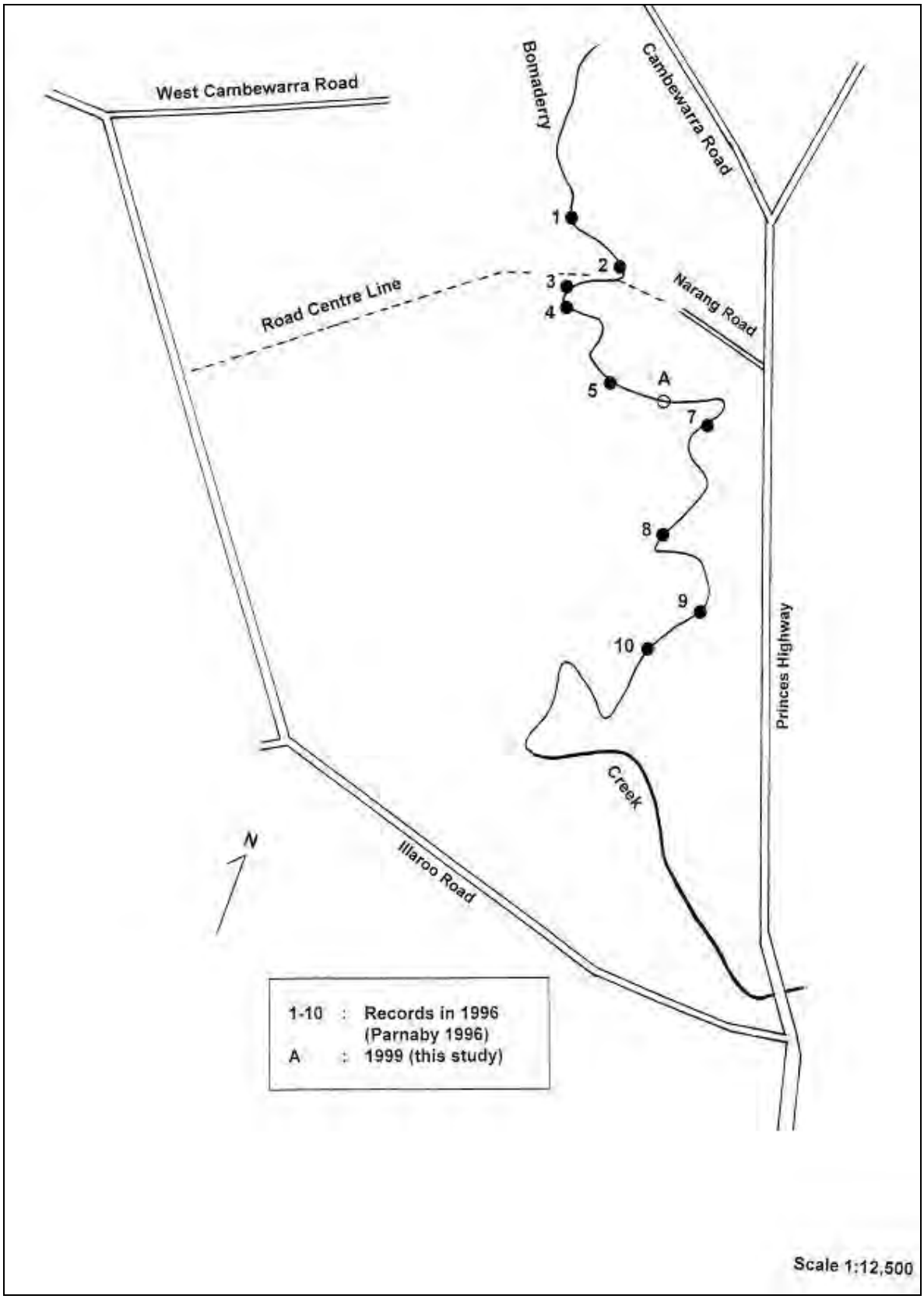

Figure 4. Records of Large-footed Myotis.

5.4 Critical Habitat

There is no critical habitat, as provided for under the *Threatened Species Conservation Act 1995* (NSW), in the Bomaderry Creek area. In 2002, the National Parks & Wildlife Service prepared a report documenting a proposal for a large section of the Bomaderry Creek area to be gazetted as critical habitat for the locally endemic plant species *Zieria baeuerlenii* (NPWS 2002). **Figure 5** provides a copy of their draft map. The proposed gazettal did not proceed.

5.5 Riparian Habitat

Riparian habitats include the Bomaderry Creek and associated vegetation. Riparian vegetation is defined as 'vegetation on land that adjoins, directly influences or is influenced by, a water body or watercourse'.

All three route options cross Bomaderry Creek and would require some removal of riparian vegetation. The Southern route would probably have the greatest impact, as the creek gorge at that point is wide and deep and undisturbed. The Central route is disturbed by an existing pipeline and a powerline, and crosses a site where a weir used to be constructed before it was breached. The Northern route crossing is largely undisturbed, although located just below cleared paddocks.

5.6 Key Threatening Processes

Key threatening processes in New South Wales are listed under the *Threatened Species Conservation Act* 1995 and the *Fisheries Management Act 1994* (FMA Act). A threat abatement plan must be prepared for each listed key threatening process under Part 5 of the TSC Act, although only three such plans have so far been finalised. Key threatening processes are the things that threaten - or could threaten - the survival or evolutionary development of species, populations or ecological communities. The list of key threatening processes is a good list for the threats to be considered when assessing development proposals. Other threats certainly exist and these should be considered where relevant; for example, road-kill (death through collision with motor vehicle).

The applicability of these processes to the proposed road at North Nowra has been summarised below. Those matters flagged in the list would need to be considered along with any other relevant threat at the detailed project application stage. These processes apply to each route fairly equally although the Southern route would cause more clearing and more disturbance; see summary in **Table 9**.

5.7 Recovery Plans

Recovery plans are prepared and approved under Part 4 of the *Threatened Species Conservation Act 1995*. The purpose of a recovery plan is to promote the recovery of a threatened species, population or ecological community with the aim of returning the species, population or ecological community to a position of viability in nature.

The only relevant recovery plan that has either been finalised or that is pending finalisation as at July 2008 is a final plan for the Yellow-bellied Glider. This plan would need to be considered further at the detailed project application stage, when mitigation measures would need to be carefully considered; see discussion at 5.1.3.

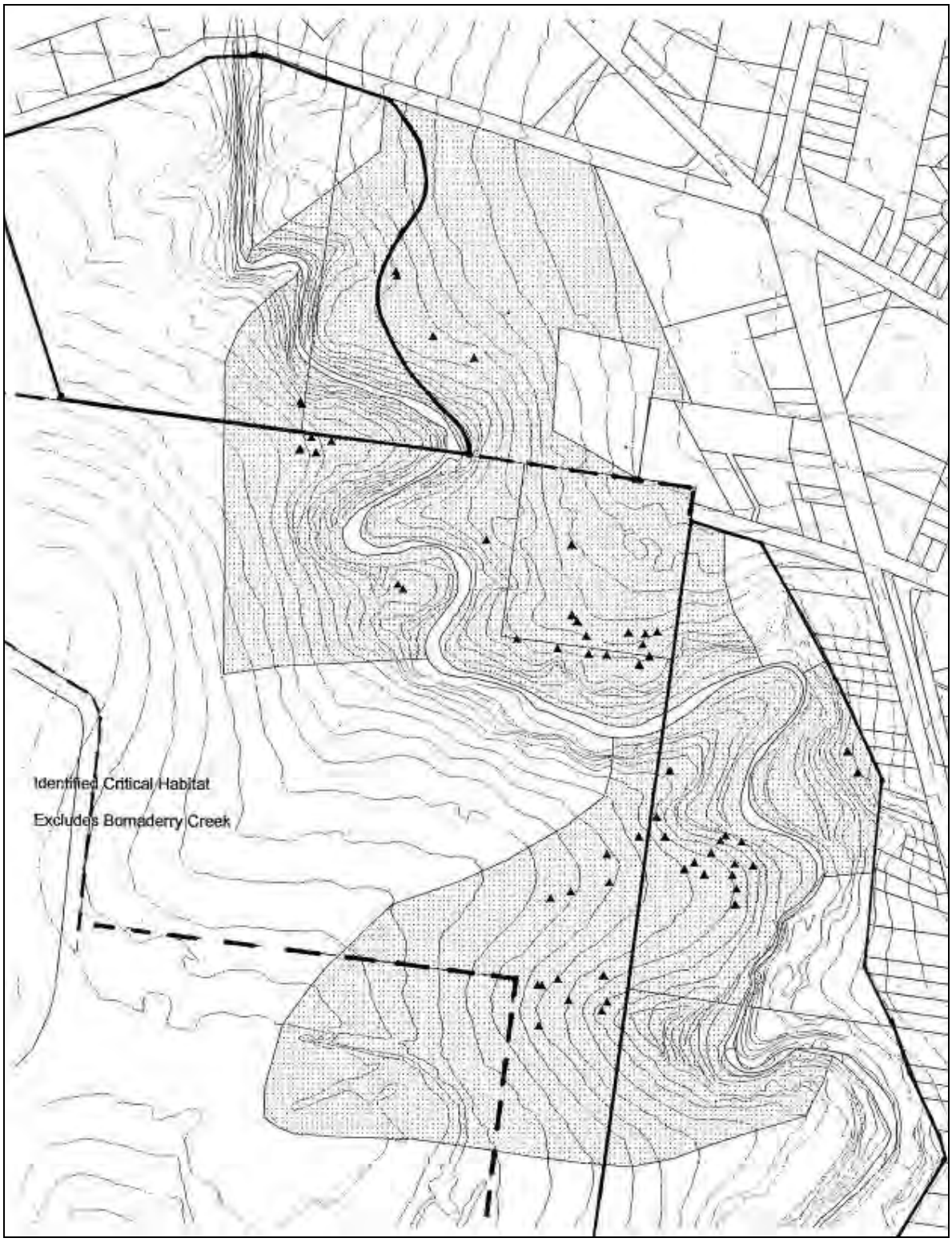

Figure 5.
Distribution of *Zieria baeuerlenii*
The solid black lines are the boundaries of the proposed dedicated land.
The broken lines are the current boundaries of Bomaderry Creek Regional Park.
(Source: Critical habitat report by NPWS 2002.)

Key Threatening Process	Relevant
TSC Act	
Weeds	
Invasion and establishment of exotic vines and scramblers	no
Invasion and establishment of Scotch Broom *Cytisus scoparius*	no
Invasion of native plant communities by bitou bush *Chrysanthemoides monilifera* and boneseed	no
Invasion of native plant communities by exotic perennial grasses	possible
Invasion, establishment and spread of *Lantana camara*	no
Pest Animals	
Competition and grazing by feral European Rabbit	no
Competition and habitat degradation by Feral Goats	no
Competition from Feral Honey Bees	no
Herbivory and environmental degradation caused by feral deer	no
Importation of Red Imported Fire Ants	no
Introduction of the Large Earth Bumblebee	no
Invasion and establishment of the Cane Toad *Bufo marinus*	no
Invasion of the Yellow Crazy Ant, *Anoplolepis gracilipes*	no
Predation by the Feral Cat	no
Predation by the European Red Fox	no
Predation by Plague Minnow *Gambusia holbrooki*	no
Predation from the Ship Rat on Lord Howe Island	no
Impact of Feral Pigs	no
Habitat loss/change	
Alteration to the natural flow regimes of rivers, etc.	no
Bushrock removal	yes
Clearing of native vegetation	yes
Alteration of habitat following subsidence due to longwall mining	no
High frequency fire resulting in the disruption of life cycle processes	no
Anthropogenic Climate Change	minor
Loss and/or degradation of sites used for hill-topping by butterflies	no
Loss of hollow-bearing trees	yes
Removal of dead wood and dead trees	yes
Diseases	
Infection by Psittacine Circoviral Disease in Parrots	no
Infection of frogs by amphibian chytrid	no
Infection of native plants by *Phytophthora cinnamomi*	no
Other Threats	
Death or injury to marine species following capture in shark control programs	no
Entanglement in or ingestion of anthropogenic debris in marine and estuarine environments	no
FM Act	
Current shark meshing program	no
Hook and line fishing in areas with threatened fish	no
Introduction of fish to fresh waters	no
The removal of large woody debris	no
The degradation of native riparian vegetation	yes
Instream structures altering natural river flow regimes	possible
Introduction of fish and vegetation to coastal waters	no

6 BOMADERRY CREEK REGIONAL PARK

Regional Parks are dedicated under Section 30H of the *National Parks and Wildlife Act 1974* (NSW) and have the following purpose and management objectives. While Regional Parks are managed for their nature conservation values, they are also managed to provide recreational opportunities.

"30H Regional Parks

(1) The purpose of reserving land as a regional park is to identify, protect and conserve areas in a natural or modified landscape that are suitable for public recreation and

enjoyment so as to enable those areas to be managed in accordance with subsection (2).

(2) A regional park is to be managed in accordance with the following principles:
   (a) the provision of opportunities, in an outdoor setting, for recreation and enjoyment in natural or modified landscapes,
   (b) the identification, interpretation, management and conservation of the park so as to maintain and enhance significant landscape values,
   (c) the conservation of natural and cultural values,
   (d) the promotion of public appreciation and understanding of the regional park's natural and cultural values,
   (e) provision for sustainable visitor use and enjoyment that is compatible with the conservation of the regional park's natural and cultural values,
   (f) provision for the sustainable use (including adaptive reuse) of any buildings or structures or modified natural areas having regard to the conservation of the regional park's natural and cultural values."

Bomaderry Creek Regional Park was dedicated in March 2002 under Section 30H of the *National Parks and Wildlife Act 1974*. The Park is managed by the South Coast Region of the National Parks and Wildlife Service of New South Wales, and currently has an area of 82 hectares. The plan of management for the park has not yet been completed, although the Bushfire Management Plan has been finalised.

6.1 Revocation Requirements

All three route options traverse the Bomaderry Creek Regional Park, involving distances of, from Northern to Southern options, 330 metres, 740 metres and 60 metres, respectively. Assuming a 30 metre wide corridor would be required to be revoked for a road, the area revoked for each route would be, from north to south, approximately 1.0 hectare, 2.2 hectares and 0.2 hectares, respectively.

The revocation of a protected area gazetted under the *National Parks and Wildlife Act 1974* (NSW) requires an act of parliament passed by both houses of Parliament. The policy on revocation of reserves is contained in the document titled Revocation of Land Policy (NPWS 2002). The Minister's letter dated April 2006 makes it clear that "revocation of reserved land will generally be undertaken as an avenue of last resort and only where no other practical options are available" (see also Policy no. 10 in the above document). That letter goes on to state that "in terms of area at least, the transfer of such a large area of high conservation value land to the regional Park would more than offset the relatively small loss associated with the construction of the link road."

Any proposal to revoke part of the Bomaderry Creek Regional Park would have to demonstrate that the road proposal was "essential and that the public value of the proposed activity outweighs any conservation loss" (see Policy no. 11 in the above document).

6.2 Fragmentation of the Park

The fragmentation of natural areas can have a significant impact on native plants and animals. Fragmentation here means the breaking up of a contiguous area of habitat into smaller patches through the creation of different habitat, particularly cleared land, or the imposition of barriers, such as fences. The impact of fragmentation is greatest where the original area of natural habitat is small.

The impact of fragmentation on plants and animals will be different for different species and in different habitats. The impact of a two lane road on birds will, in the main, be minor, while the impact on small to medium sized mammals may be high, not the least because of roadkill. Plants generally may not be impacted by roads, however for species that only or mostly propagate through vegetative means a road is an ultimate barrier.

The problem of barriers to fauna movement has been addressed through various measures, including maintaining overhanging trees wherever possible, building fauna bridges over cuttings, constructing road underpasses in association with drift fences and installing tall poles each side of the barrier (road) to facilitate crossings by gliding arboreal mammals.

6.3 Indirect Impacts and Edge Effects

In addition to the removal of habitat, road construction can have indirect impacts, particularly in regard to weed invasion, vegetation die-back and adverse impacts from motor vehicle use. The chief concerns for roads through natural areas include stormwater management and vehicle use off the formed roadway. Stormwater runoff, in particular, adds nutrients, extra water and weed seeds to otherwise undisturbed natural areas, leading to adverse changes to the habitat values of the area. Unrestrained vehicle access usually leads to impacts on the natural environment such as damage to ground habitats, removal of bush rock and firewood, vandalism, rubbish dumping and arson, often associated with the abandonment of stolen motor vehicles. All road options have the potential to impact on the bushland in the above ways.

The so-called 'edge effect' is where impacts occur along an edge to a habitat because of the adjoining land use or activity. An example would be the invasion of weeds due to increased runoff and nutrients, and possibly light, into habitat adjoining a new road. Most edge effects can be controlled through appropriate design of the development and through on-going management. Some impacts, however, cannot be avoided because the character of the local environment is permanently modified.

In terms of the road options investigated here, the potential for edge effects to occur is related to road design and construction parameters as well as the length of 'edge' exposed. All road options have the potential to cause edge effects on the local bushland, particularly the Southern option around the gorge where there is currently no significant disturbances to the natural environment.

7 COMMONWEALTH LEGISLATION

Environment Protection and Biodiversity Conservation Act 1999

The impact of a proposed action on matters of national environmental significance is assessed under the provisions of the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

Matters of national environmental significance are World Heritage properties, National Heritage places, wetlands of international importance (RAMSAR wetlands), threatened species and ecological communities listed under the EPBC Act, migratory species listed under the EPBC Act, Commonwealth marine environment, and nuclear actions (including uranium mining).

An "action" is a project, a development, an undertaking, an activity or a series of activities, and an alteration of any of the above. An action can be on Commonwealth land, State land council land, private land, or water.

Approval is required from the Commonwealth Environment Minister for actions that are likely to have a significant impact on a matter of national environmental significance; these are called "controlled actions". A proposed action is a "controlled action" if:

- is likely to have a significant impact on a matter of national environmental significance,
- is likely to have a significant impact on the environment of Commonwealth land,
- is to be undertaken on Commonwealth land and is likely to have a significant impact on the environment anywhere, and
- is an action to be taken by the Commonwealth that is likely to have a significant impact on the environment anywhere.

Only the Commonwealth can advise definitively whether a proposed action is a controlled action; however, the Department of the Environment and Heritage has prepared guidelines to facilitate a self-assessment process to help proponents decide whether an action is likely be a controlled action that should be referred to the Minister for assessment and approval. The document is titled *Significant Impact Guidelines: Matters of National Environmental Significance* (DEWR May 2006).

The Bilateral Agreement

The Agreement between the Commonwealth of Australia and the State of New South Wales relating to environmental impact assessment (Australian Government 2007), referred to as the Bilateral Agreement, accredits the assessment regimes under Part 3A, Part 4 and Part 5 of the EP&A Act for assessment purposes under the EPBC Act. The Bilateral Agreement applies to "controlled actions" in relation to matters of national environmental significance, with the exception of nuclear actions.

The following implications of the agreement for environmental impact assessment processes in New South Wales have been set out by the NSW Department of Planning in their Guide to Implementation in NSW (NSW Department of Planning 2007).

"Prior to the Bilateral Agreement, the NSW assessment process was accredited by the Commonwealth on a project by project basis when a full assessment was required under the EPBC Act. This avoided the need to assess the developments under both Acts. Now under the Bilateral Agreement, project by project accreditation of the process is no longer required.

Following the assessment and determination under the EPA Act, the Assessment Report and determination including approval conditions (if approved) is forwarded to the Department of the Environment and Water Resources. This means that there is no longer a need for parallel assessments by the Commonwealth and the NSW government for controlled actions, and that projects which require approval from both the State and Commonwealth would only be assessed once – by a State agency or a council. The same assessment is then used by both the State and the Commonwealth to determine whether to approve the proposal.

The Bilateral Agreement will only apply to projects that are determined to be controlled actions by the Commonwealth. These projects may be assessed under the Bilateral Agreement if Part 3A, Part 4 and Part 5 of the EPA Act apply. . . The Bilateral Agreement does not apply to developments that affect Commonwealth land or developments undertaken by Commonwealth agencies. Such developments will need to be assessed separately by the Commonwealth and NSW State governments.

The Bilateral Agreement only provides for accreditation of the specified state assessment processes to meet the assessment requirements of the EPBC Act. The Commonwealth will still need to issue a separate approval for the development (based on the state assessment and approval conditions)."

Assessment under the EPBC Act

The following questions in the *Significant Impact Guidelines* (DEWR May 2006) must be addressed when deciding whether or not to refer a proposed action to the Commonwealth Minister for the Environment:

1. Are there any matters of national environmental significance located in the area of the proposed action (noting that 'the area of the proposed action' is broader than the immediate location where the action is undertaken; consider also whether there are any matters of national environmental significance adjacent to or downstream from the immediate location that may potentially be impacted)?

2. Considering the proposed action at its broadest scope (that is, considering all stages and components of the action, and all related activities and infrastructure), is there potential for impacts, including indirect impacts, on matters of national environmental significance?

3. Are there any proposed measures to avoid or reduce impacts on matters of national environmental significance (and if so, is the effectiveness of these measures certain enough to reduce the level of impact below the 'significant impact' threshold)?

4. Are any impacts of the proposed action on matters of national environmental significance likely to be significant impacts (important, notable, or of consequence, having regard to their context or intensity)?

An action must be referred to the Commonwealth Minister if the action has, will have, or is likely to have a significant impact on matters of national environmental significance. In addition to setting out "significant impact criteria" for the various matters of national environmental significance, e.g. endangered species, vulnerable species, endangered ecological communities and listed migratory species, the *Guidelines* provide the following important definitions.

"A *significant impact* is an impact which is important, notable, or of consequence, having regard to its context or intensity. Whether or not an action is likely to have a significant impact depends upon the sensitivity, value, and quality of the environment which is impacted, and upon the intensity, duration, magnitude and geographic extent of the impacts. You should consider all of these factors when determining whether an action is likely to have a significant impact on matters of national environmental significance."

"To be *likely*, it is not necessary for a significant impact to have a greater than 50% chance of happening, it is sufficient if a significant impact on the environment is a real or not remote chance or possibility."

"*Population*, in relation to critically endangered, endangered or vulnerable, threatened species, means:

- a geographically distinct regional population, or collection of local populations; or
- a regional population, or collection of local populations occurring within a particular bioregion."

"An *important population* is a population that is necessary for a species' long-term survival and recovery. This may include populations identified as such in recovery plans, and/or that are:

- key source populations either for breeding or dispersal,
- populations that are necessary for maintaining genetic diversity, and/or
- populations that are near the limit of the species' range.

"*Habitat critical to the survival of a species or ecological community*" refers to areas that are necessary:

- for activities such as foraging, breeding, roosting, or dispersal;
- for the long-term maintenance of the species or ecological community (including the maintenance of species essential to the survival of the species or ecological community, such as pollinators);
- to maintain genetic diversity and long term evolutionary development, or
- for the reintroduction of populations or recovery of the species or ecological community."

Such habitat may be, but is not limited to: habitat identified in a recovery plan for the species or ecological community as habitat critical for that species or ecological community; and/or habitat listed on the Register of Critical Habitat maintained by the Minister under the EPBC Act.

The Grey-headed Flying-fox is the only nationally listed threatened fauna species recorded at Bomaderry Creek. Two nationally threatened plant species occur in the area; these are *Zieria baeuerlenii* and *Eucalyptus langleyi.* These species are assessed below under the relevant assessment criteria.

Significant Impact Criteria for Critically Endangered and Endangered Species
An action is likely to have a significant impact on a critically endangered or endangered species if there is a real chance or possibility that it will:

- lead to a long-term decrease in the size of a population;
- reduce the area of occupancy of the species;
- fragment an existing population into two or more populations;
- adversely affect habitat critical to the survival of a species;
- disrupt the breeding cycle of a population;
- modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline;
- result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species' habitat;
- introduce disease that may cause the species to decline; or interfere with the recovery of the species.

Impact of the Proposed Action Zieria baeuerlenii
There are two plants of the Bomaderry Creek Zieria *Zieria baeuerlenii* located about 13 metres north of the centre line of the Central route option, just to the west of the gorge. Many other plants occur further away to the north. A Central road option could have a significant impact upon this species as it may fragment the population by creating a permanent barrier to further expansion and interaction of the species, which apparently reproduce only vegetatively.

It would have to be demonstrated that through careful design, construction and operation, the impact on this species was avoided; this includes management of stormwater and invasive species (weeds) that are harmful to the species.

Significant Impact Criteria for Vulnerable Species
An action is likely to have a significant impact on a vulnerable species if there is a real chance or possibility that it will:

- lead to a long-term decrease in the size of an important population of a species;
- reduce the area of occupancy of an important population;
- fragment an existing important population into two or more populations;
- adversely affect habitat critical to the survival of a species;
- disrupt the breeding cycle of an important population;
- modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline;
- result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat;
- introduce disease that may cause the species to decline; or
- interfere substantially with the recovery of the species.

Impact of the Proposed on Grey-headed Flying-foxes
The development of either the Northern or Central route option is unlikely to have a significant impact on Grey-headed Flying-foxes; in both cases a minute amount of foraging habitat would be impacted. The gorge on the Southern option may contain an "important population" of Grey-headed Flying-foxes, as defined above, if it is used as a camp site.

Impact of the Proposed Action on Eucalyptus langleyi
Two plants of Nowra Mallee-Ash *Eucalyptus langleyi* occur on the Central route option; other specimens are over 25 metres to the north. These two plants, located just to the east of the gorge crossing point, would be destroyed to construct the Central route option. The action will lead to a decrease in the size of a local population, albeit by only two specimens.

Significant Impact Criteria for Listed Migratory Species
An action is likely to have a significant impact on a migratory species if there is a real chance or possibility that it will:

- substantially modify (including by fragmenting, altering fire regimes, altering nutrient cycles or altering hydrological cycles), destroy or isolate an area of important habitat for a migratory species;

- result in an invasive species that is harmful to the migratory species becoming established in an area of important habitat for the migratory species; or
- seriously disrupt the lifecycle (breeding, feeding, migration or resting behaviour) of an ecologically significant proportion of the population of a migratory species.

An area of "important habitat" for a migratory species is:
- habitat utilised by a migratory species occasionally or periodically within a region that supports an ecologically significant proportion of the population of the species; and/or
- habitat that is of critical importance to the species at particular life-cycle stages; and/or
- habitat utilised by a migratory species which is at the limit of the species range; and/or
- habitat within an area where the species is declining.

Listed migratory species cover a broad range of species with different life cycles and population sizes. An "ecologically significant proportion" of a population therefore varies from species to species.

In relation to migratory species, "population" means the entire population or any geographically separate part of the population of any species or lower taxon of wild animals, a significant proportion of whose members cyclically and predictably cross one or more national jurisdictional boundaries including Australia.

Impact of the Proposed Action on Listed Migratory Species
The proposed road, whichever route is selected, is not likely to have a significant impact on listed migratory species. There is no important habitat in the area for such species and the habitat in the vicinity is not likely to support an ecologically important proportion of a population of a listed migratory species. Small numbers of listed migratory species do occur in the area, such as diurnal birds of prey, but none of these species congregate in the area.

Conclusion, EPBC Act
Our assessment has found that construction of the Northern route option would likely involve:
- no impact on threatened plants;
- no impact on threatened animals;
- no impact on migratory species; and
- no impact on threatened ecological communities.

In our opinion, the Northern route option would be unlikely to have a significant impact on matters of national environmental significance and that referral of the Northern route option to the Commonwealth for assessment is not warranted.

Our assessment has found that construction of the Central route option would likely involve:
- destruction of two plants of the vulnerable plant species *Eucalyptus langleyi*;
- the potential to impact upon a population of the endangered plant *Zieria baeuerlenii;*
- no impact on threatened animals;
- no impact on migratory species; and
- no impact on threatened ecological communities.

Because of the likely impacts as set out above, it is our opinion that referral of the Central route option to the Commonwealth for assessment should be explored with the relevant department, as it is only the Commonwealth who can decide if it is a controlled action.

Our assessment has found that construction of the Southern route option would involve:
- no impact on threatened plants;
- no impact on threatened animals, unless a Grey-headed Flying-fox camp occurs in the gorge;
- no impact on migratory species; and
- no impact on threatened ecological communities.

In our opinion, referral of the Southern route option to the Commonwealth is probably not warranted, unless a camp of the Grey-headed Flying-fox occurs in the gorge on or near the route option.

8 COMPARISON OF THE ROUTE OPTIONS

8.1 Summary of Impact of Route Options

The following flora and fauna parameters were used to compare the three route options; these parameters are summarised in **Table 9**.

State Matters
- Presence of threatened flora species;
- Area of identified critical habitat (draft document);
- Presence of threatened fauna species;
- Presence of endangered ecological communities;
- Presence of rare plant (ROTAP) species;
- Presence of riparian habitat;
- Land within the Bomaderry Creek Regional Park;
- Fragmentation of the Regional Park;
- Area of natural vegetation to be cleared.

Commonwealth Matters
- Presence of threatened plants;
- Presence of threatened animals;
- Habitat for migratory species.

Council has indicated that it is willing to dedicate about 50 hectares of land that they have control over as part of the Bomaderry Creek Regional Park in compensation for the clearing of bushland to construct the road, and for revocation of a part of the park. This land is described in the next section of the report.

8.2 Threatened Plants

Zieria baeuerlenii
This species does not occur on or near the Northern or Southern routes. As noted elsewhere, two plants on the edge of a large population occur about 13 metres north of the centreline of the Central option. This would be within the proposed 30 metre wide road easement. Construction activities would be very close to these two plants and particular attention would have to be given to the design and construction of the road in this area. In particular, there is a danger of impacting upon these plants and the broader population just to the north through changes to runoff and impacts of contaminated stormwater from the road. The Central route therefore has the potential to impact upon *Zieria baeuerlenii*.

Eucalyptus langleyi
This species does not occur on the Northern or Southern routes. Populations occur to the east of the gorge to the north and south of the Central route, with two plants growing on the centre line on the edge of the gorge. The Central route would therefore result in the loss of two plants of *Eucalyptus langleyi*.

8.3 Threatened Fauna

Several threatened fauna species occur in the Bomaderry Creek area. The only confirmed resident is the Yellow-bellied Glider, with two additional species that may be resident, namely the Large-footed Myotis and Giant Burrowing Frog. Foraging habitat of the Glossy Black-cockatoo would be removed by the Northern and Central routes. Other species may occur there from time to time; these are regarded as itinerant visitors. The impact upon these three species is assessed below.

Table 9
Summary of Key Flora and Fauna Issues

	Northern Route	Central Route	Southern Route
STATE MATTERS			
Threatened Species - Plants			
Zieria baeuerlenii Bomaderry Creek Zieria	na	Two plants occur about 13 metres north of the centre line. Other plants further north.	na
Significance of issue:	na	Potentially high.	na
Zieria baeuerlenii Draft Critical Habitat	nil	~1.7 hectares[2]	~0.3 hectares[2]
Significance of issue:	na	potential high	low
Eucalyptus langleyi Nowra Mallee-Ash	na	Two plants occur on the centre line, other plants are 25m+ to the north.	na
Significance of issue:	na	low	na
Threatened Species - Animals			
Yellow-bellied Glider *Petaurus australis*	On edge of potential habitat.	Known habitat on both sides of route.	Known habitat on both sides of route.
Significance of issue:	low	potentially high	potentially high
Glossy Black-Cockatoo *Calyptorhynchus lathami*	Habitat present, feeding evidence found; ~ 100 m² of habitat removed[2].	Habitat present, feeding evidence found; ~1,750 m² of habitat removed[2].	No foraging habitat present.
Significance of issue:	low	low	na
Large-footed Myotis *Myotis adversus*	Foraging habitat present downstream.	Known foraging and potential roosting habitat present along creek.	Known foraging and potential roosting habitat present along creek.
Significance of issue:	na	probably low	probably low
Giant Burrowing Frog *Heleioporus australiacus*	Edge of potential breeding habitat.	Potential breeding habitat both sides of route.	Probably no breeding habitat present.
	Probably low	unknown	unknown
Grey-headed Flying-fox *Pteropus poliocephalus*	Foraging habitat present.	Foraging habitat present.	Foraging habitat present. Camp site possible in gorge forest.
Significance of issue:	low	low	probably low

Table 9 cont...
Summary of Key Flora and Fauna Issues

	Northern Route	**Central Route**	**Southern Route**
Gang-gang Cockatoo *Callocephalon fimbriatum* Significance of issue:	Foraging habitat present. low	Foraging habitat present, potential nest trees present nearby. low	Foraging habitat present, potential nest trees present. Probably low
Masked Owl *Tyto novaehollandiae* Significance of issue:	Foraging habitat present. low	Foraging habitat present, potential nest trees present nearby. low	Foraging habitat present, potential nest trees present nearby. Probably low
Square-tailed Kite *Lophoictinia isura* Significance of issue:	Foraging habitat present. low	Foraging habitat present. low	Foraging habitat present. low
Endangered Ecological Communities Significance of issue:	na na	na na	Gorge may contain Lowland Rainforest. unknown
ROTAP Species *Acacia subtilinervis* Wattle Significance of issue:	na na	<100 plants on route corridor. low	Not known to be present. na
Leptospermum sejunctum Nowra Teatree Significance of issue:	na na	<50 plants on route corridor. low	Not known to be present. na
Rulingia hermanniifolia Wrinkled Kerrawang Significance of issue:	na na	Previously recorded on route corridor. unknown	Not known to be present. unknown
Riparian Habitats Significance of issue:	Crosses Bomaderry Creek. low	Crosses Bomaderry Creek in gorge. probably low	Crosses Bomaderry Creek in gorge. Possibly high
Bomaderry Creek Regional Park Revocation required[1] Significance of issue:	1.0 hectare moderate	2.2 hectares moderate	0.2 hectares low

Table 9 cont...
Summary of Key Flora and Fauna Issues

	Northern Route	**Central Route**	**Southern Route**
Fragmentation of Regional Park	Located on far northern edge of park.	Cuts park across centre.	Mostly outside southern edge of park.
Significance of issue:	moderate	high	low
Natural Vegetation to be cleared[1]	2.2 hectares	1.5 hectares	2.7 hectares
Significance of issue:	low	low	low
COMMONWEALTH MATTERS			
Threatened Species - Plants			
Zieria baeuerlenii Bomaderry Creek Zieria	na	Two plants occur about 13 metres north of the centre line; other plants further north.	na
Significance of issue:	na	potentially high	na
Eucalyptus langleyi Nowra Mallee-Ash	na	Two plants occur on the centre line, other plants are 25m+ to the north.	na
Significance of issue:	na	low	na
Threatened Species - Animals			
Grey-headed Flying-fox *Pteropus poliocephalus*	Foraging habitat present.	Foraging habitat present.	Foraging habitat present. Camp site possible in gorge forest.
Significance of issue:	low	low	Probably low; presence of camp would be significant.
Habitat for Migratory Species			
Waterfowl	na	na	na
Seabirds	na	na	na
Diurnal birds of prey	na	na	na
Other birds	na	na	na
Reptiles	na	na	na
Invertebrates	na	na	na

1. Assumes a 30 metre wide corridor is required.
2. Assumes a clearing corridor of 15 metres width.

Yellow-bellied Glider
The habitat of the Yellow-bellied Glider, Spotted Gum forest and adjoining Grey Gum forest/woodland, occurs on all routes. The Northern route traverses the edge of the habitat, while the Central and Northern routes would create a significant clearing across high quality, undisturbed forest. The least impact on the habitat of the glider is the Northern route because it is located on the edge of the habitat and there is no tall Spotted Gum forest involved.

Large-footed Myotis
Myotis forage on the pools along Bomaderry Creek and possibly roost in the caves in the gorge. None of the routes is likely to directly impact upon the pools. Potential roosting caves would also be likely to be avoided by the bridge across the gorge (Central and Southern routes) as it is well above the gorge. In summary, none of the routes are likely to seriously impact upon the Large-footed Myotis.

Giant Burrowing Frog
The presence of the Giant Burrowing Frog has never been confirmed in the area, although habitat that is suitable for the species is present. This habitat is in and near the poorly drained areas along the western side of the gorge. This habitat occurs to the north and south of the Central route, but is probably absent from the Northern and Southern routes. The Northern route is unlikely to have any impact on the frog, while the Central and Southern routes could, if the species is present, bisect the habitat of the frog.

Glossy Black-Cockatoo
Small areas of foraging habitat would be removed by the Northern and Central routes. This is used by occasional visits by the local population of the cockatoo. Mitigation would involve revegetating currently cleared areas with *Allocasuarina littoralis*, such as the old gravel pit in the area of existing stands of this tree.

8.4 Endangered Ecological Communities

Small pockets of rainforest in the lower gorge probably qualify as Lowland Rainforest in the NSW North Coast and Sydney Basin Bioregions. This rainforest only occurs on the Southern route.

8.5 Draft Critical Habitat

The proposal for a large section of the Bomaderry Creek area to be gazetted as critical habitat for *Zieria baeuerlenii* was mentioned above (NPWS 2002). The gazettal did not proceed, although a map was prepared.

Figure 5 provides a copy of the draft map. The Northern route does not traverse any land delineated as critical habitat in the critical habitat identification report (NPWS 2002). The Central route extends for about 670 metres across land identified as critical habitat in the above report. The Southern route traverses a distance of 110 metres across the identified critical habitat on the far south-eastern corner of the area.

9 ASSESSMENT UNDER PART 3A

As this project is being assessed under Part 3A of the *EP&A* Act, where relevant this investigation and report follow the *Guidelines for Threatened Species Assessment* (DEC 2005); see Section 1.4.

Step 1 – Preliminary Assessment
"The main purpose of a preliminary assessment is to determine the likelihood of the study area and subject site supporting threatened species" (*Guidelines*, page 2). As noted in the *Guidelines*, this step is primarily a 'desktop' study, using existing information, literature and

data bases to identify relevant threatened species. The *Guidelines* state that the following matters should be included in the preliminary assessment:

- a description of the location and nature of the proposed development;
- a description of dominant vegetation types;
- a description of habitat features;
- a list of threatened species that are known or likely to occur within the study area;
- an assessment of which of the threatened species that are known or likely to occur are likely to be directly or indirectly affected by the proposal provides a list of factors for consideration in identifying adverse impacts. This list is not necessarily exhaustive and is not development-specific." (*Guidelines*, page 3)

The matters identified under Step 1 in the *Guidelines* are dealt with in the previous sections of this report or in the accompanying documentation (description of the development). In particular, Sections 3 and 4 describe the flora and fauna of the area and Section 5 describes the conservation values, including threatened species. Potential adverse impacts of the route options are described in Sections 5 to 8.

Step 2 – Field Survey and Assessment

As noted in the *Guidelines*, "the required intensity and extent of survey will vary greatly depending upon the species likely to be present, size of the development area, the level of biological and habitat diversity on the site, and the type and complexity of vegetation on the site." (*Guidelines*, page 3)

The *Guidelines* point out the need "to ensure that a reliable assessment of the presence or absence of threatened species can be made" (*Guidelines*, page 3). It is also noted that consideration needs to be given to the relevance of climatic or seasonal conditions for the target species.

Where relevant, the survey methods set out in the document titled *Threatened Species Survey & Assessment: Guidelines for Developments and Activities* (DEC 2004) should be followed. As noted above, the level of the survey will very much depend upon site conditions.

The outcome of Step 2 should be that adequate field surveys are undertaken for all target species identified in Step 1 such that confident statements can be made regarding the potential for the presence of the species on the subject site and hence the level of impact that would be expected. In some instances, the precautionary principle should be adopted and the presence of a species assumed for the purposes of impact assessment.

The survey methods are set out in detail in Sections 3 and 4 of this report. The surveys that have been undertaken by Kevin Mills & Associates and others over many years provide an adequate basis for assessing the road route options in terms of comparing the potential impact of the options.

Step 3 – Evaluation of Impact

This step involves identifying the potential magnitude and extent of the impact, if any, the development will have on each of the target species.

The *Guidelines* suggest that "impacts will be more significant if:

- areas of high conservation value are affected;
- individual animals and/or plants and/or subpopulations that are likely to be affected by the proposal play an important role in maintaining the long-term viability of the species, population or ecological community;
- habitat features that are likely to be affected by the proposal play an important role in maintaining the long-term viability of the species, population or ecological community;
- the duration of impacts are long-term;
- the impacts are permanent and irreversible." (*Guidelines* page 4)

Section 8 discusses the key issues and their relative importance, while **Table 9** provides a comparison of the potential impact of the three road route options. This comparison is specific to each identified threatened species and other significant flora and fauna issue.

Step 4 – Avoid, mitigate and then offset

Where there is a potential to impact on threatened species, this should be addressed through, firstly, avoiding the impact; this may mean making some changes to the proposed development. If avoidance is not possible, then some form of mitigation may be required. Finally, if neither avoidance nor mitigation is possible, then some form of offset or compensation will be required. This could entail the rehabilitation of similar habitat nearby.

The Northern route option would avoid almost all significant impacts on threatened species, except for the removal of a relatively small area of foraging habitat for the Glossy Black-Cockatoo and possibly the Yellow-bellied Glider. This loss could be readily mitigated through revegetation of nearby bare areas with *Allocasuarina littoralis* and forest trees.

The Central option cannot avoid an impact on *Eucalyptus langleyi* as two plants are in the middle of the route. Moving the route, if this was possible, to the north or south would then impact on other species and/or more plants of *Eucalyptus langleyi.* The impact on *Zieria baeuerlenii* could be avoided (the closest plants are 13 metres away from the centre line); this would require special design, construction and operational techniques. This option could not avoid the creation of a barrier for the population of this plant to the north from all other populations that occur further on the south. This impact could not be mitigated.

The Central route would bisect the forest habitat of the Yellow-bellied glider, although little additional clearing of this forest would be needed as the power line easement is already cleared through this area. A 15 metre wide clearing is probably not a significant barrier for the glider. This route also bisects the potential habitat of the Giant Burrowing Frog; the road potentially imposes a significant barrier to the movement of this species.

The Southern route option would probably impact upon an endangered ecological community known as Lowland Rainforest, would impact upon the habitat of the Yellow-bellied Glider and could impact upon a camp of the Grey-headed Flying-fox, if it occurs in the gorge in this area. Most of this impact could not be avoided because a crossing of the deep gorge must occur as part of the Southern route. The major impact is upon the gorge environment; this would be significant because of the location of the crossing and the angle the road route would have to take across the gorge.

Table 10 summarises the mitigation measures that would be required to address the potential impact upon flora and fauna for each route. Most of these relate to road design and construction and detail can only be provided once the route is chosen and detailed road design is undertaken. The issue of compensation for impacts on the habitat of flora and fauna is also a matter for consideration.

Step 5 – Key thresholds

The *Guidelines* state that "the development application needs to contain a justification of the preferred option based on:

- whether or not the proposal, including actions to avoid or mitigate impacts or compensate to prevent unavoidable impacts will maintain or improve biodiversity values;
- whether or not the proposal is likely to reduce the long-term viability of a local population of the species, population or ecological community;
- whether or not the proposal is likely to accelerate the extinction of the species, population or ecological community or place it at risk of extinction;
- whether or not the proposal will adversely affect critical habitat." (*Guidelines* page 4)

Table 10 ***Mitigation Measures for Potential Impacts***		
Key Issue	**Route**	**Measures**
Stormwater Management	Northern	Standard water management techniques; see other documentation.
	Central	Standard water management techniques; see other documentation. Particular care and special design are required near the *Zieria baeuerlenii* population (see below).
	Southern	Standard water management techniques; see other documentation.
Protection of gorge environment	Northern	Standard water management techniques; see other documentation. As the route is not in the gorge, the main focus is on water quality.
	Central	Standard water management techniques; see other documentation. Careful bridge design and construction required.
	Southern	Standard water management techniques; see other documentation. Careful bridge design and construction required.
Protection of the endangered plant *Zieria baeuerlenii*	Northern	Not applicable.
	Central	Special design measures are required along the section west of the gorge to project the population of *Zieria baeuerlenii*. Measures would include minimising the width of the road at the location, building stormwater control structures to take water away from the site, fencing the edge of the road, and taking measures during the construction period to protect the site.
	Southern	Not applicable.
Protection of other threatened species	Northern	Minimise the footprint of the road.
	Central	Minimise the footprint of the road, particularly to the immediate west of the gorge. Measures are required to provide opportunities for Yellow-bellied Gliders to cross the road and to allow ground fauna to underpass the road.
	Southern	Minimise the footprint of the road, particularly in and around the gorge. Measures are required to provide opportunities for Yellow-bellied Gliders to cross the road and to allow ground fauna to underpass the road.

Table 10 cont... ***Mitigation Measures for Potential Impacts***		
Protection of Bomaderry Creek Regional Park	All routes	The following are minimum requirements for protecting the Park from impacts emanating from the road: - avoid places for vehicles to stop beside the road; - fence the road to stop vehicle incursion into the park and bushland; - design appropriate stormwater control structures; - take above measures to minimise impact on threatened species. Additional measures for the Central route: - make provision for the walking track below the bridge, and possibly a crossing point at another location further to the west.
Compensation in the form of dedication of land for conservation purposes (i.e. added to the Regional Park) is required.	Northern	Land dedication required because: Revocation of part of Regional Park. Clearing of threatened species habitat, i.e. Glossy Black-Cockatoo, Yellow-bellied Glider.
	Central	Land dedication required because: Revocation of part of Regional Park. Clearing of threatened species habitat, i.e. Glossy Black-Cockatoo, Yellow-bellied Glider. Loss of two specimens of *Eucalyptus langleyi*; this should involve inclusion of the population of this species to the north of the Central route in the land to be dedicated (currently outside identified land).
	Southern	Land dedication required because: Revocation of part of Regional Park. Clearing of threatened species habitat, i.e. Yellow-bellied Glider. Major impact upon the gorge environment.
Compensation in the form of revegetation/regeneration of habitat may be required.	Northern	Revegetation required because: Habitat of Glossy Black-Cockatoo cleared. Potential habitat of Yellow-bellied Glider cleared.
	Central	Revegetation required because: Habitat of Glossy Black-Cockatoo cleared. Habitat of Yellow-bellied Glider cleared. Habitat of rare plant species removed.
	Southern	Revegetation required because: Habitat of Yellow-bellied Glider cleared. Good quality moist forest habitat cleared. An endangered ecological community, Lowland Rainforest probably cleared.

Appendix 3 to the *Guidelines* contains more detail for identifying potential impacts on threatened species.

It is not the role of this report to justify any particular route, but to describe and compare each route in terms of flora and fauna values. The above matters for justification must be considered once a preferred option is identified.

10 LAND TO BE DEDICATED

If the Central route for the North Nowra Link Road is adopted, Shoalhaven City Council has committed to providing 50 hectares of compensatory land for inclusion into the Bomaderry Creek Regional Park. With the additional 50 hectares, the total area of the regional park would be 132 hectares, which is an increase of 61%.

The land to be dedicated is in three parcels, of 4 hectares, 18 hectares and 28 hectares, and is located to the north, east and south of the existing Park; see **Figure 6**. Owned by Shoalhaven City Council, the land is on both sides of the gorge and includes a substantial length of the gorge.

One of the key outcomes of the dedication of the land would be the inclusion of almost all of the known colonies of the local endemic *Zieria baeuerlenii*. As previously discussed, *Zieria baeuerlenii* is an endangered plant species endemic to the Bomaderry Creek area.

The map attached to the NPWS (2002) report, a copy of which is provided in **Figure 5**, shows the distribution of the *Zieria baeuerlenii* colonies throughout the area. The information below is based on the NPWS map shown in **Figure 5**. The land that would be dedicated contains approximately 37% of the *Zieria baeuerlenii* colonies. The area of critical habitat identified for the species (NPWS 2002) shows a similar pattern.

	Populations of Zieria		Draft Critical Habitat	
	No. of Colonies	Proportion of Total Colonies	Area	Proportion of Total Area
Regional Park	34	60%	30 ha	51%
Dedication	21	37%	22 ha	37%
Other Land	2	3%	7 ha	12%
Total	57	100%	59 ha	100%

Thus, 60% of the colonies occur in the Regional Park and 37% occur on the land identified for dedication. Council's proposed dedication would bring almost the entire population of this species, 55 of the 57 colonies (97%) into the reserve. The two additional colonies are on Council's land below the tennis courts at the end of Narang Road.

The flora and fauna conservation benefits of the land dedication can be summarised in the following way:

(i) *Zieria baeuerlenii*
Zieria baeuerlenii will be better represented within a protected area than at present. Of the known populations, 97% would be within the park, up from the current 60%. The area of identified critical habitat within such a reserve, would increase to 88%, up from the current 51%.

(ii) Habitat for Yellow-bellied Glider
The known habitat along Bomaderry Creek gorge would be almost entirely included in the park; only about one third of the habitat is included in the existing park.

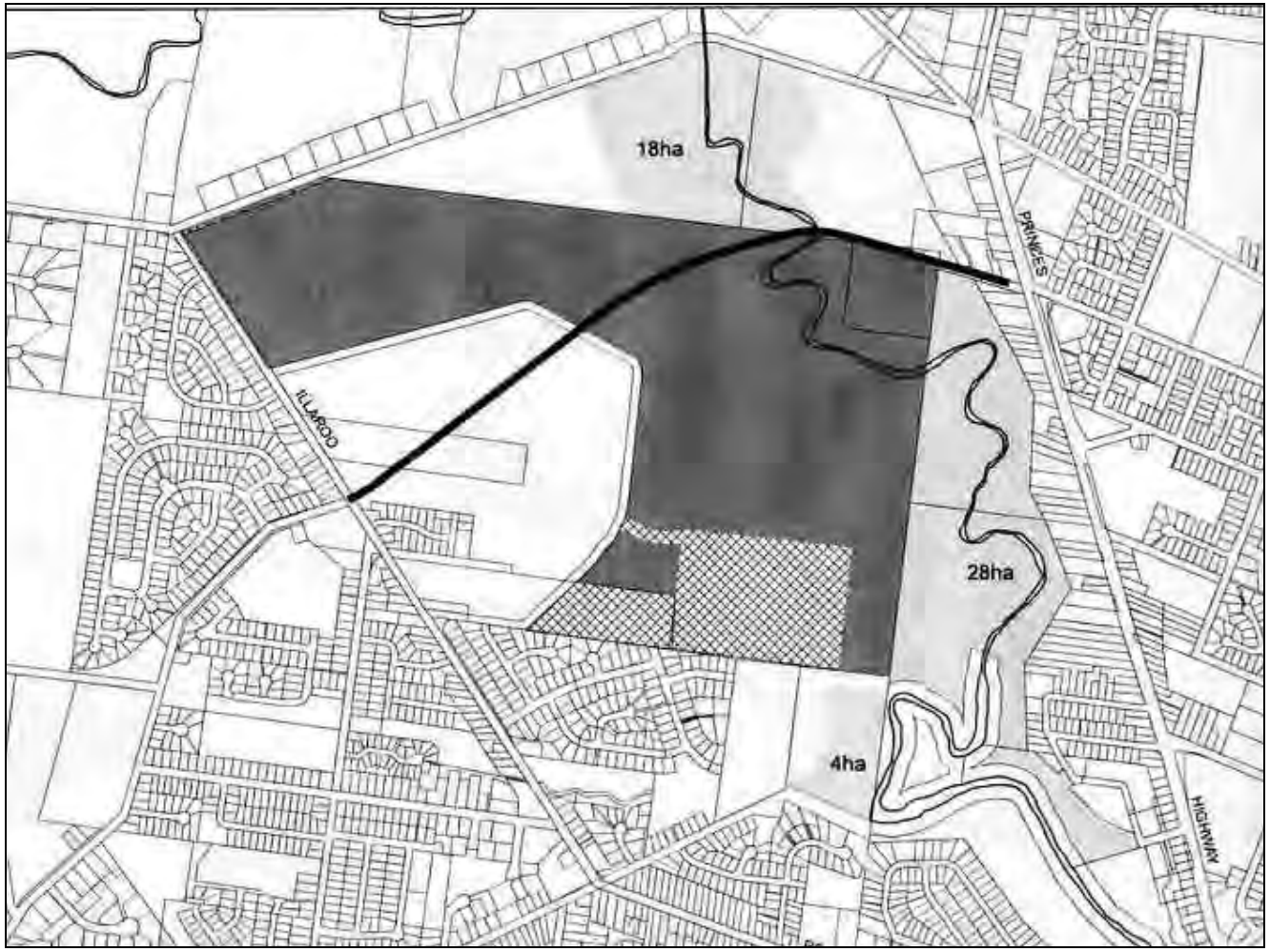

Figure 6.
Land Proposed for Dedication.
(Land for dedication is grey; Bomaderry Regional Park is black)

(iii) Habitat for Large-footed Myotis
All of the pools on Bomaderry Creek where the bat was recorded previously would be incorporated into the park; most of the creek habitat is mostly outside the existing park.

(iv) Habitat for rare species
The additions to the park contain known habitat for two rare species, namely: *Acacia subtilinervis* and *Leptospermum sejunctum*.

(v) Habitat for Significant Vegetation
Rainforest in the gorge, best described as low altitude subtropical/warm temperate rainforest, part of which may be an endangered ecological community, would be added to the park. Most of this rainforest is currently outside the park, the dedication bringing most of this rainforest into the park.

In addition to the biodiversity gains to be made through the dedication of the land, there will be several benefits in terms of park management. These management benefits include a substantial increase in the size of the Regional Park, the inclusion of both sides of Bomaderry Creek within the Park and the inclusion of all existing recreational facilities, e.g. walking tracks. This will result in the reserve being managed more efficiently and effectively, and the whole Bomaderry Creek area being managed as an integrated management unit.

It is likely that any revocation of the Bomaderry Creek Regional Park will require some form of compensatory dedication of land to add to the park; note all three routes require revocation of a part of the Park. This study has also identified Council land to the north of the Central route, east of the gorge, containing populations of *Eucalyptus langleyi* and *Zieria baeuerlenii* that should be added to the dedicated land, partly in compensation for the loss of the plants of the eucalypt on the Central route, should that route be selected.

11 CONCLUSION

This report has investigated the flora and fauna issues associated with the proposed North Nowra Link Road, located between the Princes Highway in the east and Illaroo Road in the west. Three route options for the proposed road were investigated, known as the Northern, Central and Southern Route Options.

The purpose of this report is to identify, describe and assess the flora and fauna issues associated with each of the three route options and identify the most important flora and fauna issues associated with the three routes.

The key flora and fauna issues associated with each route are identified, described and assessed, then compared between the three route options. The key issues include the presence of endangered, vulnerable and rare plants and animals, the occurrence of natural vegetation, general habitat values and the impact on the Bomaderry Creek Regional Park.

The report concludes that the Southern route would impact very significantly on the gorge of Bomaderry Creek, as it traverses a wide section of the gorge with no existing disturbance. This area supports stands of tall forest and rainforest, with riparian and escarpment habitats utilised by threatened animals.

The report further concludes that the impact of the Northern and Central route options is similar in many respects; this includes the area of bushland cleared and the impact on Bomaderry Creek. The major difference is that the Central route traverses the core of the bushland, whereas the Northern route is located on the edge of the bushland. Thus the Central route would bisect the Regional Park and the habitats of several threatened species, including the Yellow-bellied Glider, *Zieria baeuerlenii* and, should it be present, the Giant Burrowing Frog. The Central route also results in the removal of two specimens of the vulnerable mallee *Eucalyptus langleyi* and is very close to a population of the endangered shrub *Zieria baeuerlenii.*

Our assessment under the *Environment Protection and Biodiversity Conservation Act 1999* (Commonwealth) suggests that should the Central route be ultimately chosen as the preferred route, road construction along that route may be a controlled action as it potentially has a significant impact upon two listed threatened plants, namely *Zieria baeuerlenii* and *Eucalyptus langleyi*. It is our conclusion that in that case, the Commonwealth should be consulted. The other two routes are less likely to be called in by the Commonwealth as controlled actions.

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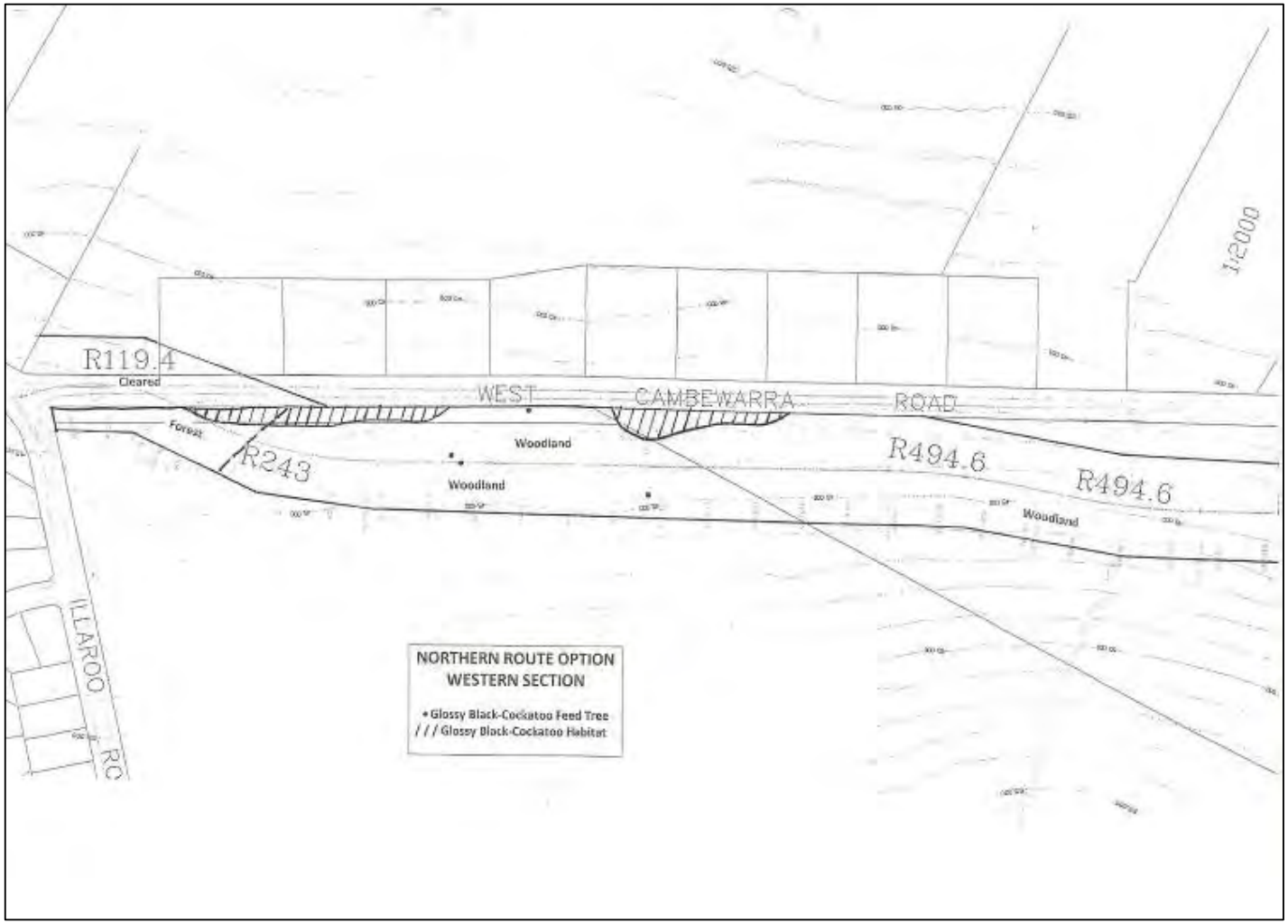
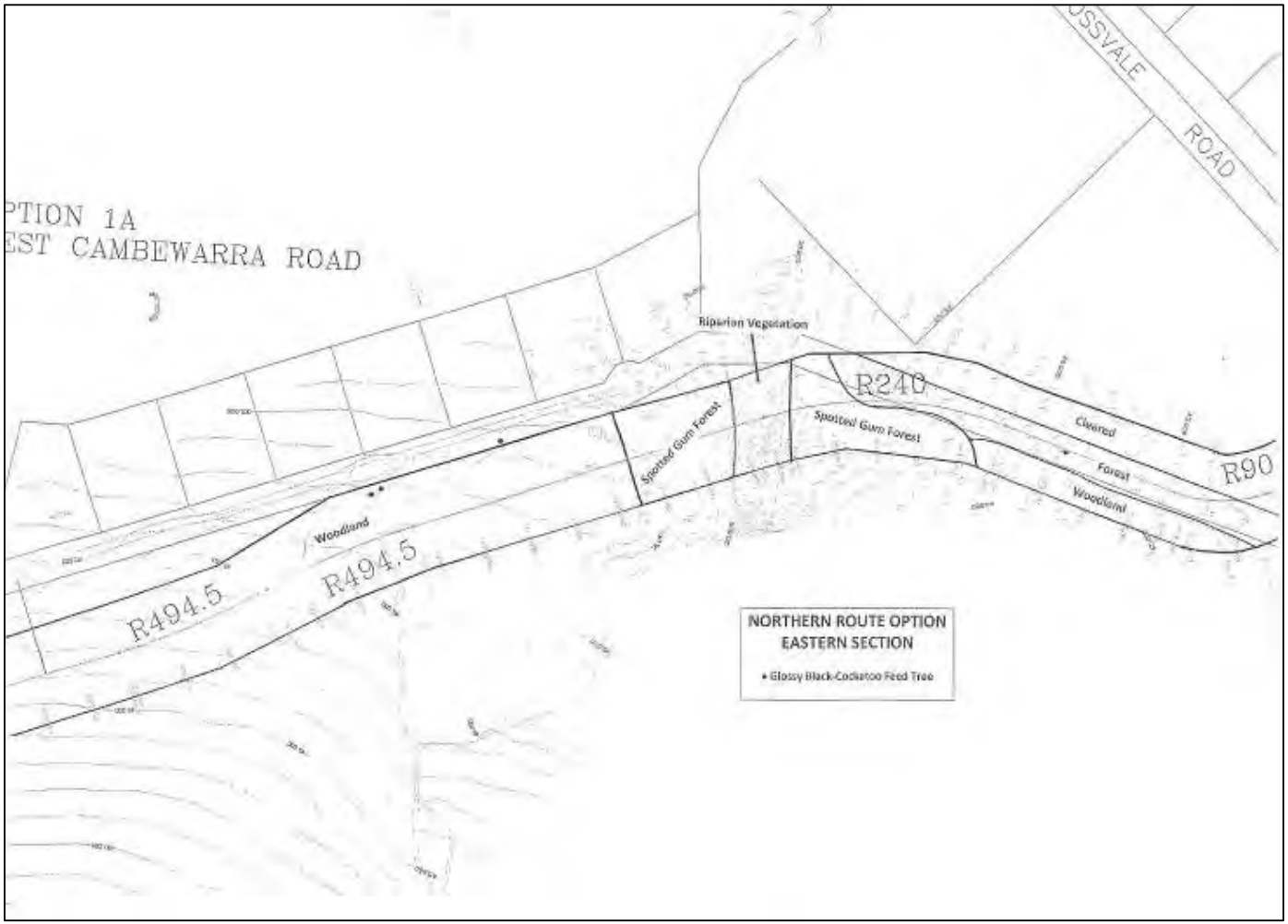
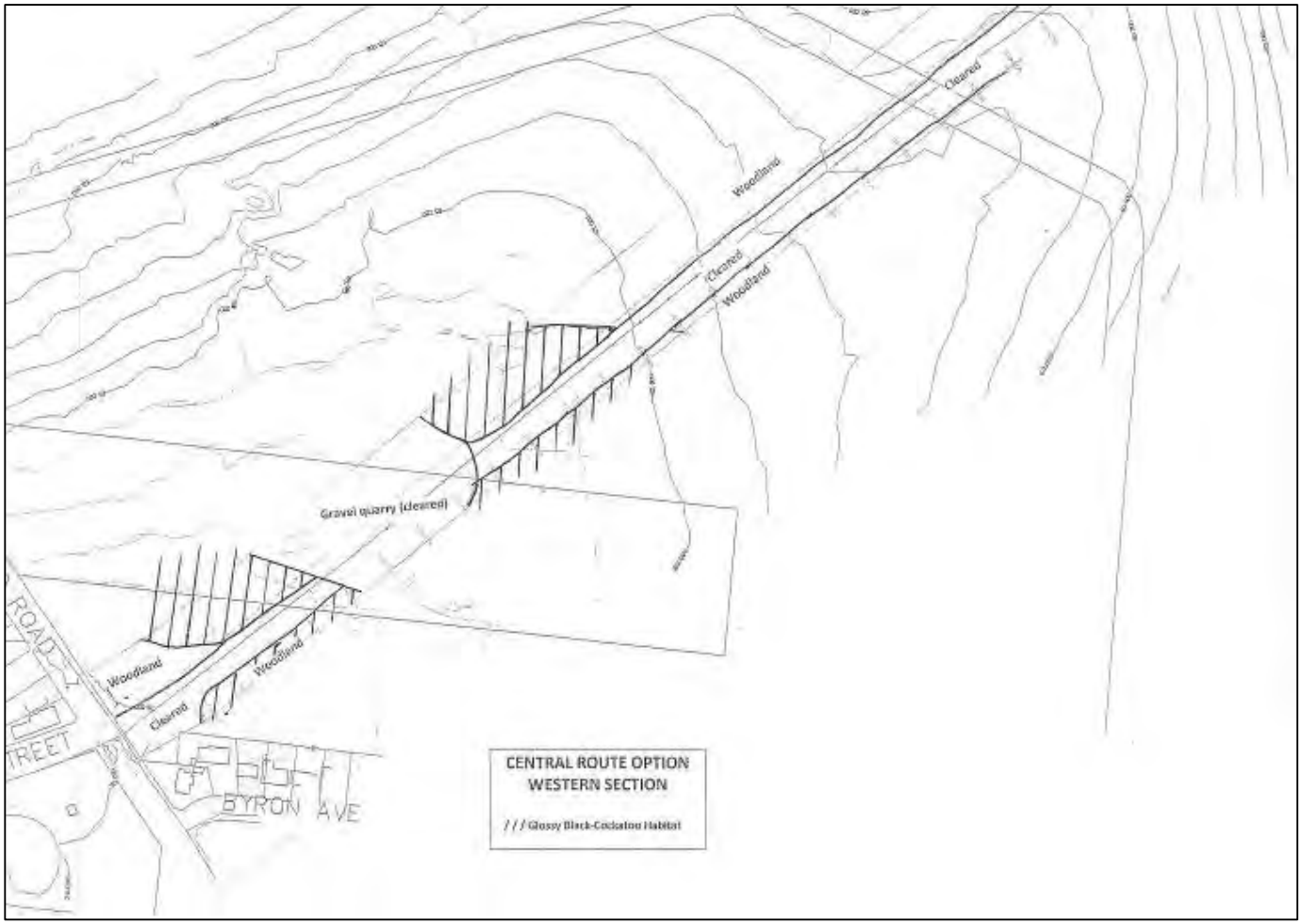


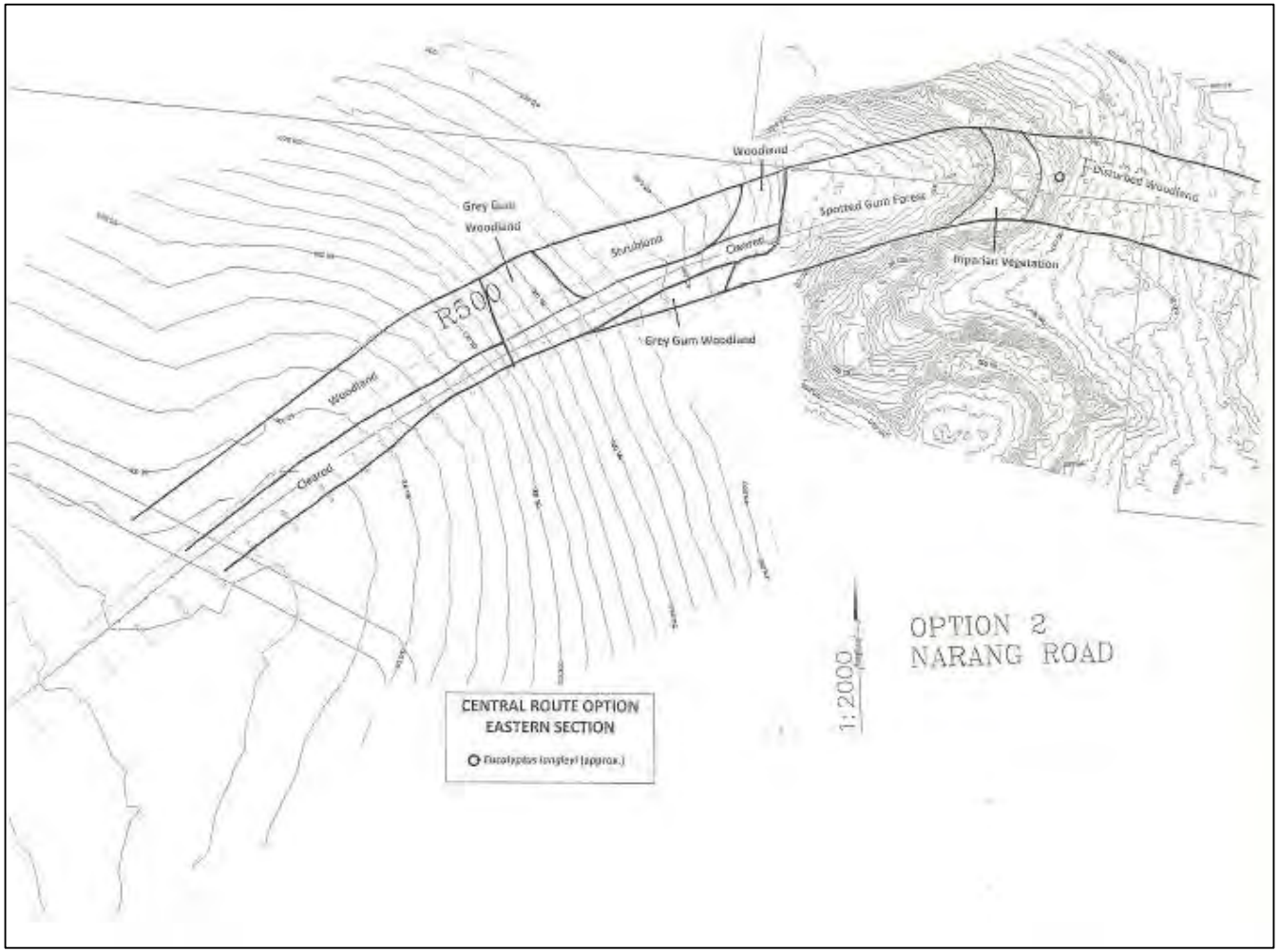
Map 1.
Northern Route Option - vegetation and habitats western section.
Not to Scale.



Map 2.
Northern Route Option - vegetation and habitats eastern section.
Not to Scale.



Map 3.
Central Route Option - vegetation and habitats western section.
Not to Scale.



Map 4.
Central Route Option - vegetation and habitats eastern section.
Not to Scale.

APPENDIX 1
Plant Species recorded on Northern and Central Route Options

This list provides the names of those species recorded during the 2007 surveys.

Species	Common Name	Route Options[1] Northern	Central
Indigenous Species			
Acacia binervata	Two-veined Hickory	N	C
Acacia falcata	Sickle Wattle	N	
Acacia irrorata	Green Wattle	N	C
Acacia longifolia	Sydney Golden Wattle	N	C
Acacia mearnsii	Black Wattle	N	C
Acacia myrtifolia	Myrtle Wattle	N	
Acacia suaveolens	Sweet Wattle	N	C
Acacia subtilinervis	Wattle		C
Acacia terminalis	Sunshine Wattle	N	C
Acacia ulicifolia	Prickly Moses	N	C
Adiantum aethiopicum	Common Maidenhair	N	C
Allocasuarina distyla	She-oak		C
Allocasuarina littoralis	Black She-oak	N	C
Amperea xiphoclada	Broome Spurge	N	
Angophora floribunda	Rough-barked Apple	N	
Aotus ericoides	Common Aotus	N	
Aristida ramosa	Cane Wiregrass		C
Backhousia myrtifolia	Ironwood	N	C
Banksia paludosa	Swamp Banksia	N	C
Banksia serrata	Old Man Banksia	N	C
Banksia spinulosa	Hairpin Banksia	N	C
Billardiera scandens	Common Apple-berry	N	C
Bossiaea ensata	Sword Bossiaea	N	C
Bossiaea heterophylla	Variable Bossiaea	N	C
Brachyloma daphnoides	Daphne Heath		C
Breynia oblongifolia	Breynia	N	
Brunoniella pumilio	Dwarf Blue Trumpet		C
Bursaria spinosa	Blackthorn	N	C
Cassytha glabella	Slender Dodder-laurel	N	
Cassytha pubescens	Downy Dodder-laurel	N	C
Casuarina cunninghamiana	River Oak		C
Caustis flexuosa	Curly Wig		C
Ceratopetalum gummiferum	NSW Christmas Bush	N	
Clematis aristata	Australian Clematis		C
Comesperma ericinum	Heath Milkwort	N	C
Conospermum longifolia	Long-leaved Smoke-bush		C
Corymbia gummifera	Red Bloodwood	N	C
Corymbia maculata	Spotted Gum	N	C
Cryptostylis subulata	Large Tongue Orchid		C
Cyathochaeta diandra	a sedge	N	C
Cymbidium suave	Snake Orchid	N	C
Cymbopogon refractus	Barbed-wire Grass		C
Cynodon dactylon	Couch Grass	N	
Dampiera scottiana	Dampiera	N	C
Danthonia sp.	Wallaby Grass		C
Davallia pyxidata	Hare's-foot Fern		C
Daviesia alata	Winged Bitter-pea		C
Daviesia ulicifolia	Gorse Bitter-pea	N	C
Dianella caerulea	Flax-lily	N	

Species	Common Name	Route Options[1] Northern	Central
Dichondra repens	Kidney weed	N	
Dillwynia ramosissima	Bushy Parrot-pea	N	
Diuris sulphurea	Tiger orchid		
Dodonaea multijuga	Hop-bush	N	
Dodonaea triquetra	Large-leaf Hop-bush	N	C
Doodia media	Common Rasp Fern	N	
Drosera auriculata	Tall Sundew	N	
Echinopogon caespitosus	Tufted Hedgehog Grass		
Elaeocarpus reticulatus	Blueberry Ash	N	C
Entolasia marginata	Margin Panic	N	
Entolasia stricta	Wiry Panic	N	C
Eragrostis leptostachya	Love-grass	N	
Eucalyptus agglomerata	Blue-leaved Stringybark	N	C
Eucalyptus consideniana	Yertchuk		C
Eucalyptus eugenioides	Thin-leaved Stringybark	N	
Eucalyptus imitans	Stringybark		C
Eucalyptus langleyi	Nowra Mallee		C
Eucalyptus punctata	Grey Gum		C
Eucalyptus sclerophylla	Hard-leaved Scribbly Gum	N	C
Eustrephus latifolius	Wombat Berry	N	C
Ficus coronata	Sandpaper Fig		C
Ficus rubiginosa	Rusty Fig		C
Glochidion ferdinandi	Cheese Tree	N	C
Glycine tabacina	Variable Glycine	N	
Gompholobium glabratum	Dainty Wedge Pea	N	C
Gompholobium grandiflorum	Large Wedge Pea	N	
Gompholobium pinnatum	Pinnate Wedge-pea	N	
Gonocarpus tetragynus	Poverty Raspwort	N	
Goodenia hederacea	Forest Goodenia	N	
Hakea dactyloides	Finger Hakea	N	C
Hakea salicifolia	Willow-leaved Hakea	N	
Hakea sericea	Bushy Needlewood	N	C
Hardenbergia violacea	Native Sarsaparilla	N	C
Hibbertia dentata	Trailing Guinea Flower	N	
Hibbertia empetrifolia	Guinea Flower	N	
Hymenanthera dentata	Tree Violet	N	
Hypericum gramineum	Small St John's Wort	N	
Imperata cylindrica	Blady Grass	N	C
Isopogon anemonifolius	Drumsticks	N	
Kennedia rubicunda	Dusky Coral-pea	N	C
Kunzea ambigua	White Kunzea	N	C
Lagenifera stipitata	Blue Bottle-daisy	N	
Lambertia formosa	Mountain Devil	N	C
Lasiopetalum ferrugineum	Brown Velvet-bush	N	
Lepidosperma laterale	Variable Sword-sedge	N	
Leptospermum arachnoides	Spider Teatree		C
Leptospermum continentinale	Prickly Teatree	N	
Leptospermum polygalifolium	Yellow Teatree	N	C
Leptospermum sejunctum	Nowra Teatree		C
Leptospermum trinervium	Paperbark Teatree	N	C
Lepyrodia scariosa	Scale-rush	N	
Leucopogon ericoides	Pink Beard-heath	N	
Leucopogon juniperinus	Juniper Beard-heath		C
Leucopogon lanceolatus	Lance Beard-heath	N	C
Lindsaea linearis	Screw Fern	N	C

Species	Common Name	Route Options[1] Northern	Central
Liparis reflexa	Yellow Rock Orchid		
Lissanthe strigosa	Peach Heath		
Lomandra confertifolia	Mat-rush	N	C
Lomandra filiformis	Wattle Mat-rush	N	
Lomandra longifolia	Spiny-headed Mat-rush	N	C
Lomandra multiflora	Many-flowered Mat-rush	N	
Lomandra obliqua	Twisted Mat-rush	N	C
Lomatia ilicifolia	Holly Lomatia	N	C
Marsdenia rostrata	Common Milk Vine	N	
Melaleuca hypericifolia	Red-flowered Paperbark		C
Melaleuca linariifolia	Narrow-leaved Paperbark		C
Melaleuca thymifolia	Thyme Honey-myrtle	N	
Micrantheum ericoides	Heath Micrantheum	N	C
Microlaena stipoides	Weeping Grass	N	C
Mirbelia rubiifolia	Heathland Merbelia	N	C
Mitrasacme polymorpha	Varied Mitrewort	N	
Morinda jasminoides	Morinda	N	
Myrsine variabilis	Muttonwood		C
Notelaea longifolia	Native Olive	N	C
Opercularia aspera	Thin Stinkweed	N	
Ozothamnus diosmifolius	Everlasting		C
Pandorea pandorana	Wonga Vine	N	
Parsonsia straminea	Monkey-rope Vine	N	
Patersonia sericea	Silky Purple Flag	N	C
Pellaea falcata	Sickle Fern	N	
Persoonia levis	Smooth Geebung	N	C
Persoonia linearis	Narrow-leaf Geebung	N	C
Persoonia mollis	Soft Geebung	N	C
Petrophile pedunculata	Stalked Conestick	N	C
Phebalium squamulosum	Scaly Phebalium	N	
Phyllanthus hirtellus	Thyme Spurge	N	C
Phyllota phylicoides	Heath Phyllota		C
Pimelea linifolia	Slender Rice-flower	N	C
Pittosporum revolutum	Rough-fruit Pittosporum	N	
Pittosporum undulatum	Sweet Pittosporum	N	C
Platylobium formosum	Handsome Flat-pea	N	
Platysace lanceolata	Shrubby Platysace	N	
Plectranthus graveolens	Cockspur Flower	N	
Pomaderris intermedia	Pomaderris	N	
Pomax umbellata	Pomax	N	C
Poranthera microphylla	Small Poranthera	N	
Pratia purpurescens	Lobelia pratia	N	
Prostanthera incana	Velvet Mintbush		C
Pteridium esculentum	Common Bracken	N	C
Pultenaea blakelyi	Blakely's Bush-pea	N	
Pultenaea daphnoides	Large-leaf Bush-pea	N	C
Pultenaea elliptica	Wreath Bush-pea		C
Pultenaea linophylla	Halo Bush-pea	N	C
Pyrrosia rupestris	Rock Felt Fern	N	C
Scaevola ramosissima	Hairy Fan-flower	N	
Smilax glyciphylla	Thornless Sarsaparilla	N	
Stipa sp.	Spear-grass	N	C
Stylidium graminifolium	Grass Triggerplant		C
Stylidium laricifolium	Giant Triggerplant		C
Syncarpia glomulifera	Turpentine	N	C

Species	Common Name	Route Options[1] Northern	Central
Syzygium smithii	Lilly Pilly	N	
Telopea speciosissimum	Waratah	N	
Tetratheca thymifolia	Pink Bells	N	
Thelymitra ixioides	Spotted Sun Orchid		C
Themeda australis	Kangaroo Grass	N	C
Tristaniopsis laurina	Water Gum	N	C
Tylophora barbata	Bearded Tylophora	N	
Viola hederacea	Native Violet	N	
Wahlenbergia gracilis	Small Bluebell	N	
Xanthorrhoea resinifera	Grass-tree	N	
Zieria baeuerlenii	Bomaderry Creek Zieria		C
Introduced (Weed) Species			
*Acetosella vulgaris**	Sheep Sorrel	N	
*Ageratina adenophora**	Crofton Weed		C
*Ageratina riparia**	Mistflower	N	C
*Anagallis arvensis**	Scarlet or Blue Pimpernel		C
*Andropogon virginicus**	Whisky Grass	N	C
*Araujia hortorum**	Moth Vine	N	
*Axonopus affinis**	Narrow-leaf Carpet Grass	N	
*Bidens pilosa**	Cobbler's Pegs	N	C
*Briza maxima**	Large Quaking Grass		C
*Centaurium erythraea**	Common Centaury	N	
Cerastium glomeratum	Mouse-eared Chickweed		C
*Chloris gayana**	Rhodes Grass	N	
*Cinnamonum camphora**	Camphor Laurel	N	
*Cirsium vulgare**	Spear Thistle		C
*Coreopsis lanceolata**	Coreopsis	N	C
*Cyperus eragrostis**	Umbrella Sedge	N	
*Echium plantagineum**	Paterson's Curse	N	
*Eragrostis curvula**	African Lovegrass	N	
*Gamochaeta americanum**	American Cudweed	N	
*Hypochaeris radicata**	Flatweed	N	C
*Jacaranda mimosaefolia**	Jacaranda		C
*Lantana camara**	Lantana	N	C
*Ligustrum lucidum**	Large-leaved Privet	N	C
*Lonicera japonica**	Honeysuckle		C
*Melaleuca armillaris**	Bracelet Honey Myrtle	N	
*Modiola carolinensis**	Red-flowered Mallow	N	
*Olea europaea**	Olive		C
*Paspalum dilatatum**	Paspalum	N	
*Paspalum urvillei**	Vasey Grass	N	
*Passiflora edulis**	Passionfruit	N	
*Pennisetum clandestinum**	Kikuyu Grass	N	C
*Pinus radiata**	Radiata Pine	N	
*Pinus pinasta**	Slash Pine	N	
*Plantago lanceolata**	Ribbed Plantain	N	C
*Protasparagus aethiopicus**	Asparagus Fern	N	C
*Rubus fruticosa**	Blackberry		C
*Rumex crispus**	Curled Dock		C
*Senecio madagascariensis**	Fireweed	N	C
*Sida rhombifolia**	Paddy's Lucerne	N	C
*Solanum pseudocapsicum**	Madeira Winter Cherry	N	
*Sonchus oleraceus**	Common Sow-thistle	N	C
*Sporobolus indicus**	Parramatta Grass	N	C

Species	Common Name	Route Options[1] Northern	Central
*Tradescantia albiflora**	Wandering Jew	N	C
*Trifolium repens**	White Clover	N	
*Verbena bonariensis**	Purpletop		C

1. Route options: N – northern; C – central.
* Introduced species.

APPENDIX 2
Fauna Species recorded in the Bomaderry Creek Area

Mammals

Terrestrial, Large	
Common Wombat	*Vombatus ursinus*
Eastern Grey Kangaroo	*Macropus giganteus*
Short-beaked Echidna	*Tachyglossus aculeatus*
Swamp Wallaby	*Wallabia bicolor*
Terrestrial, Small	
Brown Antechinus	*Antechinus stuartii*
Bush Rat	*Rattus fuscipes*
Arboreal	
Common Brushtail Possum	*Trichosurus vulpecula*
Common Ringtail Possum	*Pseudocheirus peregrinus*
Sugar Glider	*Petaurus breviceps*
Yellow-bellied Glider	*Petaurus australis*
Aquatic	
Platypus	*Ornithorhynchus anatinus*
Bats	
Chocolate Wattled Bat	*Chalinolobus morio*
Eastern Horseshoe Bat	*Rhinolophus megaphyllus*
Eastern Freetail Bat	*Mormopterus* species
Gould's Longeared Bat	*Nyctophilus gouldi*
Gould's Wattled Bat	*Chalinolobus gouldii*
Grey-headed Flying-fox	*Pteropus poliocephalus*
Large Forest Bat	*Vespadelus darlingtoni*
Large-footed Myotis	*Myotis adversus*
Little Forest Bat	*Vespadelus vulturnus*
Southern Forest Bat	*Vespadelus regulus*
Introduced	
Dog*	*Canis lupus*
Cat*	*Felis catus*
Fox*	*Vulpes vulpes*
Rabbit*	*Oryctolagus cuniculus*

Birds

Australasian Grebe	*Tachybaptus novaehollandiae*
Australian King-Parrot	*Alisterus scapularis*
Australian Magpie	*Gymnorhina tibicen*
Australian Raven	*Corvus coronoides*
Australian Wood Duck	*Chenonetta jubata*
Azure Kingfisher	*Alcedo azurea*
Bassian Thrush	*Zoothera lunulata*
Black-faced Cuckoo-shrike	*Coracina novaehollandiae*
Brown Gerygone	*Gerygone mouki*
Brown Quail	*Coturnix ypsilophora*
Brown Thornbill	*Acanthiza pusilla*
Brown-headed Honeyeater	*Melithreptus brevirostris*
Buff-rumped Thornbill	*Acanthiza reguloides*
Channel-billed Cuckoo	*Scythrops novaehollandiae*

Birds cont…

Collared Sparrowhawk	*Accipiter cirrhocephalus*
Common Koel	*eudynamys scolopacea*
Common Myna*	*Acridotheres tristis*
Crested Pigeon	*Ocyphaps lophotes*
Crimson Rosella	*Platycerus elegans*
Dollarbird	*Eurystomus orientalis*
Double-barred Finch	*Taeniopygia bichenovii*
Dusky Woodswallow	*Artamus cyanopterus*
Eastern Spinebill	*Acanthorhynchus tenuirostris*
Eastern Whipbird	*Psophodes olivaceus*
Eastern Yellow Robin	*Eopsaltria australis*
Fan-tailed Cuckoo	*Cacomantis flabelliformis*
Galah	*Cacatua roseicapilla*
Gang-gang Cockatoo	*Callocephalon fimbriatum*
Glossy Black-Cockatoo	*Calyptorhynchus lathami*
Grey Butcherbird	*Cracticus torquatus*
Grey Fantail	*Rhipidura fuliginosa*
Grey Shrike-thrush	*Colluricincla harmonica*
House Sparrow*	*Passer domesticus*
Laughing Kookaburra	*Dacelo novaeguineae*
Leaden Flycatcher	*Myiagra rubecula*
Lewin's Honeyeater	*Meliphaga lewinii*
Little Wattlebird	*Anthochaera chrysoptera*
Little Lorikeet	*Glossopsitta pusilla*
Magpie-lark	*Grallina cyanoleuca*
Masked Lapwing	*Vanellus miles*
Masked Owl	*Tyto novaehollandiae*
Mistletoebird	*Dicaeum hirundinaceum*
Musk Lorikeet	*Glossopsitta concinna*
New Holland Honeyeater	*Phylidonyris novaehollandiae*
Noisy Friarbird	*Philemon corniculatus*
Olive-backed Oriole	*Oriolus sagittatus*
Pallid Cuckoo	*Cuculus pallidus*
Peaceful Dove	*Geopelia striata*
Peregrine Falcon	*Falco peregrinus*
Pied Currawong	*Strepera graculina*
Rainbow Bee-eater	*Merops ornatus*
Rainbow Lorikeet	*Trichoglossus haematodus*
Red Wattlebird	*Anthochaera carunculata*
Red-browed Finch	*Neochmia temporalis*
Red-whiskered Bulbul*	*Pycnonotus jocosus*
Rockwarbler	*Origma solitaria*
Rufous Fantail	*Rhipidura rufifrons*
Rufous Whistler	*Pachycephala rufiventris*
Sacred Kingfisher	*Todiramphus sanctus*
Satin Bowerbird	*Ptilonorhynchus violaceus*
Scarlet Honeyeater	*Myzomela sanguinolenta*
Shining Bronze-Cuckoo	*Chrysococcyx lucidus*
Silvereye	*Zosterops lateralis*
Southern Boobook	*Ninox novaeseelandiae*
Southern Emu-wren	*Stipiturus malachurus*
Spotted Pardalote	*Pardalotus punctatus*
Spotted Turtle-Dove*	*Streptopelia chinensis*
Square-tailed Kite	*Lophoictinia isura*
Striated Pardalote	*Pardalotus striatus*
Striated Thornbill	*Acanthiza lineata*

Birds cont...

Sulphur-crested Cockatoo	*Cacatua galerita*
Superb Fairy-wren	*Malurus cyaneus*
Topknot Pigeon	*Lopholaimus antarcticus*
Varied Sittella	*Daphoenositta chrysoptera*
Welcome Swallow	*Hirundo neoxena*
White-browed Scrubwren	*Sericornis frontalis*
White-eared Honeyeater	*Lichenostomus leucotis*
White-throated Needletail	*Hirundapus caudacutus*
White-throated Treecreeper	*Cormobates leucophaeus*
Willie Wagtail	*Rhipidura leucophrys*
Yellow-faced Honeyeater	*Lichenostomus chrysops*
Yellow-tailed Black-Cockatoo	*Calyptorhynchus funereus*
Yellow-tufted Honeyeater	*Lichenostomus melanops*

Reptiles

Barred-sided Skink	*Eulamprus tenuis*
Blind Snake	*Ramphotyphlops nigrescens*
Copper-tailed Skink	*Ctenotus taeniolatus*
Delicate Skink	*Lampropholis delicata*
Diamond Python	*Morelia spilota*
Eastern Blue-tongued Lizard	*Tiliqua scincoides*
Eastern Tiger Snake	*Notechis scutatus*
Eastern Water Dragon	*Physignathus lesueurii*
Eastern Water Skink	*Eulamprus quoyii*
Golden Crowned Snake	*Cacophis squamulosus*
Jacky Lizard	*Amphibolurus muricatus*
Lesueur's Velvet Gecko	*Oedura lesueurii*
Long-necked Tortoise	*Chelodina longicollis*
Red-throated Skink	*Leiolopisma platynotum*
Wall Lizard	*Cryptoblepharus virgatus*
Weasel Skink	*Saproscincus mustelinus*
Yellow-faced Whip Snake	*Demansia psammophis*

Frogs

Bleating Tree Frog	*Litoria dentata*
Brown Toadlet	*Pseudophryne bibronii*
Brown-striped Frog	*Limnodynastes peronii*
Common Eastern Froglet	*Crinia signifera*
Giant Burrowing Frog	*Heleioporus australiacus* (Unconfirmed)
Green Tree Frog	*Litoria caerulea*
Leaf Green Tree Frog	*Litoria phyllochroa*
Lesueur's Frog	*Litoria lesueuri*
Peron's Tree Frog	*Litoria peronii*
Tyler's Toadlet	*Uperoleia tyleri*
Verreaux's Tree Frog	*Litoria verreauxii*

APPENDIX 3
Species Profiles - Threatened and Rare Plants

Zieria baeuerlenii (Rutaceae)

Bomaderry Creek Zieria *Zieria baeuerlenii* (Rutaceae) is a small shrub species that is restricted to a small number of sites in the Bomaderry Creek area. The species is endangered, listed on Schedule 1 under the *Threatened Species Conservation Act 1995*. It has a conservation code of "2E" (Briggs & Leigh 1996), which means that it has a very restricted distribution and that it is endangered or in serious risk of disappearing from the wild state within one or two decades if present land use and other causal factors continue to operate.

Zieria baeuerlenii is endemic to the Bomaderry Creek area, which means that it occurs nowhere else in the world. The species is of considerable botanical interest because of its means of reproduction, by which this non-fertile or non-seed-producing species reproduces vegetatively (J. Armstrong, Herbarium of Western Australia, *in litt.*, September 1989). The species was the subject of a comprehensive field study and mapping exercise by Kevin Mills & Associates (1992), a conservation research statement and research plan by Whelan and Leonard (1994), and recent surveys carried out on behalf of the National Parks and Wildlife Service.

Additional populations of this species have been found since the 1992 field study was undertaken, in habitats and topographic locations similar to the previously known populations. In mid-1992, Kevin Mills found a small population on the eastern side of Bomaderry Creek. Other populations were surveyed on the eastern side of Bomaderry Creek during the 1992 study, i.e. sites 2, 3, 4, 10 and 11.

Kevin Mills & Associates (1996) counted 492 'plants' of *Zieria baeuerlenii* at 13 sites although, because the species reproduces vegetatively, it is difficult to define exactly what an individual plant is. In a genetic sense, a group of plants could be considered to be one individual. The total population of *Zieria baeuerlenii* was estimated by Kevin Mills & Associates (1996) to be 450 to 550 plants. Mr T. Barratt (1993) also estimated the size of the population, while a recent field study by the same person for the NPWS, identified over 1,200 'plants'.

Regardless of the number of plants existing in the wild, it is a very small number. The plants are restricted to an area of about 0.3 hectares, within a circle of radius 350 metres. An area of 0.3 hectares is about 0.1% of the 230 hectares of bushland in the Bomaderry Creek area. Clearly, such a small area is very vulnerable, particularly to the effects of fire and vandalism.

Zieria baeuerlenii occurs on dry, mainly north-facing gentle slopes among rocks in dry woodland and forest with a moderately dense to open understorey. The dominant tree species are Grey Gum *Eucalyptus punctata* and Blue-leaved Stringybark *Eucalyptus agglomerata*, occurring with Red Bloodwood *Corymbia gummifera*, Spotted Gum *Corymbia maculata* and Turpentine *Syncarpia glomulifera*. *Zieria baeuerlenii* often occurs on the edge of, but seldom within, a closed shrubland of White Kunzea *Kunzea ambigua* and the rare teatree *Leptospermum sejunctum.* All populations are critical to the survival of the species in the wild because of the small size of the total population and the fact that the species appears to reproduce only by suckering; there is no seed store in the soil.

The occurrence of isolated individual plants and the presence of the species on both sides of the gorge suggest that *Zieria baeuerlenii* possibly sets viable seed occasionally. However, the main method of reproduction is certainly by vegetative means. Plantlets (ramets) formed by root suckering are common (K. Mills, pers. obs.) and the production of plants by stem layering has also been observed (K. Mills, pers. obs.); these methods

are clearly the most common method of propagation. As one would expect of a species that propagates in this way, the plants occur in distinct patches. Even within these patches, groups of plants are discernible.

One interesting discovery during the 1996 study was of seven specimens of *Zieria cytisoides* in a patch among the largest population of *Zieria baeuerlenii*. This species, one of the supposed parents of *Zieria baeuerlenii*, is relatively common to the west, along the Shoalhaven Gorge.

***Eucalyptus langleyi* (Myrtaceae)**

Nowra Mallee Ash *Eucalyptus langleyi* (Myrtaceae) was first described by Johnson and Hill (1991). The species has a conservation code of 2V (Briggs & Leigh 1996), which means that it has a very restricted distribution and that it is vulnerable or at risk of disappearing from the wild state over a period of 20 to 50 years. *Eucalyptus langleyi* is vulnerable, listed on Schedule 2 under the *Threatened Species Conservation Act 1995*.

Eucalyptus langleyi occurs in open woodland to mallee-shrubland, usually on or near broad areas of sandstone bedrock. In 1985, the author recorded the species in 22 stands and subsequently at another four sites, including two sites at Bomaderry Creek. Most of the stands occur at altitudes of 130 to 255 metres, although the stands at Bomaderry Creek are about 30 metres above sea level. The total population of *Eucalyptus langleyi* is many thousands of plants, and some of the known stands contain several hundred specimens. A more recent study by Kevin Mills & Associates (2002) surveyed the stands to the southwest of Nowra and counted over 4,000 plants in 13 stands. Recent field investigations have located further populations of this mallee to the west of Nowra (K. Mills, pers. obs.)

***Acacia subtilinervis* (Fabaceae)**

This shrub wattle grows on sandstone rock outcrops and is fairly common in the Shoalhaven region, particularly in and around Morton National Park. Briggs and Leigh (1996) give this species a conservation code of 3RCa; this means that it has a natural geographic distribution of over 100 kilometres (3), is regarded as rare (R), but not threatened, is known from at least one conservation reserve (C) and is considered to be adequately reserved (a). At Bomaderry creek, the species is found on rock surfaces along the edges of the gorge; it grows in such a situation on the central route option to the west of the gorge.

***Leptospermum sejunctum* (Myrtaceae)**

This shrub is endemic to the Nowra district, where it grows on rock outcrops, often in dense thickets. Under the ROTAP system it has a conservation code of 2K, meaning that it has a geographic distribution of less than 100 kilometres (2), and is poorly known (K) so its status cannot be documented.

***Rulingia hermanniifolia* (Sterculiaceae)**

This prostrate shrub has a wide distribution in the region and further afield. The 3RCa conservation code means that it has a range of over 100 kilometres (3), is regarded as rare (R), but not threatened, is known from at least one conservation reserve (C) and is considered to be adequately reserved (a). At Bomaderry Creek, it was observed on the central route to the east of the gorge many years ago, after a bushfire in the area; typical of this species, it has subsequently disappeared.

Appendix 4
Conservation Codes for Rare or Threatened Australian Plants

The Distribution Category

1 Known by one collection only.

2 Geographic range in Australia is less than 100 km.

3 Geographic range in Australia is greater than 100 km.

The Conservation Status

X Presumed Extinct: taxon not collected or otherwise verified over the past 50 years despite thorough searching in all known and likely habitats, or of which all known wild populations have been destroyed more recently.

E Endangered: taxon in serious risk of disappearing from the wild within 10-20 years if present land use and other threats continue to operate. This category includes taxa with populations possibly too small (usually less than 100 individuals) to ensure survival even if present in proclaimed reserves.

V Vulnerable: taxon not presently Endangered, but at risk over a longer period (20-50 years) of disappearing from the wild through continued depletion, or which occurs on land whose future use is likely to change and threaten its survival.

R Rare: taxon which is rare in Australia (and hence usually in the world) but which currently does not have any identifiable threat. Such species may be represented by a relatively large population in a very restricted area or by smaller populations spread over a wide range or some intermediate combination of distribution pattern.

K Poorly Known: taxon that is suspected, but not definitely known, to belong to one of the above categories. At present, accurate field distribution information is inadequate.

C Reserved: indicates taxon has at least one population within a national park, other proclaimed conservation reserve or in an area other-wise dedicated for the protection of flora. The taxon may or may not be considered adequately conserved within the reserve(s), as reflected by the conservation status assigned to it. Where applicable, the 'C' symbol immediately follows the conservation status symbol in the written code, e.g. 2RC.

The Size-class of all Reserved Populations

a 1000 plants or more are known to occur within a conservation reserve(s).
i Less than 1000 plants are known to occur within a conservation reserve(s).
- The reserved population size is not accurately known.
t Total known population reserved.
+ Overseas occurrence (included if the taxon has a natural occurrence overseas).

Based on Briggs & Leigh (1996).

APPENDIX 5
Species Profiles - Threatened Fauna

Broad-headed Snake
Hoplocephalus bungaroides

Status in New South Wales: Endangered; species listed on Schedule 1 of the *Threatened Species Conservation Act 1995*. Vulnerable under the *EPBC Act 1999* (Commonwealth).

Distribution: The Broad-headed Snake is restricted to New South Wales, where it occurs on the coast and ranges within an area of about 250 kilometres from Sydney.

Habitat: The Broad-headed Snake usually occurs on sandstone rock outcrops on the Hawkesbury Sandstone especially where slabs of fallen rock sit on the parent rock. A nocturnal species, the Broad-headed Snake is usually found in rock crevices under flat rock slabs in locations with a warm aspect, usually facing north or west. This species feeds on frogs and small reptiles.

Threats: The Broad-headed Snake is considered to be adversely affected by habitat removal, as bushrock is collected for use in garden landscapes. The species has also been collected by reptile fanciers.

Regional Records: The Broad-headed Snake has been reported in several locations in the northern Shoalhaven region, all in sandstone country. These records mainly come from the Yerriyong-Yalwal area, the Bugong area and the western area of Kangaroo Valley. Since few surveys have targeted this species, it may be widespread in the sandstone areas throughout the Shoalhaven region.

Local Records (North Nowra): There are no records of this snake at Bomaderry Creek, even though this area has been searched on several occasions by herpetologists. The closest record to North Nowra is apparently Bugong, about five kilometres west of the project area, where it was found by Daly and Murphy (1996).

East-coast Freetail-bat
Mormopterus norfolkensis

Status in New South Wales: Vulnerable; species listed on Schedule 2 of the *Threatened Species Conservation Act 1995.* Not listed under the *EPBC Act 1999* (Commonwealth).

Distribution: The East-coast Freetail-Bat *Mormopterus norfolkensis* occurs along the east coast of Australia between Sydney and Brisbane, on the eastern side of the Great Dividing Range (Hall & Richards 1979, Parnaby 1992, Churchill 1998).

Habitat: Although its habitat preferences are unclear, almost all records come from dry eucalypt forest and woodland (Allison & Hoye 1995). This species roosts during the day in tree hollows, crevices, under loose bark, in caves and buildings, either alone or in small colonies (Hall & Richards 1979, Cronin 1991). Emerging after dusk to feed on flying insects, the East-coast Freetail-Bat hawks through the forest canopy, or in clearings along the edge. Terrestrial insects may also be gleaned from the ground (Cronin 1991, Allison & Hoye 1995).

Threats: Although not well known, threats to this bat probably include the clearing of its habitat and, particularly, the loss of hollow-bearing trees necessary for roosting.

Regional Records: The closest record to Nowra in the NSW Wildlife Atlas is one from Culburra in 1996, about 20km to the southeast. This bat has also been recorded at Bugong (15km west), Mount Scanzi (18km northwest) and Tallowa (28km west) between 1994 and 1996

(Daly & Murphy 1996). The bat is expected to be more common in the district than these few records suggest.

Local Records (North Nowra): This bat has not been recorded in the Bomaderry Creek area, either by Coles (1993) or during other studies.

Gang-gang Cockatoo
Callocephalon fimbriatum

Status in New South Wales: Listed as vulnerable on Schedule 2 of the *Threatened Species Conservation Act 1995* (NSW). Not listed under the *EPBC Act 1999* (Commonwealth).

Distribution: The Gang-gang Cockatoo is distributed from southern Victoria through south and central NSW north to the southern parts of the Northern Tablelands.

Habitat: The Gang-gang Cockatoo mostly inhabits forests and occasionally woodlands. It requires large trees with hollows for breeding.

Threats: The decline in the species in the past two decades is not well understood. The NSW Scientific Committee states that "The late age at which it first breeds and the species' dependence and specificity in its preference for tree hollows may have rendered it vulnerable to decline as a result of habitat loss and degradation. Clearing of native vegetation, which is listed as a key threatening process in NSW, and degradation of habitat e.g. as a result of altered fire regimes, reduces the availability of tree hollows and may reduce the abundance of optimum foraging and roosting habitat. The distribution of the species coincides with cool temperature. (Bassian) vegetation (Emison 1982), and climate change may alter the extent and nature of this vegetation."

Regional Records: This cockatoo is quite common throughout the region, being a resident as well s a winter visitor form higher altitudes. Pairs and small flocks are common in many places.

Local Records (North Nowra): Occasionally visits the North Nowra area, as it does most parts of the region.

Giant Burrowing Frog
Heleioporus australiacus

Status in New South Wales: Vulnerable; the species was listed on Schedule 2 of the *Threatened Species Conservation Act 1995*. Vulnerable under the *EPBC Act 1999* (Commonwealth).

Distribution: The Giant Burrowing Frog occurs on the coast and ranges from central New South Wales to eastern Victoria (Cogger 1992). It has been recorded in several conservation reserves and state forests, such as Royal National Park, Ku-ring-gai Chase National Park, Morton National Park, Marramarra National Park, Barren Grounds Nature Reserve and Watagan State Forest.

Habitat: The Giant Burrowing Frog inhabits areas underlain by sandstone, where it lives in burrows in the banks of small creeks and gullies (Cogger 1992). Although little is yet known about the ecology of this species, it breeds in permanent and ephemeral streams and may then disperse into other suitable habitat. The species has been recorded in swampy heathland and in wet and dry eucalypt woodland. Insufficient research has been undertaken to establish the size of its home range and its shelter requirements. According to York, (Mitchell McCotter 1993) the most suitable habitats for the Giant Burrowing Frog are sandstone escarpments, ephemeral or permanent creeks, free flowing rivers, hanging swamps, wet heathlands and eucalypt woodland.

Threats: Ecological research has not clearly established the threats to this frog, although habitat loss is likely to be a contributing factor to the rarity of the species.

Regional Records: There are several records of this frog species from the Shoalhaven district. Most records are from sandstone areas, such as Barren Grounds, Morton National Park and Jervis Bay.

Local Records (North Nowra): Daly and Murphy (1996) reported this frog's presence at Bugong, where breeding has been recorded. The Giant Burrowing Frog was reported to occur in the Bomaderry Creek area in 1992, based on a single call heard at night. The following discussion summarises the statements made about this frog at Bomaderry Creek.

Symbiosis (1992) stated that five frog species were recorded from call or observation during the eight hour survey of frogs and reptiles undertaken mainly by Dr Alan York. Although referred to as the "owl frog", the Giant Burrowing Frog *Helioporus australiacus* was among the frog species detected. The report did not state whether it was seen, heard or both, and no other mention of the species was made in the report.

Mitchell McCotter (1993) mentioned the Giant Burrowing Frog in section 4.2.1, among "other species considered to be endangered". The report mentions that the species was added to Schedule 12 in December 1992, after the preparation of the FIS. Their report provides brief information on Giant Burrowing Frog distribution and habitat preferences, but does not acknowledge that it was recorded there in the Symbiosis study. Rather, the report states that

> "Given the known distribution of this species, it could feasibly be found within the study area. Its prime habitat would be expected to occur within the gorge habitat and along creeks in the immediate vicinity of the gorge. The gorge habitat in the area of the proposed bridge crossing is substantially degraded and is not considered prime habitat for this species. It is considered therefore that the proposed road will not impact upon this species. The proposal to reserve a large "buffer" of native vegetation along the gorge would make a substantial contribution to the preservation of potential habitat for this species."

In a subsequent report, Mitchell McCotter (1993) states that the sections on the Giant Burrowing Frog were written by Mr Michael Mahony, who provides information on conservation status, distribution, dispersal and movement, habitat requirements, home range, feeding requirements, shelter requirements, breeding requirements and habitat distribution. This report provides the following summary of the only record of the Giant Burrowing Frog at Bomaderry Creek:

> "During the fauna survey of the study area conducted during May 1992 Dr Alan York and Gary Daly heard a call which they concluded was likely to be a Giant Burrowing Frog (Symbiosis 1993). This remains an unconfirmed record at this locality. Confirmation was not sought as the species calls from a burrow into which it rapidly retreats when approached, and the species was not listed as "endangered" at the time. The call was heard during spotlighting adjacent to the western side of the gorge north of the proposed road alignment, on the edge of vegetation Community 3 which is a Grey Gum woodland and adjacent to Community 5 which is a dry scrub dominated by White Kunzea and Tea-tree (Figure 4.3)."
>
> "The Giant Burrowing Frog has not been recorded from any other site in the local area other than the unconfirmed made by York and Daly on the 16th of May 1992 (Mitchell McCotter 1992). The position of this record in the area is marked on Figure 1 in York (1993). There are no Museum, literature or Wildlife Atlas records (NSW NP&WS) of the species."

Mahony made the following comment about the suitability of the Bomaderry Creek site for breeding.

> "At the Bomaderry Creek site there are a range of habitats that would appear to be suitable for this species. There are two small creeks that flow slowly and obtain water

from seepage over larger areas. Numerous pools are formed in these drainage lines that would be suitable for tadpoles. It would appear that these pools would be permanent for most of the year. In general appearance the site is not dissimilar to habitat in the Barren Grounds Nature Reserve (less than 20km away in a direct line) where there is a population of the species. Similarly the Bomaderry Creek site bears resemblances to those in the Sydney region such as Coal and Candle Creek in Kuringai National Park, Fishburns Road and Galston Gorge, and Walkers Ridge Road in the Watagan State Forest. Moore (1961), Fletcher (1889) and Harrison (1922) all note that in the Sydney region the species occurs in regions of sandstone cliffs associated with freshwater creeks, where they burrow in the earth between the rocks. Inspection of the Bomaderry Creek site indicates that is offers several suitable areas for breeding of this species."

"*Suitable breeding areas at the Bomaderry site*: Suitable habitat for breeding of the species is found on the western side of Bomaderry Creek to the north and south of the preferred Alternative 2 (along the power and water easement). Two hanging swamps occur in this region. They appear to drain small areas of the Scribbly Gum Woodland that occurs on the plateau above the gorge. These two areas are marked on the accompanying map. Other suitable sites also occur further to the south along the western side of Bomaderry Creek in similar situations. Drainage at these hanging swamps occurs mainly as seepage and forms shallow ponds (up to 10cm deep) on the sandstone where the drainage lines begin. These pools form in a series which are interconnected. The pools range in size, at site 2 they are up to 3 square metres. The edges of the pools are surrounded by a small layer of Sphagnum moss. Water flow from these pools from small drainage lines which join Bomaderry Creek. At the time of the visit on 31st October the pools were full and a small flow proceeded down the creek line. Significant rain had occurred over a fortnight previously."

"The Scribbly Gum Woodland provides suitable habitat for the adults to forage. The soil is sandy in many places and potentially suitable for adult and juvenile diurnal burrows. Other areas of extensive clay soils would not appear to be suitable for this species."

In another fauna report from ERM Mitchell McCotter (1995), the earlier work by Mahony was repeated, but it adds "the Giant Burrowing Frog has not been observed in the study area or nearby habitats. York and Daly recorded an unconfirmed record in the Bomaderry bushland in 1993."

The report further stated that "Daly (in prep) investigated potential habitat and possible occurrence of the Giant Burrowing Frog in the Bomaderry bushland. No evidence of this species was found although five possible breeding sites were located. Assessment of the population viability or significance could not be made as the species' presence has not been determined."

Searches in and near the project area were undertaken on rainy and non-rainy nights during February and March 1999. This would appear to be a prime time for locating this frog should it be present, particularly if the evening is warm and rainy. Despite several searches and a considerable amount of time spent in the Bomaderry Creek area, this frog was not located. Despite many searches of the Bomaderry Creek area since 1992, the Giant Burrowing Frog has not been found there.

Glossy Black-Cockatoo
Calyptorhynchus lathami

Status in New South Wales: As recently as 1981, the Glossy Black-Cockatoo was still considered to be moderately common in New South Wales (Morris, McGill & Holmes 1981). It is now vulnerable; the species is listed on Schedule 2 of the *Threatened Species Conservation Act 1995*.

Distribution: The Glossy Black-Cockatoo *Calyptorhynchus lathami* occurs along the Great Dividing Range and the east coast of New South Wales, Queensland and Victoria, from

Eungella in the north to Gippsland in the south. It also occurs on Kangaroo Island in South Australia. Its distribution is thin and patchy within this range. Forshaw (1981) commented that, in New South Wales, the Glossy Black-Cockatoo "is locally common in some districts, resident in small numbers in others and a rare vagrant to most parts of its range".

Habitat: The Glossy Black-Cockatoo feeds almost exclusively on the seeds of Casuarinas *Allocasuarina* and *Casuarina*, and is therefore restricted to woodlands and forests containing these species. They are sustained by mature stands of casuarinas producing sufficient quantities of cones and seed. Immature and/or scattered trees do not yield enough food.

Threats: The main threat to this species is the loss of habitat, as stands of mature Casuarinas have been cleared for agriculture and urban development. The species is also adversely affected by the clearing of large trees with hollows, used for nesting.

Regional Records: The Glossy Black-Cockatoo has been recorded throughout the Nowra to Jervis Bay region. In the Nowra district, it mainly occurs in Scribbly Gum - Casuarina forest containing abundant mature Black She-oaks *Allocasuarina littoralis*. The discarded remains of the cones, beneath the trees, indicate the presence of Glossy Black-Cockatoos.

Local Records (North Nowra): Chewed casuarina cones indicating the presence of the Glossy Black-Cockatoo were found near West Cambewarra Road by the consultant in 1995 and has been recorded regularly there since that time.

Grey-headed Flying-fox
Pteropus poliocephalus

Status in New South Wales: Listed as vulnerable on Schedule 2 of the *Threatened Species Conservation Act 1995* (NSW). Also listed as vulnerable under the *EPBC Act 1999* (Commonwealth).

Distribution: The Grey-headed Flying-fox occurs throughout eastern Australia, from about Rockhampton, Queensland to Western Victoria. It is mostly seen to the east of the Great Dividing Range.

Habitat: This bat is found in a wide range of habitats, from coastal rainforest, mangroves, dry forest to cultivated orchards and urban trees. Blossom and fruit of a variety of native and exotic trees attract the bat.

Threats: The bat is mainly threatened at its nursery camps, where large numbers of bat congregate, particularly in summer to breed. In the past, indiscriminate killing of bats at these camps has greatly reduced the population of the species.

Regional Records: The Grey-headed Flying-fox is mainly seen in the Shoalhaven during summer, when they congregate at a handful of camp sites; these are mainly located in moist rainforest on the slopes of the escarpments.

Local Records (North Nowra): As noted above, the bat visits the region in summer when it can be observed throughout the region, including the North Nowra area.

Large Bentwing-bat
Miniopterus schreibersii

Status in New South Wales: Listed as vulnerable on Schedule 2 of the *Threatened Species Conservation Act 1995* (NSW). Listed under the *EPBC Act 1999* (Commonwealth) as “conservation dependent”.

Distribution: The Large Bentwing-bat occurs in New Guinea, Indonesia, Malaysia, Africa and Eurasia (Dwyer 1995), as well as in Australia in high rainfall zones in the northern and eastern parts of the mainland (Churchill 1998). The species lives along the coast and ranges from Cape York in Queensland to southeastern South Australia, as well as in the Northern Territory and in the north of Western Australia. The species is considered by many authorities to be common and widespread across its range (e.g. Hall & Richards 1979, Dwyer 1995, Parnaby 1992). Research by Dwyer (1966, 1969), Dwyer and Hamilton-Smith (1965) and Hamilton-Smith (1965, 1972) showed discrete populations of Large Bentwing-bats in New South Wales and Victoria, each dependent on a particular nursery site. Population dispersal was throughout a widespread but defined geographical range. There was some overlap of populations and some mingling, but the unity of each population was generally preserved.

Habitat; The Large Bentwing-bat is a common cave dwelling species. The species occurs in well-timbered valleys where it forages on insects above the tree canopy. It roosts in caves, old mines, stormwater channels and comparable structures including buildings (Dwyer 1995). Large distances are traveled between different roosts, according to the species' seasonal requirements (Hall & Richards 1979, Reardon & Flavel 1987, Smith & Smith 1990, Dwyer 1995, Churchill 1998). The bats use cold roosts in winter, when they are torpid. The females travel up to 200km to suitable nursery caves in spring where the temperature, humidity and physical dimensions permit breeding (Baudinette et al. 1994, Dwyer 1995). The nursery caves may support up to 150,000 females and juveniles and may be used by a number of groups year after year (Reardon & Flavel 1987). The nursery colony disbands in late summer or early autumn and the bats disperse over distances of many hundreds of kilometres.

Regional Records: There are only a few records of the Large Bentwing-bat in the Shoalhaven, although it is likely to be a common species there. The lack of records probably reflects the lack of survey effort rather than the species' scarcity. There is a major breeding colony at Bungonia, on the western edge of the Shoalhaven region.

Local Records (North Nowra): The Large Bentwing-bat has not been recorded in the Bomaderry Creek area, either by Coles (1993) or during this study. The closest records to Nowra in the NSW Wildlife Atlas are from Barren Grounds, 23km to the northwest, and Culburra 20km to the southwest. The bat is, however, expected to be common in the district, although there may be no nursery caves in this district. Given the extensive nature of the rock outcrops in the gorge, this species could occur in the area but is probably not a permanent resident there.

Large-footed Myotis
Myotis adversus

Status in New South Wales: Vulnerable; the species was listed on Schedule 2 of the *Threatened Species Conservation Act 1995*. Not listed under the *EPBC Act 1999* (Commonwealth).

Distribution: Also known as the Large-footed Mouse-eared Bat, the Large-footed Myotis inhabits the high rainfall regions of northern and eastern Australia, as well as an area on the Victorian/South Australian border, although there is probably two species involved (Churchill 1998).

Habitat: Colonies of this bat are found in "caves, mines or tunnels, under bridges and buildings and even in dense foliage in the tropical part of its range" (Richards 1995), and it seldom occurs far from waterbodies such as streams, lakes and dams, where it sweeps the surface for insects and small fish. Breeding usually occurs in caves.

Threats: The Large-footed Myotis has probably been affected by the large scale clearing of forests for agriculture and timber. However, the main threat is from the destruction and/or degradation of caves in which the species roosts and breeds. Disturbance could threaten the ability of some populations to breed.

Regional Records: The Large-footed Myotis has been recorded at few locations in the Shoalhaven region, for example Green Point at Jervis Bay (Braithwaite, Austin, Margules, Catling & Bedford 1988) and Bomaderry Creek (Parnaby 1996).

Local Records (North Nowra): The Large-footed Myotis was found to inhabit the Bomaderry Creek gorge by Parnaby (1996), who trapped 19 animals between January and March 1996. Regarding the use of the "weir pool", which was in the gorge below the proposed bridge but has since been destroyed by breaching the weir, Parnaby (1996) made the following comments:

> "Individuals were observed at the southern end of the weir pool on all three nights. Bats were observed by spotlight and calls recorded simultaneously to confirm identification. Animals were observed foraging above the water surface, usually either alone or in pairs, with one individual following the other. On February 9 the pool was observed for 30 minutes starting at sunset to determine whether the first bats arrived from upstream or downstream. Two groups of 2-5 bats and several solitary individuals were observed abut 10 minutes after dark traveling upstream from the weir.
>
> "It is clear from spotlight observations that individuals and small groups circling in a regular beat over the water surface were foraging, presumably on insects flying above the water surface. On a number of occasions animals, including small groups, were flying directly upstream along the pool and were presumably commuting through the site."

Based on observations of animals just after dark along Bomaderry Creek, Parnaby (1996) speculated that there was a colony of Myotis between his sites 7 and 10, about 900 metres and 1900 metres downstream of the proposed bridge. Bats can forage a considerable distance from their roost sites, as shown by Richards (1997), who found roost and forage sites separated by about 11 kilometres. Because of the presence of apparently suitable crevices in the cliffline at Bomaderry Creek, the Myotis there are probably roosting in the gorge. The Myotis was observed and its call recorded over a pool about 400 metres downstream of the project area, on 2 March 1999. This corresponds to Site 6 of Parnaby (1996).

Long-nosed Potoroo
Potorous tridactylus

Status in New South Wales: Vulnerable; the species was listed on Schedule 2 of the *Threatened Species Conservation Act 1995*. Also listed under the *EPBC Act 1999* (Commonwealth) as vulnerable.

Distribution: The Long-nosed Potoroo *Potorous tridactylus tridactylus* occurs in southeastern Queensland, coastal New South Wales and Victoria, southeastern South Australia and in southwestern Western Australia. The distribution of the species has contracted throughout its range on the mainland. The Long-nosed Potoroo in Tasmania and on the Bass Strait islands is considered to be a separate subspecies, *Potorous tridactylus apicalis.*

Habitat: Johnson reports that the Long-nosed Potoroo occurs in a wide range of habitats ranging from coastal heath to wet and dry sclerophyll forests. It is generally restricted to areas with a rainfall in excess of 760mm per year, and is more likely to occur in locations on light sandy soils (Johnson 1995). The species requires dense shrubs and thick ground cover vegetation for food, shelter and camouflage, and it rarely ventures far from cover. The diet of the Long-nosed Potoroo consists substantially of underground fungi (Claridge 1993) as well as leaves, seeds and invertebrates.

Threats: Large areas of habitat suitable for the Long-nosed Potoroo and other small mammal species were destroyed in New South Wales when the forests were logged, or cleared for agricultural purposes. Fragmentation of the remaining habitat increases the vulnerability of this animal and the risk of local extinctions. Where the species has survived, it is threatened by introduced predators such as the Fox *Vulpes vulpes* and the Dog *Canis familiaris*, and by

inappropriate fire regimes. Catling (1991) found the Long-nosed Potoroo to be disadvantaged by a simplification of the forest structure caused by frequent low-intensity burns.

Regional Records: Little is known about the distribution and abundance of the Long-nosed Potoroo in the Shoalhaven area. To date, most statements about this species seem to be based on a few well substantiated records, a larger number of unconfirmed reports, and a creative interpretation of ecological information provided in the popular literature. A single animal was recorded in dense understorey vegetation at Barren Grounds Nature Reserve in 1988 (RAOU 1988) and the species still exists there. Robinson recorded the species in the same location in 1985 (Robinson 1985) and noted that it occurred in many other parts of the Illawarra district as well (Robinson 1987 and 1988). However, because no survey data were provided, it is impossible to know which records were recent and which were historical, and to differentiate between substantiated records and unconfirmed reports. Most reports of the Long-nosed Potoroo in the district are from locations along the Illawarra Escarpment and Cambewarra Range, from Barren Grounds to Cambewarra.

Local Records (North Nowra): The closest records of the Potoroo to North Nowra are from the Cambewarra Range area, about eight kilometres to the north. There are apparently no records from the forests along the Shoalhaven River, although the species could occur there.

Masked Owl
Tyto novaehollandiae

Status in New South Wales: Vulnerable; the species was listed on Schedule 2 of the *Threatened Species Conservation Act 1995*. Not listed under the *EPBC Act 1999* (Commonwealth).

Distribution: The Masked Owl occurs in Australia and New Guinea. Although it has been recorded in all states, mainly in coastal areas, its distribution is very sparse and it is recorded only rarely. It is more common in Tasmania.

Habitat: The Masked Owl inhabits eucalypt forest and woodlands. It roosts in dense trees in gullies and hunts along the edge of the forest. Its prey includes insects, mammals and birds. Its decline has been linked to the decline of native mammals since European settlement (Blakers, Davies & Reilly 1984). The species has a large territory of about 500-1000ha.

Threats: The Masked Owl is primarily threatened through loss of habitat.

Regional Records: The closest records to Nowra in the NSW Wildlife atlas are from Seven Mile Beach in 1980 (15km northeast), Bangalee in 1992 (5km west), also reported in Daly and Murphy (1996), and Callala in 1996 (20km southwest).

Local Records (North Nowra): The Masked Owl was recorded at "Bomaderry Creek" in May 1996 (Newsletter No.192, Illawarra Bird Observers Club).

Oliver Whistler
Pachycephala olivacea

Status in New South Wales: Vulnerable; the species was listed on Schedule 2 of the *Threatened Species Conservation Act 1995*. Not listed under the *EPBC Act 1999* (Commonwealth).

Distribution: The range of the Olive Whistler extends from Toowoomba in Queensland to Tasmania. On the mainland, it occurs in Victoria, south-eastern South Australia, eastern New South Wales and south-eastern Queensland. The species is widespread and common in Tasmania but its abundance on the mainland decreases northwards. The Olive Whistler normally occurs in the high country, but migrates to lower altitudes in winter.

Habitat: The habitat preference of the Olive Whistler varies markedly from north to south. In the northern part of its range, it lives in rainforest and eucalypt forest at about 500 metres in altitude. In south-eastern New South Wales it mainly inhabits eucalypt forest. Further south, it inhabits alpine woodland and has an affinity for teatree, heathland and thickets (Boles 1988). The Olive Whistler feeds in dense undergrowth in the lower strata of the forest, where it forages for insects and berries. It perches higher when singing. The threats to this species have not been well documented. Like most forest birds, it has probably been affected by habitat loss.

Regional Records: The Olive Whistler has been recorded infrequently at several locations along the Illawarra Escarpment and Cambewarra Range, including Barren Grounds and Red Rocks Nature Reserve; it is usually recorded in this district in winter. The species does not breed in the Shoalhaven Region and is only a rare vagrant to coastal districts so that the bushland at Bomaderry Creek is very unlikely to be utilised by this species. Most records in the Nowra district come from the higher parts of the Cambewarra Range, which is not surprising since the Olive Whistler is basically a tablelands species.

Local Records (North Nowra): The Olive Whistler is a very rare non-breeding visitor to the Nowra area, where there have been only a few sightings. The closest sightings to North Nowra are records in the NSW Wildlife Atlas from the Cambewarra Range area, abut eight kilometres north of North Nowra. The high altitude, moist forests there are very different to the habitats in the Bomaderry Creek area.

Pink Robin
Petroica rodinogaster

Status in New South Wales: Vulnerable; the species was listed on Schedule 2 of the *Threatened Species Conservation Act 1995*. Not listed under the *EPBC Act 1999* (Commonwealth).

Distribution: The Pink Robin inhabits the moist forests of south-eastern Australia, and is most common in Tasmania (Blakers, Davies & Reilly 1984). During winter, when the birds disperse more widely, stragglers are reported as far north as Sydney; however, the males remain in the breeding territories all year. The species has not been recorded breeding in New South Wales, although Boles (1988) reported what appeared to be breeding activity at Bombala in the south of the state. It is regularly recorded in the extreme south-eastern part of the state, outside the breeding season.

Habitat: The Pink Robin mainly inhabits rainforest and wet eucalypt forest in mountain gullies in Victoria and Tasmania, dispersing to drier and more open habitats in winter. The species prefers vegetation close to the ground, and sometimes forages on the ground. It eats insects and other small arthropods (Boles 1988). The Pink Robin is a quiet and often sedentary species, but active when foraging. It usually occurs alone or as part of a small family group.

Threats: According to Klippel (1992), the Pink Robin has been adversely affected by the clear-felling of rainforest in gullies where it breeds. The bird may be threatened in Victoria and Tasmania, but in NSW it is a non-breeding visitor and is unlikely to be threatened in a serious way.

Regional Records: The Pink Robin is a very rare non-breeding visitor to the Shoalhaven region, where there have been only a few sightings. Daly and Murphy (1996) and IBOC (1989) mention Kangaroo Valley as a sighting location, but do not provide any other information.

Local Records (North Nowra): The closest sighting to North Nowra is a record in the NSW Wildlife Atlas from Bamarang, 6km to the southwest (reported in IBOC 1989).

Southern Brown
Bandicoot *Isoodon obesulus*

Status in New South Wales: Endangered; the species was listed on Schedule 1 of the *Threatened Species Conservation Act 1995*. Also endangered under the *EPBC Act 1999* (Commonwealth).

Distribution: The Southern Brown Bandicoot *Isoodon obesulus obesulus* occurs across southern Australia, in southwestern Western Australia, New South Wales and Victoria. In New South Wales, it occurs around Eden and Sydney (Ashby, Lunney, Robertshaw & Harden 1990). Another subspecies, *peninsulae*, occurs at Cape York in Queensland. The range of the Southern Brown Bandicoot has contracted in southern Australia since European settlement, its distribution is patchy and the population size has declined.

Habitat: Although the habitat requirements of the Southern Brown Bandicoot are not fully known, it is generally agreed that the species prefers scrubby vegetation on sandy soils, with areas of low ground cover that are burnt out periodically. As Braithwaite (1995) explains, "during the early stages of regeneration, after fire, the diversity of growing vegetation supports abundant insect food and is a very favourable habitat. Later, as the vegetation approaches maturity, the food supply is reduced." The Southern Brown Bandicoot is known to inhabit forests, woodlands and heathlands, and has been recorded in ground cover of varying density (Claridge, McNee, Tanton & Davey 1991). Ground cover of low to medium density provides good foraging habitat, and dense vegetation provides shelter. The presence of a mosaic of such habitats is probably necessary to sustain a stable population. The Southern Brown Bandicoot digs conical holes 5-10cm deep, as it seeks subterranean food. Its diet includes insects, larvae, worms, fungi and other plant material below ground level. Its nest is concealed in dense vegetation and organic debris. The home range varies considerably but is thought to be about seven hectares (Braithwaite 1995).

Threats: Threats to the Southern Brown Bandicoot include inappropriate fire regimes, the clearing of habitat for agriculture and forestry, the fragmentation of habitat and predation by feral animals.

Regional Records: There are records of the Southern Brown Bandicoot from the Jervis Bay area, West Cambewarra and Morton National Park (NSW Wildlife Atlas), but none from Nowra. The species might be more common than the records indicate; the lack of survey effort and the difficulty in trapping bandicoots may obscure the actual status of this species in this region.

Local Records (North Nowra): There are no local records of the Southern Brown Bandicoot, the closest record to North Nowra is a report from the Bugong area (NSW Wildlife Atlas).

Spotted-tailed Quoll
Dasyurus maculates

Status in New South Wales: Vulnerable; the species was listed on Schedule 2 of the *Threatened Species Conservation Act 1995*. Not listed under the *EPBC Act 1999* (Commonwealth).

Distribution: Also known as the Spotted-tailed Quoll, the range of the Spotted-tailed Quoll *Dasyurus maculatus maculatus* extends along the east coast of Australia from southern Queensland to southern Victoria and Tasmania. The distribution is now disjunct over most of its range. It used to occur in South Australia but is now thought to be extinct in that state. There is another subspecies, *gracilis*, in northern Queensland.

Habitat: The Spotted-tailed Quoll lives in a wide variety of habitats including rainforest and eucalypt forest, woodlands and coastal heath. It has a large home range, 1287 to 1452 hectares for males and 614 to 1067 hectares for females (Edgar & Belcher 1995). Dens are in

hollow logs, tree hollows, caves and crevices. The Spotted-tailed Quoll is usually considered to be a terrestrial species although, as an agile climber, it is also partly arboreal. Its diet mainly consists of medium sized mammals but also includes birds, small mammals and carrion.

Threats: The species is thought to have declined because of competition from cats and foxes. It has also been shot, poisoned and trapped, for it was generally regarded as a pest in rural areas. The clearing of habitat is another reason for its decline. Not only has there been a huge loss of habitat area, but the species' distribution is now disjunct over much of its range. It is still threatened by habitat loss, as the remaining habitat becomes increasingly fragmented and populations become isolated. As Edgar and Belcher (1995) commented, the species "now exists mostly in isolated areas that may be too small to support long-term viable populations while current land management practices continue".

Regional Records: The Spotted-tailed Quoll occurs in the forests along the Illawarra Escarpment and Cambewarra Range. There has been an increasing number of reports in recent years between Macquarie Pass and Kangaroo Valley, with occasional reports south of the Shoalhaven River.

Local Records (North Nowra): A Spotted-tailed Quoll was reported at North Nowra in February 1992, in Pitt Street about one kilometre southwest of the project area. Despite many surveys of the Bomaderry Creek area by various people, no quolls have been found there, although no targeted trapping has probably been carried out in this area.

Square-tailed Kite
Lophoictinia isura

Status in New South Wales: Vulnerable; the species was listed on Schedule 2 of the *Threatened Species Conservation Act 1995*. Not listed under the *EPBC Act 1999* (Commonwealth).

Distribution: The Square-tailed Kite *Lophoictinia isura* is widespread on the Australian mainland, except in the arid regions of the interior and in South Australia. It is sparsely distributed throughout its range. Most records in New South Wales are from the north and northeast of the state (Marchant & Higgins 1993); in the southeast it is recorded only sporadically. The species is migratory, moving south in summer and north in winter.

Habitat: The Square-tailed Kite inhabits forests and woodlands, mainly in and near coastal regions. Records are usually of a single bird flying over bushland, often along a watercourse or gully. It prefers a structurally diverse landscape (Debus & Czechura 1989).

Threats: This species is threatened by loss of foraging habitat and possibly nesting trees.

Regional Records: The Square-tailed Kite is rare in the Shoalhaven Region. Most records are from the Nowra to Jervis Bay region, where the number of observations has increased since 1989. There are few records from other parts of the Shoalhaven, although the species is regularly recorded in the Eurobodalla region, to the south. The Square-tailed Kite has been recorded nesting near Nowra, in Bangalee Reserve in 1994/1995, about five kilometres west of the Project Area (Daly & Evison 1996). During that summer, the Kite was observed throughout the Nowra area, Daly and Evison (1996) suggesting the breeding pair were foraging over an area of about 30,000 hectares.

Local Records (North Nowra): A Square-tailed Kite was observed flying over the project area during the present surveys, on 27 January 1999 and again on 3 October 2007.

White-footed Dunnart
Sminthopsis leucopus

Status in New South Wales: Vulnerable; the species was listed on Schedule 2 of the *Threatened Species Conservation Act 1995*. Not listed under the *EPBC Act 1999* (Commonwealth).

Distribution: The White-footed Dunnart occurs in south-eastern New South Wales, southern Victoria and Tasmania. It has also been recorded in northern Queensland (Lunney 1995). In New South Wales it is rarely seen north of the Eden region, although it has been recorded as far north as Sydney. On the mainland, it is restricted to within 150 kilometres of the coast (Morton, Wainer & Thwaites 1980). Its distribution is patchy and sparse.

Habitat: The White-footed Dunnart has been recorded in many habitat types including tussock grassland, sedgeland, scrub, heathland, woodland and open forest. Although often thought to require good ground cover (e.g. Morton et al. 1980), the preferred habitat in Mumbulla State forest is treeless ridges and mid-slopes with sparse ground cover (Lunney, O'Connell, Sanders & Forbes 1989) and at Eden the species prefers dry, open sclerophyll forest with very limited understorey and ground cover (Braithwaite, Clayton, Maclean & Parker 1984). The nest of the White-footed Dunnart is a shallow depression lined with a few leaves and grasses, usually under a log or piece of bark. It eats mainly terrestrial invertebrates and skinks. The home range of the White-footed Dunnart is relatively small. The average daily range of the "explorer" male is 720 metres (Lunney et al. 1989); females and "resident" males have a smaller home range.

Threats: Logging and fire are detrimental to the White-footed Dunnart, for it is unable to persist in the dense regrowth vegetation that develops after these events. Although Lunney et al. (1989) reported a population increase nine months after logging and wildfire in Mumbulla State Forest, the increase was only associated with the immediate post-logging and post-fire period. Within three years of these events the White-footed Dunnart had disappeared.

Regional Records: The White-footed Dunnart has been found in several localities in the Nowra to Jervis Bay region. There are records from Currambene (CSIRO 1988), Parma Creek (Barrer 1990), Jervis Bay National Park (King 1980) and from Bugong (Daly & Murphy, 1996). All of these locations appear to be in heathy vegetation on sandstone soils.

Local Records (North Nowra): The White-footed Dunnart has been recorded from Bugong, about five kilometres west of the project area (Daly & Murphy 1996). Other than this record, the species has not been recorded anywhere near Nowra. The White-footed Dunnart is not expected to occur in the study area, but it could conceivably occur there. No targeted trapping programs have apparently been undertaken in this bushland for this species.

A pitfall trapping program in the project area was undertaken between 21 September 1999 and 21 October 1999 in an attempt to trap this small mammal. The pitfall traps were two drift fences twenty metres long at right angles with nine 11 litre tins buried at five metre intervals. The drift fence was constructed of plastic damp course, held up with pegs. The results of the pitfall trapping program are provided below; no White-footed Dunnarts were trapped in the study area.

Results of Pitfall Trapping Program at North Nowra	
Date Checked	**Species trapped / notes**
21/9/99	Traps established
27/9/99	All traps full of water as a result of rain. Traps bailed out and holes drilled into the bottom. Possible negation of trap effectiveness for the preceding few days.
29/9/99	Traps dry.

1/10/99	1 x Toadlet *Pseudophryne ? dendyi*
4/10/99	1 x Barred-sided Skink *Eulamprus tenuis*
6/10/99	1 x Bibron's Toadlet *Pseudophryne bibronii*
19/10/99	4 x Common Eastern Froglet *Crinia signifera* 1 x Bush Rat *Rattus fuscipes* 4 x Jacky Lizard *Amphibolurus muricatus*
21/10/99	1 x Delicate Skink *Lampopholis delicate*
21/12/99	1 x Copper-tailed Skink *Ctenotus taeniolatus* 1 x Jacky Lizard *Amphibolurus muricatus* 1 x Common Ringtail Possum (juv.)

Yellow-bellied Glider
Petaurus australis

Status in New South Wales: Vulnerable; species listed on Schedule 2 of the *Threatened Species Conservation Act 1995*. Not listed under the *EPBC Act 1999* (Commonwealth).

Distribution: The Yellow-bellied Glider *Petaurus australis* inhabits the coast and ranges of eastern Australia, usually east of the Great Dividing Range. Its range extends from central Queensland to southern Victoria. There is another subspecies, *reginae*, in northern Queensland. Although the Yellow-bellied Glider can be locally common, its distribution is patchy.

Habitat: The Yellow-bellied Glider inhabits tall, mature moist eucalypt forests. Its preferred habitat is characterised by a mosaic of tree species associations including species that flower in winter (Kavanagh 1987). Its diet is composed of nectar, pollen, insects and eucalypt sap and, while it utilises many eucalypt species for food, it usually confines itself to only a few species in a particular district. Furthermore, the glider favours some trees of those species while apparently ignoring others; large trees are preferred. The presence of Yellow-bellied Gliders is often indicated by V-shaped marks incised through the bark of a eucalypt; the glider feeds on the sap as it oozes from the tree. The Yellow-bellied Glider has a very large home range, probably because its sources of food are seasonal and ephemeral. A small family group of two to five animals occupies between 30 and 65 hectares (Goldingay & Kavanagh 1991).

Threats: The Yellow-bellied Glider no doubt declined when large areas of forest were felled for agriculture and other landuses. It is also adversely affected by changes to the structure of its forest habitat, for it prefers large trees for feeding and needs nesting hollows. Logging and wildfire have both caused such changes.

Regional Records: The Yellow-bellied Glider occurs throughout the Shoalhaven region. Most records come from within or near Grey Gum *Eucalyptus punctata* and Spotted Gum *Eucalyptus maculata* forests.

Local Records (North Nowra): The Yellow-bellied Glider has been recorded at Bomaderry Creek (e.g. Mitchell McCotter 1992), where a small population exists. This population is isolated from other populations along the Shoalhaven River, such as in the Bangalee area (Daly & Murphy 1996), and further afield.

Symbiosis (1992) stated that "evidence of the Yellow-bellied Glider was obtained from recent feeding incisions on Grey Gum. Five such trees were positively identified, all to the south of the proposed road alignment. The feeding trees identified were in three "clumps", with the closest clump within 100m of the proposed road. All trees with incisions characteristic of the Yellow-

bellied Glider were Grey Gum *Eucalyptus punctata*. There were a number of unconfirmed feed trees on the northern side of the proposed road alignment. One animal was detected during spotlight searches and a den tree positively identified."

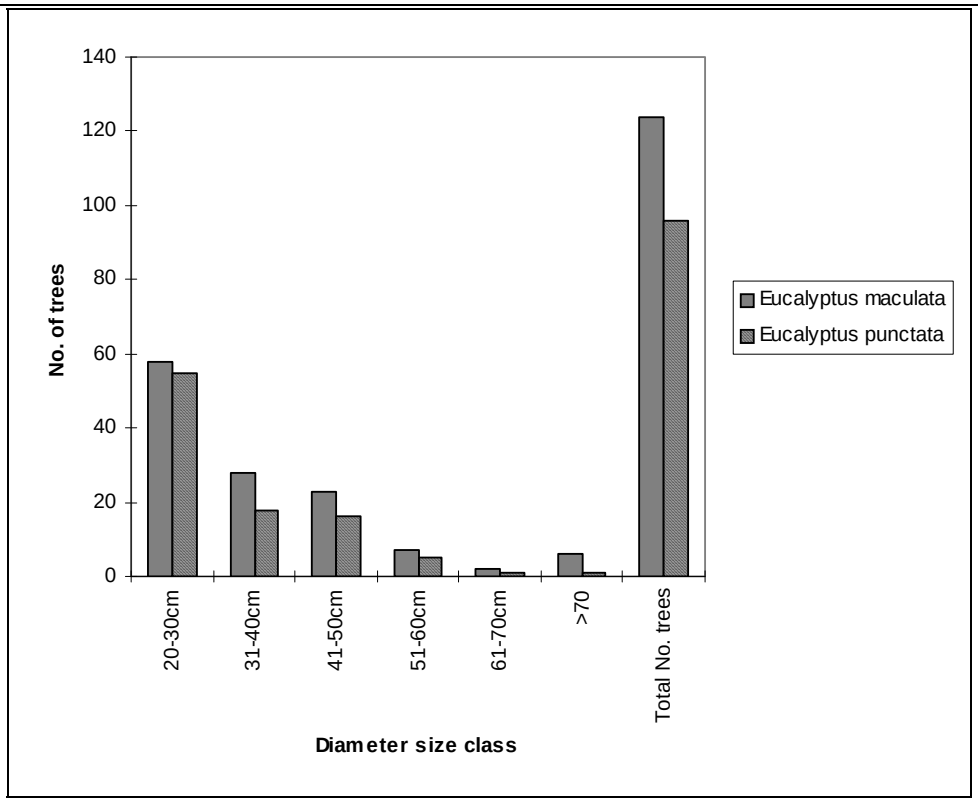
Mitchell McCotter & Associates (1992) estimated that there are "16,000ha of forest potentially available to Yellow-bellied Gliders" in the region extending from Kangaroo Valley, west to Morton National Park and south to the Shoalhaven River. That study also made the following statements about the glider at Bomaderry Creek.

> "Surveys for glider incised trees on-site located several trees both north and south of the proposed road route and on both sides of Bomaderry Creek ... This suggests that the gliders use the grey gum forest throughout much of the study site if not all of it. There is at present at least 200 hectares of forest and woodland available to this species on-site."
>
> "The study site itself appears to be isolated from any other areas of habitat suitable for Yellow-bellied Gliders and appears to have been that way for at least 20 years, based on the examination of aerial photographs dating back to the early 1970s. The Princes Highway would present an effective barrier to any glider movement on the eastern side of the site and although them is some suitable habitat elsewhere in Bomaderry, no evidence exists that the species remains within it."
>
> "The amount of habitat available to the yellow-bellied glider in the study area has been estimated. The study area presently contains at least 200 hectares of forest and woodland, however, it is believed that the amount of habitat being used by gliders could be much less than 200 hectares. The yellow-bellied glider lives in small family groups which use home ranges containing between 32 and 65 hectares of forest (Goldingay & Kavanagh, 1991)."
>
> "The study site at Bomaderry Creek could presently provide habitat for no more than two groups of gliders (i.e. 4-6 individuals).
>
> "The current mapped edge of the Grey Gum forest core habitat should be reviewed because in some areas the Grey Gums appear to extend 100 metres or so west of the boundary shown in Figure 1. Assuming Figure 1 is generally accurate the total core habitat area (Grey Gum forest) is approximately 38 hectares. The forest complex along the creek is approximately 60 hectares. The study area has been estimated to be presently capable of supporting two groups of gliders. An area of Scribbly Gum woodland would therefore need to be conserved in addition to the core area and the creek complex vegetation to maintain the existing potential of the area as home range for the gliders."

The calls of Yellow-bellied Gliders were heard in Spotted Gum - Grey Gum forest to the south of the Central route over several nights in January and February 1999. It was thought that two family groups were present.

The tree survey found six scarred feeding trees, two north of the road and four south of the road; some to the south were outside the 100 metre survey area. The diameter at chest height (dch) of the scarred food trees, all Grey Gums, are 26, 28, 29, 50, 52, and 58cm. Some old scarred trees were found to the north of the transmission line, so that at least in the past the gliders have used the Grey Gums in that area, whereas the records of gliders and fresher feed scars have only been made to the south of the transmission line.

Yellow-bellied Gliders were heard calling at several locations near the road route soon after dark so that it is postulated that the den tree is one of the very large Spotted Gums just to the south of the road route. There are four such large trees with many hollows; the diameters at breast height of these trees are 92, 110, 125 and 140cm.



Diameter Size Classes of Yellow-bellied Glider Food Trees in the Project Area

Powerful Owl
Ninox strenua

Status in New South Wales: Vulnerable; the species was listed on Schedule 2 of the *Threatened Species Conservation Act 1995*. Not listed under the *EPBC Act 1999* (Commonwealth).

Distribution: The Powerful Owl *Ninox strenua* occurs along the coast and ranges of eastern Australia from near Rockhampton in Queensland, southwards throughout eastern New South Wales and Victoria. It mainly occurs on the coastal side of the Great Dividing Range but is also recorded on the western slopes. It is thinly distributed across its range.

Habitat: The Powerful Owl inhabits rainforest and wet and dry eucalypt forest, where its main prey species occur. The species often roosts in rainforest gullies by day and hunts at night, mainly in forests with an open structure and along the edge of forests. There are differing estimates of the size of its home range, although it is agreed that the home range is very large; Fleay (1968) estimated 800-1000 hectares, Davey (1993) estimated 400-1450 hectares. The Powerful Owl prefers old growth forest or, at least, forest with old growth elements. At Kioloa, Davey (1993) recorded the Powerful Owl in mid- and late-successional forest and in uneven-aged forest, but not in forest with a development age of less than 70 years. It requires large tree hollows for nesting, at least 0.5m deep (Schodde & Mason 1980). The Powerful Owl eats mainly arboreal mammals such as the Common Ringtail Possum *Pseudocheirus peregrinus* and the Sugar Glider *Petaurus breviceps*, and semi-arboreal mammals and birds. It is a sedentary species that occupies a permanent territory, either singly or in pairs.

Threats: The Powerful Owl is particularly dependent upon arboreal mammals for food and large old eucalypts with hollows for nesting. Historically, the main threat to the Powerful Owl was the loss of habitat when forests were cleared for farming purposes. It is still adversely affected by the clearing of habitat and inappropriate forest management practices. Intensive logging leads to the loss of old growth elements and nesting hollows, and a reduction in the availability of prey (Braithwaite, Binns & Nowlan 1988).

Regional Records: The Powerful Owl has been recorded at several sites in the northern part of the Shoalhaven region, including Culburra, Jervis Bay, Nowra and Woollamia; it can be expected to occur in suitable tall forest throughout the region, but be thinly distributed.

Local Records (North Nowra): The Powerful Owl has been recorded in the North Nowra area, at the Illaroo Road Scout Camp. There is speculation that it occurs at Bomaderry Creek, but this has apparently not been confirmed, even though the area has been searched by many people on numerous occasions. The Powerful Owl was not recorded in the study area and has not been recorded at Bomaderry Creek, despite numerous searches by many people over the past decade.

Sooty Owl
Tyto tenebricosa

Status in New South Wales: Vulnerable; the species was listed on Schedule 2 of the *Threatened Species Conservation Act 1995*. Not listed under the *EPBC Act 1999* (Commonwealth).

Distribution: The Sooty Owl *Tyto tenebricosa* occurs along the coast and ranges, from south-eastern Queensland to eastern New South Wales and southern Victoria. Its distribution is thin and patchy. The species also occurs in New Guinea.

Habitat: The Sooty Owl lives in rainforest and tall wet eucalypt forest. Its favoured habitat is "tall wet old-growth forest on fertile soils with a dense understorey and emergent tall eucalypts" (Garnett 1992); such forest usually occurs along creeks and in gullies. Tree hollows for nesting and roosting are essential, as well as abundant prey. The species has a large home range, estimated by Milledge, Palmer and Nelson (1991) to be 600-800 hectares and by Schodde and Mason (1980) to be 200-800 hectares. It is known to occur within a mosaic of forests, logged and unlogged (Kavanagh & Bamkin 1994), young, maturing and old (e.g. Davey 1993 and Milledge et al. 1991). The Sooty Owl mainly preys on arboreal mammals, but its diet also includes terrestrial mammals and birds.

Threats: The main threat to the Sooty Owl has been the clearing of forests for agriculture and, later, for urban development. Now that the rate of clearing has slowed, the main threat is the "disturbance of creekside rainforest, particularly of trees suitable for nesting, as a result of logging operations within the range of the species" (Tanton 1994).

Regional Records: The Sooty Owl has been recorded in many parts of the region, usually in the moist forests along the Illawarra Escarpment. Although thinly distributed, it is likely to occur throughout the region wherever there are tall moist forests and rainforest.

Local Records (North Nowra): The Sooty Owl has been recorded in several forested areas to the north and west of Nowra. These locations include Bangalee Reserve, Cambewarra and Bugong. These areas all have rainforest vegetation. The closest known record to North Nowra is at Bangalee Reserve, about four kilometres west of the project area. The Sooty Owl has not been recorded in the Bomaderry Creek area, despite numerous searches by many people over the past decade. It may occur in the rainforest in the lower gorge.

APPENDIX 6
Curriculum vitae for Dr Kevin Mills

DR KEVIN GIBSON MILLS
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Academic Qualifications B.A. (Hons) Ph.D.

B.A.	University of Wollongong, 1980
Honours (Class 1)	University of Wollongong, 1981 Areas of study: Ecology, Biogeography, Physical Geography.
Ph.D.	University of Wollongong, 1986. Thesis: *The Illawarra Rainforests - an Historical, Floristic and Environmental Study of their Distribution and Ecology*.

Employment History

1988 - present:	Principal and Managing Director, Kevin Mills & Associates.
1982 - 1988:	Consultant Ecologist, self-employed.
1986 - 1991:	Research Fellow, Department of Geography, University of Wollongong.
1980 - 1990:	Tutor, Department of Geography, University of Wollongong.

Specialist Areas of Expertise
Identification, description, survey and mapping of plant communities
Identification, survey, assessment and conservation of threatened and rare species
Endangered ecological communities and their identification
Field ornithology, particularly wetlands
Management of conservation reserves
Vegetation management plans

Appearance in the Land and Environment Court of NSW
Dr Mills regularly appears as an expert witness in the Land and Environment Court of NSW, on behalf of applicants, respondents and as a Court Appointed Expert.

Consultancies with particular Industry Groups
Urban and rural residential subdivisions
Quarrying and mining
Transmission lines, pipelines, major roads and railway lines
Wind farms
Local government, particularly land use planning and infrastructure
State Commonwealth government authorities

Work with Panels and Workshops (recent)
- Department of Planning: *Independent Expert Review Panel* - Dendrobium Mine, Wollongong.
- Department of Environment and Heritage, Canberra, workshops on grassy woodland vegetation in the Bega Valley and littoral rainforest in Australia.
- NSW Law Society: workshop on court-appointed expert witnesses.
- Southern Research and Survey Steering Group, Southern Branch, NPWS.

Research Interests - Plants
The natural vegetation and endangered plant communities of coastal southern NSW
Rare and threatened plant species in southern NSW
Rainforests of southern NSW
The plants and botanical history of Norfolk Island

Research Interests - Fauna
Threatened fauna species in south-eastern NSW
Habitat corridors
Wetland habitats, vegetation and waterbird usage
The avifauna of south-eastern NSW
Impact of motor vehicles on wildlife

Participation in Co-operative Surveys - Plants
The Banksia Atlas (Bureau of Flora and Fauna)
NSW Wildlife Atlas (NPWS)
Contributions to CSIRO's ROTAP species list
Vegetation survey sites and rare species records (CRA Research, NPWS)

Participation in Co-operative Surveys - Fauna
Nest Record Scheme (RAOU)
Atlas of Australian Birds (RAOU) (1980s)
NSW Wildlife Atlas (NPWS)
NSW Bird Atlas (NSW Bird Atlasers)
Atlas of Australian Birds (RAOU) (1999-2002)

Professional and Semi-professional Memberships
Ecological Society of Australia
Zoological Society of New South Wales
Australian Bird Study Association
Coast and Wetlands Society
The Environment Institute of Australia
Royal Australasian Ornithologists Union
NSW Field Ornithologists Club
National Trust, etc.

Honorary Memberships
1989-2000: Nowra District Advisory Committee of the NPWS.
2000-08: South Coast Region Advisory Committee of the NPWS, currently Chairman.
1990-2000: Illawarra Catchment Management Committee.
1999: Recovery Team for the threatened species *Triplarina nowraensis* (NPWS).

Publications and Major Studies - Plants
Mills, K. *The Illawarra Rainforests*. Ph.D. thesis, University of Wollongong (1986)
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Mills, K. (2005). The beach weed *Euphorbia paralias* (Euphorbiaceae) in the Shoalhaven District, South Coast, New South Wales. *Illawarra Vegetation Studies No. 13.*
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