Assessment of Fauna and Flora

Jerberra Estate

Tomerong
City of Shoalhaven

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Executive Summary

AES was invited by Shoalhaven City Council to carry out a flora and fauna survey and assessment of Jerberra Estate near Tomerong. The purpose of this study is to identify which parts of the estate are capable of supporting residential development and recommended management options which will protect areas of ecological significance. This study was also carried out in order to address the Threatened Species Conservation Act. A local environment study prepared by Mitchell McCotter in 1994 outlined a development pattern for the estate but did not involve a detailed flora and fauna survey.

The results of the flora and fauna survey were as follows:

- Four vegetation communities are represented on the estate. They are Blue Gum Open Forest, Spotted Gum Open Forest, Scribbly Gum Woodland and Paperbark Heath-Scrub. Of these communities only Blue Gum Open Forest is considered adequately conserved at a state scale. However, both Blue Gum Open Forest and Spotted Gum Open Forest are inadequately conserved in the Jervis Bay region. The estate is also within the catchment of a designated wetland near the mouth of Moona Moona Creek.
- 145 flora species were found on the estate. None are listed in Schedules 1 or 2 of the Threatened Species Conservation Act nor are any listed as rare or threatened nationally. Nine species are of some conservation significance as they are at, or near the limit of, their geographical distribution in the Jervis Bay Region
- the estate is able to support a diverse fauna assembly due to its location within a large continuum of bushland, its variety in terms of flora species and vegetative structure and the provision of other habitat features such as tree hollows and creeks.
- 61 vertebrate fauna species were detected in the estate during the survey period. Of these, the Yellow-bellied Glider and Glossy Black-cockatoo are listed as threatened in NSW. A further 64 fauna species were considered likely to occur on the basis of local records and habitat preference. Of these, Square-tailed Kite, Powerful Owl, Masked Owl, Spotted-tailed Quoll, Common Bent-wing Bat, Greater Broad-nosed Bat, Large Pied Bat, Great Pipistrelle are threatened. The Yellow-bellied Glider and most of the other threatened species are strongly associated withe the habitat provided by the estate's two open forest communities.

In light of the results of the fauna and flora survey, it is considered that development on each lot would be inappropriate as it would have a significant effect on the ability of the estate and nearby bushland to support vegetation and fauna habitat of conservation significance. For the estate to retain its role in providing habitat for threatened fauna and poorly conserved vegetation communities, large areas need to remain free of residential development

Furthermore, a major factor influencing the impact development will have on the local bushland is whether sewage will be treated on-site or off-site. At the time of writing the most likely option was on-site disposal. On the basis of EPA guidelines this would result in the consolidation of many lots to meet the one hectare minimum required. Although this allows for greater scope for vegetation retention within lots there are inherent risks of disruptions to hydrology and nutrient enrichment of receiving bushland and waterways.

encountered. Those not readily identifiable were keyed out using standard botanical texts. Checks were made against Schedules 1 and 2 of the TSC Act for species considered threatened in New South Wales. To ascertain whether other nationally or regionally significant species occur in the estate checks were also made of Briggs & Leigh (1988) and Mills (1993).

3.2 Habitat Survey

The vegetation community descriptions are used to describe the different fauna habitats that occur in the estate. The habitat surrounding the site was also investigated to gain an appreciate the context of the estate within the locality

A search was undertaken for specific sources of native fauna food and shelter, such as dense shrubs, flowering trees, tree hollows and moist habitats. The presence, or lack, of particular fauna habitat requirements was noted to enable predictions of species that would be likely to utilise the estate. Species were so listed based on the habitats present in estate and other fauna records for the region (eg NPWS database). Such species would include migratory or nomadic birds and species made less active by the cold conditions during the survey period, eg reptiles and frogs.

3.3 Fauna Survey

3.3.1 Birds

Diurnal Birds
This group was surveyed by ten minute censuses in each habitat type on three consecutive mornings. Incidental sightings while undertaking other fieldwork, were also recorded.

Nocturnal Birds
Calls of the powerful owl and masked owl were broadcast via a Sony Walkman and a 13 watt loudspeaker for a period of five minutes at night. Ten minutes was allowed in which to detect the species visually (by spotlight) or by call. For the first two nights this was done in the north-east corner of the site: on the third night a transmission line easement just to the site's north was used for this purpose. Daylight searches of likely roosting/nesting areas were also carried out.

Other nocturnal species were identified by call recognition

3.3.2 Mammals

Small and Medium Sized Mammals
Trap lines were placed in three locations within the estate resulting in a total of 84 trap nights. Configurations were as follows:

- 15 small Elliot Traps, one large Elliot trap and one cage trap (20x20x56cm) in woodland and paperbark scrub in the north-east of the site
- one large Elliot trap and one cage trap (20x20x56cm) in the Spotted Gum Open forest in the north of the site
- 10 small Elliot Traps in Blue Gum Open Forest in the south-east of the site.

Traps were placed with a 5-6 metre spacing and were baited with a mixture of peanut butter, honey and rolled oats. Cage traps were baited with fish in attempt to catch the threatened Spotted-tailed Quoll.

In attempt to detect trap-shy species one large hair tube and one small hair tube was placed in each of the above three locations and in the north-west of the site. Hair samples were sent to Barbara Triggs for analysis.

A search was made for indirect evidence of small to medium sized mammals such as bandicoot holes, droppings, etc.

Arboreal Mammals
Spotlighting was undertaken in each habitat type for a period of 2 hours on three nights using a 12 volt battery, 50W spotlight and 10 x 50 Gerber binoculars. In addition to this, daytime searches for indirect evidence of the Yellow-Bellied Glider (scats, scarring of trees) were done.

Large Mammals
The site was traversed in an attempt to detect large mammals by direct observation A search was also made for indirect evidence of large mammal presence such as droppings, burrows, tracks, diggings and bones. These were identified using the keys and illustrations prepared by Triggs (1984).

Insectivorous Bats
This faunal group was not specifically surveyed as this survey was conducted during winter when bats are largely inactive.

3.3.3 Reptiles

A reptile search was undertaken throughout the site for a period of two hours on each of two consecutive days. This involved looking under bark, fallen timber, artificial debris and leaf litter. Due to the cold conditions during the survey reptile activity was very low.

3.3.4 Frogs

Debris found around moist areas was checked during the day for the presence of frogs and moist habitats were checked at night by spotlight and by listening for frog calls. Unknown calls were identified using the tapes prepared by Barker and Grigg (1983).

4. Description of the Estate's Vegetation

4.1 Description of the Vegetation Communities

Four distinct vegetation communities occur in the estate. As noted in the Mitchell McCotter study, boundaries between these communities are not always distinct but form ecotones where there is a gradual change for one to another Figure 1 illustrates the distribution of vegetation communities in the estate.

Nomenclature for the vegetation communities has been changed from that used by Mitchell McCotter (1994) to better reflect the structure and dominant species within the communities, and allow for comparison with the vegetation descriptions of the Jervis Bay Region by Mills (1993).

Table 1. Plant Community Relationships

Vegetation Community	Mitchell McCotter (1994)	Jervis Bay Region Mills (1993)
Blue Gum Open Forest	Creek Headwater Open Forest	E.saligna Tall Forest
Spotted Gum Open Forest	Open Forest	E.maculata Forest
Scribbly Gum Woodland	Woodland	E.sclerophylla - E.gummifera Forest
Paperbark Heath-Scrub	Wetland Creekline Community	Heathland-sedgeland (fresh swamp)

4.1.1 Blue Gum Open Forest

This community occurs on the south-west of the site on damper, higher nutrient soils. The canopy is dominated by Rough-barked Blue Gum[1] (*Eucalyptus saligna x botryoides*) to 20m tall. Co-dominants include Large-fruited Red Mahogany (*Eucalyptus scias*), Grey Ironbark (*E.paniculata*), Turpentine (*Syncarpia glomulifera*) and on the drier edges Blackbutt (*E.pilularis*).

There is a dense small tree layer dominated by the paperbark (*Melaleuca biconvexa*) along the creek line and Wattles (*Acacia spp*) on drier ground. The shrubs Black Wattle (*Callicoma serratifolia*) and Narrow-leaved Geebung (*Peroonia linearis*) are prominent and there is a thick groundcover layer of Saw Sedge (*Gahnia clarkei*), grasses, rushes and ferns.

4.1.2 Spotted Gum Open Forest

This community extends over most of the western half of the site on the drier slopes and plateau. The canopy to 25m tall, is dominated by Spotted Gum (*Corymbia*[2] *maculata*), Blackbutt, White Stringybark (*E.globoidea*), Large-fruited Red Mahogany[3], Red Bloodwood (*Corymbia gummifera*) and Turpentine

The small tree layer is dominated by Black She-oak (*Allocasuarina littoralis*). Below this there is a variety of low and tall shrubs mostly from the Pea family (eg Bush Pea *Pultanaea villosa*). Groundcover is dominated by native grasses such as Bladey Grass (*Imperata cylindrica*) and Kangaroo Grass (*Themeda australis*) along with Mat-rush (*Lomandra longifolia*) and Bracken (*Pteridium esculentum*).

[1] misidentified as Blackbutt in the Mitchell McCotter survey
[2] formerly *Eucalyptus*.
[3] misidentified as Swamp Mahogany in the Mitchell McCotter survey

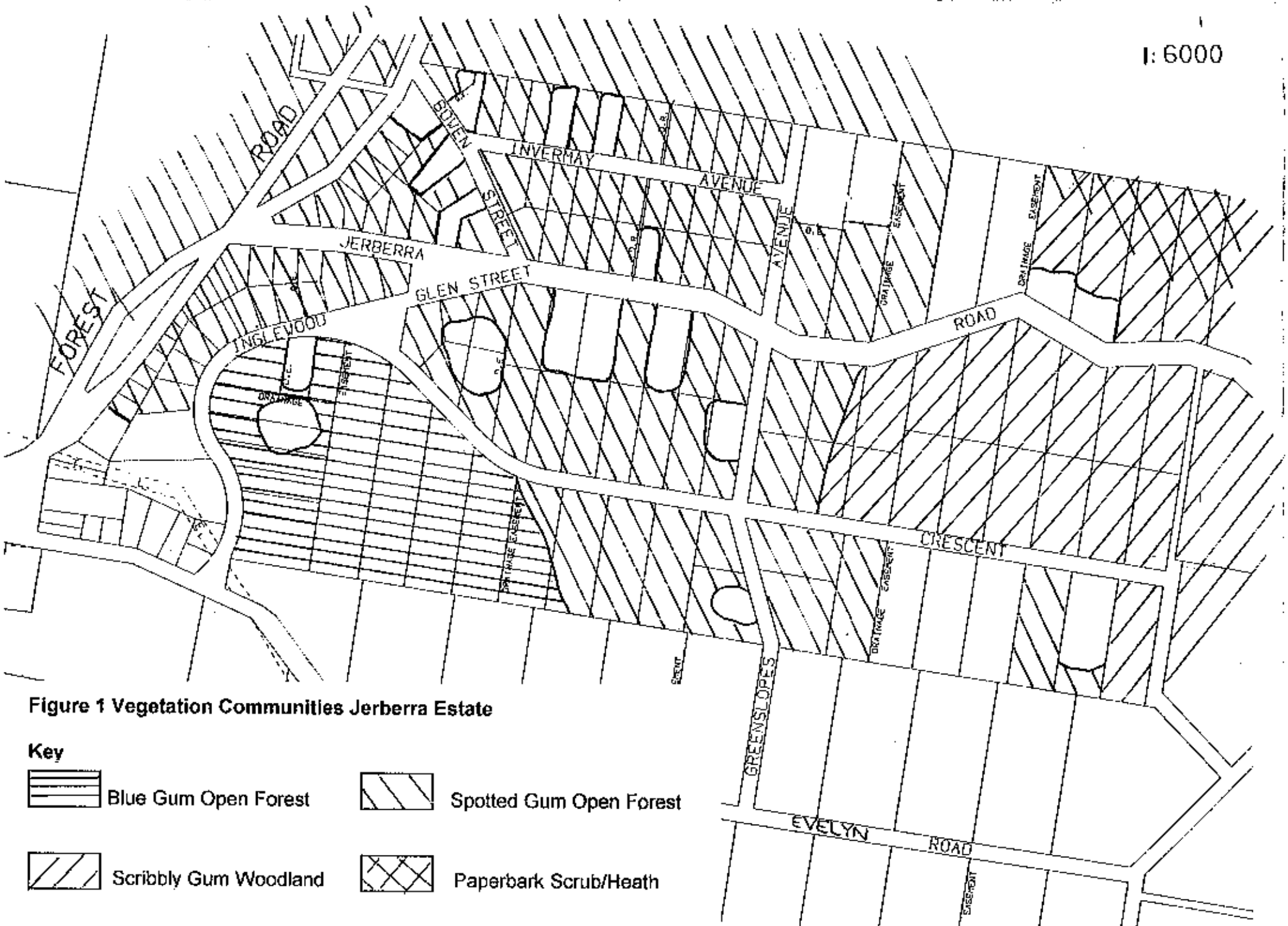

Figure 1 Vegetation Communities Jerberra Estate

Key

Blue Gum Open Forest

Spotted Gum Open Forest

Scribbly Gum Woodland

Paperbark Scrub/Heath

Scale 1: 6000 (approx)

4.1.3 Scribbly Gum Woodland

This community occurs in the eastern section of the site on poorer, well-drained soils. It is dominated by Hard-leaved Scribbly Gum (*Eucalyptus sclerophylla*) and Red Bloodwood There are also occasional Large-fruited Red Mahoganies.

Taller shrubs include Black She-oak and Yellow Tea-tree (*Leptospermum polygalifolium*). There is a variety of shrubs, particularly epacrids, peas and wattle in the lower shrub layers. A variety of native grasses, mat-rushes and lilies occur in the ground cover layer.

This community appears to be dying back in the north-east corner of the site due to a severe bushfire and changed hydrological conditions. Elsewhere, some very old Red Bloodwoods have been exposed by thinning of the canopy and are in poor condition. Other parts of this community have been completely cleared since the Mitchell McCotter study but are regenerating strongly.

4.1.4 Paperbark Scrub/Heath

Along Moona Moona Creek in the north-east of the site is a wetland community dominated by the Paperbarks *Melaleuca ericifolia* and *M.linariifolia* with emergent Scribbly Gums and Large-fruited Red Mahogany. The eucalypts are dying back giving way to thick growth of Paperbarks to 6 metres tall. On its edges is lower growth of paperbarks and Yellow Tea-tree with thick groundcover of sedges and rushes such as Spreading Rope-rush (*Empodisma minus*) and Twig-rush (*Baumea* sp).

4.2 Conservation Status of the Vegetation Communities

Blue Gum Forest

At a state scale *Eucalyptus saligna* associations are regarded as adequately conserved and not threatened (Benson. 1987).

In the Jervis Bay region, Mills (1993) comments that most of this community has been cleared for farming. Interpretation of mapping by Mills indicates Blue Gum Open Forest is not represented in either the NSW or Commonwealth Jervis Bay National Parks. This community is also significant in that it contains a stand of *Melaleuca biconvexa* which is at its southern limit in the Jervis Bay Region.

Spotted Gum Open Forest

Corymbia maculata associations are regarded as not threatened but inadequately reserved on a state scale. This community is widespread in the Jervis Bay region but inadequately conserved as most of its distribution falls within private land or State Forest. Mills' (1993) mapping indicates a very small area of this community occurs in NSW Jervis Bay National Park.

Scribbly Gum Woodland

At a state scale, *Eucalyptus sclerophylla* associations are regarded as inadequately reserved but not threatened (Benson, 1987). In the Jervis Bay region this community is widespread on sandier soils within the Wandrawandian siltstone unit (Mills, 1993). From mapping by Mills it appears to be widespread in proposed additions to NSW Jervis Bay National Park.

On the site the community contains a number of species of regional botanical significance, including *E.sclerophylla* itself. (see Table 2)

Paperbark Scrub

Melaleuca associations in general are regarded as vulnerable and inadequately conserved at a state scale (Benson, 1987). A problem with the conservation of these communities is that most were not included in wetland mapping conducted by the Department of Planning when preparing SEPP 14. Due to their limited occurrence, Fresh Wetlands (which includes the Paperbark Scrub) were regarded by Mills (1993) as a botanically significant vegetation community in the Jervis Bay Region. The community is widespread in the Moona Moona Creek wetlands, which are likely to become part of NSW Jervis Bay National Park (NPWS Nowra pers comm).

4.3 Flora

145 flora species were found in the estate (Appendix A[4]). This consisted of four species of fern and 141 species of flowering plants. None of the species are considered threatened in NSW, nor are any listed on the National Database of Rare and Threatened Plants (Briggs and Leigh, 1988).

Nine species regarded as regionally significant by Mills (1993) were found in the estate Their occurrence and significance is presented in Table 2 below. As can be seen from Table 2 all are regarded as significant as they are at the limit of their geographical distribution in the Jervis Bay area.

Table 2 Botanically Significant Plant Species at Jerberra Estate

Plant Species	Vegetation Community	Significance
Callistemon linearis	Woodland	Southern limit
Conospermum ericinum	Woodland	Southern limit
Eucalyptus resinifera	Spotted Gum Forest	Southern limit/outlying population
Eucalyptus sclerophylla	Woodland	Southern limit
Gompholobium grandiflorum	Woodland	Southern limit
Melaleuca biconvexa	Blue Gum Forest	Southern limit
Mirbelia rubiifolia	Woodland	Southern limit
Persoonia mollis ssp. leptophylla	Woodland	Northern limit
Platysace linearifolia	Woodland	Southern limit

[4] This list does not include those species that have been planted on the site but as yet have not naturalised

5 Description of Fauna

A total of 61 vertebrate fauna species were detected in the estate during the survey period This was comprised of 39 bird species, 15 mammal species, three reptile species and four frog species. In addition to this, a total of 64 species were considered likely to occur on the basis of local records and habitat preference. All species detected or likely to occur are listed in Appendix B.

5.1 Specific Habitat Features

The vegetation community descriptions provide a broad picture of the different fauna habitats that occur in the estate. Specific features within these habitats which are likely to contribute to the presence of fauna are:

- the wide variety of shrub species throughout all habitat types. Some of these require pollination by birds. Others are fed on or pollinated by insects thus providing a food source for insectivorous bats and many birds.
- the variety of canopy species (11 eucalypts[5]) which provide a year-round supply of pollen. These are important as a direct food source for flying-foxes, gliders, possums and honeyeaters. In turn these species, and insects feeding on these trees, are prey to a host of other species.
- the abundance of Black She-oak. This is an important factor contributing to the presence of Glossy-black Cockatoos. Black She-oak is abundant in the estate's Woodland and Spotted Gum Open Forest
- tree hollows of a size suitable for arboreal mammals and birds such as owls and parrots are relatively common. Such hollows are most abundant in the Spotted Gum Open Forest and Scribbly Gum Woodland.
- the ephemeral creeks and surrounding flood-prone areas. These would provide breeding habitat for a variety of frog species
- thick shrub and groundcover in the Paperbark Scrub and Blue Gum Open Forest which is favourable to small mammals such as Brown Antechinus.

5.2 Birds

39 bird species were detected during the field survey and a further 38 species were listed as likely to occur.

Amongst those detected was the threatened Glossy Black-cockatoo. Six individuals of this species were observed one morning in the centre of the estate. Evidence of them feeding (chewed Black She-oak cones) was found nearby. A pair from this group was also observed inspecting a tree hollow, presumably for suitability as a nesting site. Apart from this occasion the pair were not observed visiting the tree and it is considered they are not currently nesting on the site. Most of the estate is suitable habitat for this species as Black She-oak is abundant throughout the estate.

Amongst those bird species likely to occur are the threatened Powerful Owl, Masked Owl and Square-tailed Kite, all of which have been recorded in similar habitat in the Jervis Bay area. Indirect evidence of a large owl (either a Powerful Owl or Masked Owl) was found in the form of a sugar glider's tail which had been severed at its base.

[5] including Corymbia & Syncarpia species

5.3 Mammals

15 Mammal species were detected during the field survey, four of which are introduced (Appendix B). A further nine mammal species are likely to occur.

Of those detected, the Yellow-bellied Glider is threatened. On consecutive nights, one individual of this species was observed and heard moving through Spotted Gum Open Forest and Blue Gum Open Forest in the vicinity of the western section of Inglewood Crescent. Another individual was heard calling from Spotted Gum Forest east of the northern section of Greenslopes Avenue. This species is likely to extensively use the estate's open forests. Due to the poorer nutrient status of the Woodland, the Yellow-bellied Glider would be less likely to use that habitat type. The structure and floristics of the Paperbark Scrub precludes it from that habitat type.

Of those mammal species likely to occur, the Spotted-tailed Quoll and five insectivorous bats - Common Bent-wing bat, Greater Broad-nosed Bat, Large Pied Bat, Yellow-bellied Sheath-tail Bat and Great Pipistrelle - are threatened.

The Spotted-tailed Quoll has been recorded at Beecroft Peninsula area (Braithewaite et al, 1988); Cudmirrah Nature Reserve (NPWS, unpublished) and Parma Creek area (NPWS database). It would be likely to forage throughout the estate with the Blue Gum Open Forest and Paperbark Scrub being more favoured due the dense cover and availability of prey

On the basis of local records it is considered that there is a high probability of the Common Bent-wing Bat occurring at Jerberra Estate. This species has been recorded from St Georges Basin and near Old Erowal Bay (AES, 1995). It forages for insects above the canopy of forest and would be likely to occur over much of the estate.

There are few records of other threatened bat species in the Jervis Bay area, though they may occur. The Greater Broad-nosed Bat has been recorded in Cudmirrah National Park (NPWS, 1995) It forages along forest edges and tree lined creeks and would therefore be more restricted in its use of the estate. The Great Pipistrelle has been recorded in Currambene State Forest (Braithwaite et al, 1988). It prefers tall eucalypts forest and if occurring would favour the open forest habitats. The Large Pied Bat has been recorded at Culburra (Hoye pers comm). It forages in a range of woodland and forest habitat types.

It is considered there is a low likelihood of the Southern Brown Bandicoot and White-footed Dunnart occurring in the estate. There are few records for these species in the Jervis Bay area and they both occur only sporadically throughout their range

5.4 Reptiles

Three reptiles species were detected during the field survey and a further 14 were listed as likely to occur. None of the species are threatened.

5.5 Frogs

Four frog species were detected during the site inspection and a further three listed as likely to occur. It is considered the threatened Green and Golden Bell Frog is unlikely to

occur on the site. The only possible sites for this species are two dams - one near Invermay Road; the other along the creek in the south of the site. Both are infested with Mosquito Fish which prey on Bell Frog tadpoles.

5.6 Threatened Species

Two threatened fauna species were detected on the site. These were
- Yellow-bellied Glider and
- Glossy Black-cockatoo

The following threatened fauna species are considered likely to occur on the estate:
- Square-tailed Kite
- Powerful Owl
- Masked Owl
- Spotted-tailed Quoll
- Common Bent-wing Bat
- Greater Broad-nosed Bat
- Large Pied Bat
- Great Pipistrelle

6. Impacts of Rezoning and Subsequent Development

The following assessment considers the impact residential development would have on the estate's vegetation and fauna habitat and that of surrounding areas. Two major factors that need to be considered in assessing impacts are the provision of sewerage treatment and bushfire hazard reduction.

Sewerage Treatment

Two options are available for the provision of sewerage treatment:
- on site sewerage treatment
- connection to an existing treatment plant at Huskisson

Environment Protection Authority guidelines recommend that one hectare should be the minimum size for lots bearing on-site treatment systems. In terms of the local ecology, disadvantages of on-site treatment would be
- risk of system failure and consequent overflow of nutrients and pathogens into nearby bushland
- changes to groundwater flows with consequences for bushland vegetation

Conversely, the minimum lot size dictated by on-site treatment gives greater scope for retention of vegetation within lots. Also, due to lower population numbers there would be a lower incidence of intrusion into bushland and less likelihood of road/domestic pet kill of fauna.

Connection to the existing STP at Huskisson would mean that there would be no restriction on lot sizes. This would mean that without consideration for other issues most of the estate would be developable. Consequently there would be far greater impacts on vegetation and fauna habitat due to:

- greater amount of clearing required to accommodate residences and associated structures;
- increased pressure on local drainage systems having to cope with urban run-off;
- greater numbers of domestic pets;
- greater numbers of traffic movements and thus increased chances of road kill of fauna
- a higher human population with increased likelihood of intrusion into adjoining bushland (eg by trail bikes, dumping of rubbish)

There would be a substantial advantage in connecting to the STP as there would be a substantially reduced risk of sewerage overflows affecting the local environment.

Considering the considerable distance and cost of connecting the estate to Huskisson STP it is likely that on-site treatment will be adopted if rezoning occurs.

Bushfire Threat and Abatement

Mr Brian Parry, Council's Bushfire Control Officer, has indicated that the main threat of bushfire is from the crown land to the north of the estate. To a lesser extent there is a threat from the forests to the west of Pine Forest Road. Due to this there would need to be a hazard reduction zone of at least 30m between developed areas and any bushland. Mr Parry also advised that the retention of large tracts of natural bushland within the estate could allow development of spot fires Therefore, fuel loads within any retained vegetation would have to be reduced to less that 8 tonnes/ha. Such thinning would compromise the diversity of the understorey to re-establish and would have an impact on the recruitment of canopy species.

6.1 Impacts on Threatened Species

The Threatened Species Conservation Act, 1995 requires that when a development application is lodged a consent authority must consider (under Section 5A of the EP&A Act) whether the development is likely to significantly affect threatened species, or their habitats. If there is likely to be a significant effect then a Species Impact Statement must be prepared.

Due to the relatively small size of lots, it is unlikely that a development application for any individual lot on Jerberra Estate would require a Species Impact Statement. However, to assess the overall impact of rezoning and subsequent development it was considered appropriate to carry out a Section 5A assessment.

From the Section 5A assessment (which is attached as an addendum) it was concluded that residential development of the whole of Jerberra Estate would have a significant effect on the habitat of the Yellow-bellied Glider. This conclusion was based on the findings that development on each lot within the estate would compromise the viability of the local population by removal of feeding and sheltering resources and isolation of the estate habitat from proximate areas of habitat. Even if lots were of 1ha minimum it is considered there would still be a significant impact on the local population of the Yellow-bellied Glider

In regard to the other threatened species known and likely to occur in the estate, it is considered, on the basis of the eight-point test, that development would not significantly affect them or their habitats. It will, however, contribute to the attrition of habitat available to these species in the Jervis Bay area.

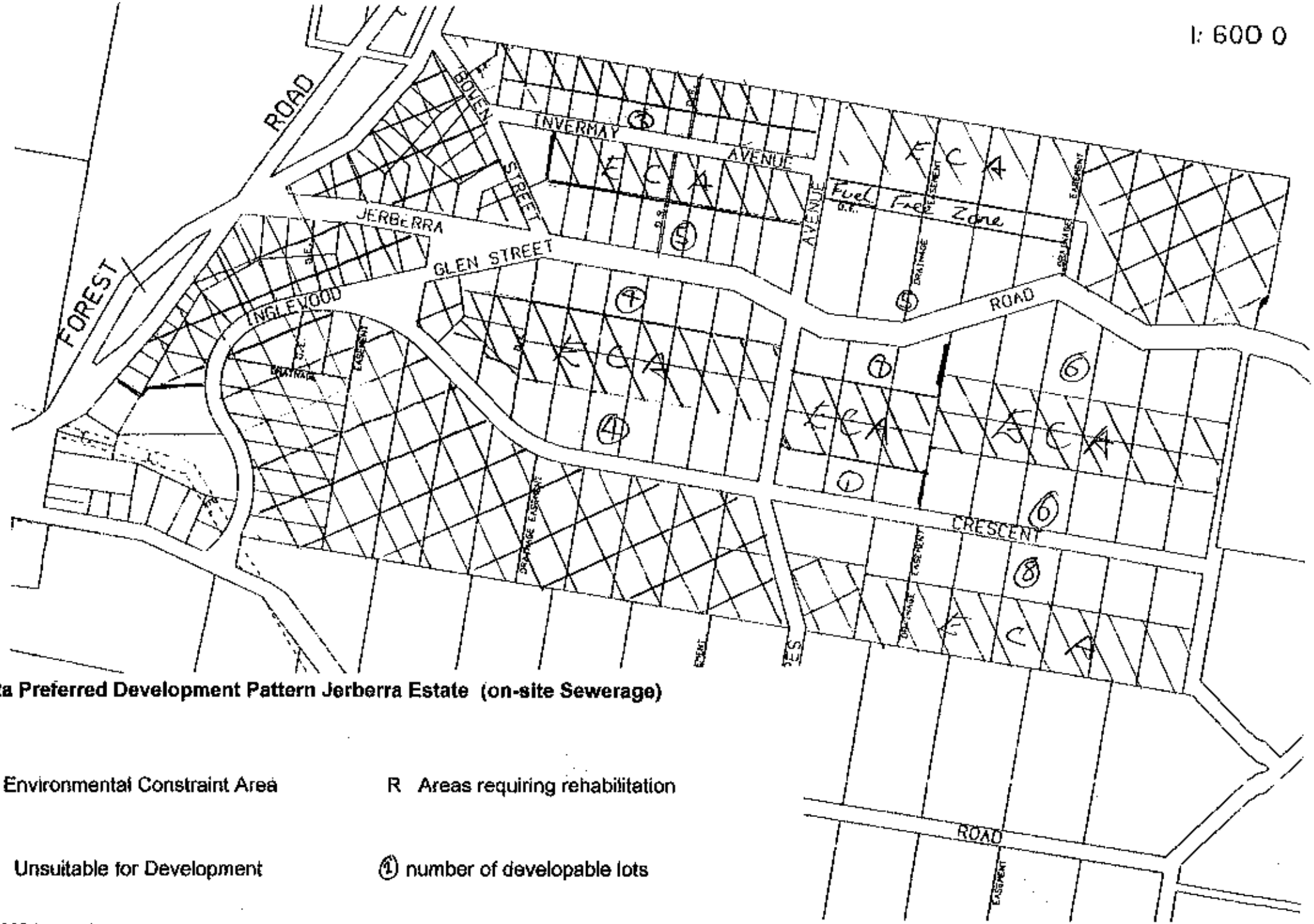

Figure 2a Preferred Development Pattern Jerberra Estate (on-site Sewerage)

Key

Environmental Constraint Area

R Areas requiring rehabilitation

Unsuitable for Development

① number of developable lots

Scale 1: 6000 (approx)

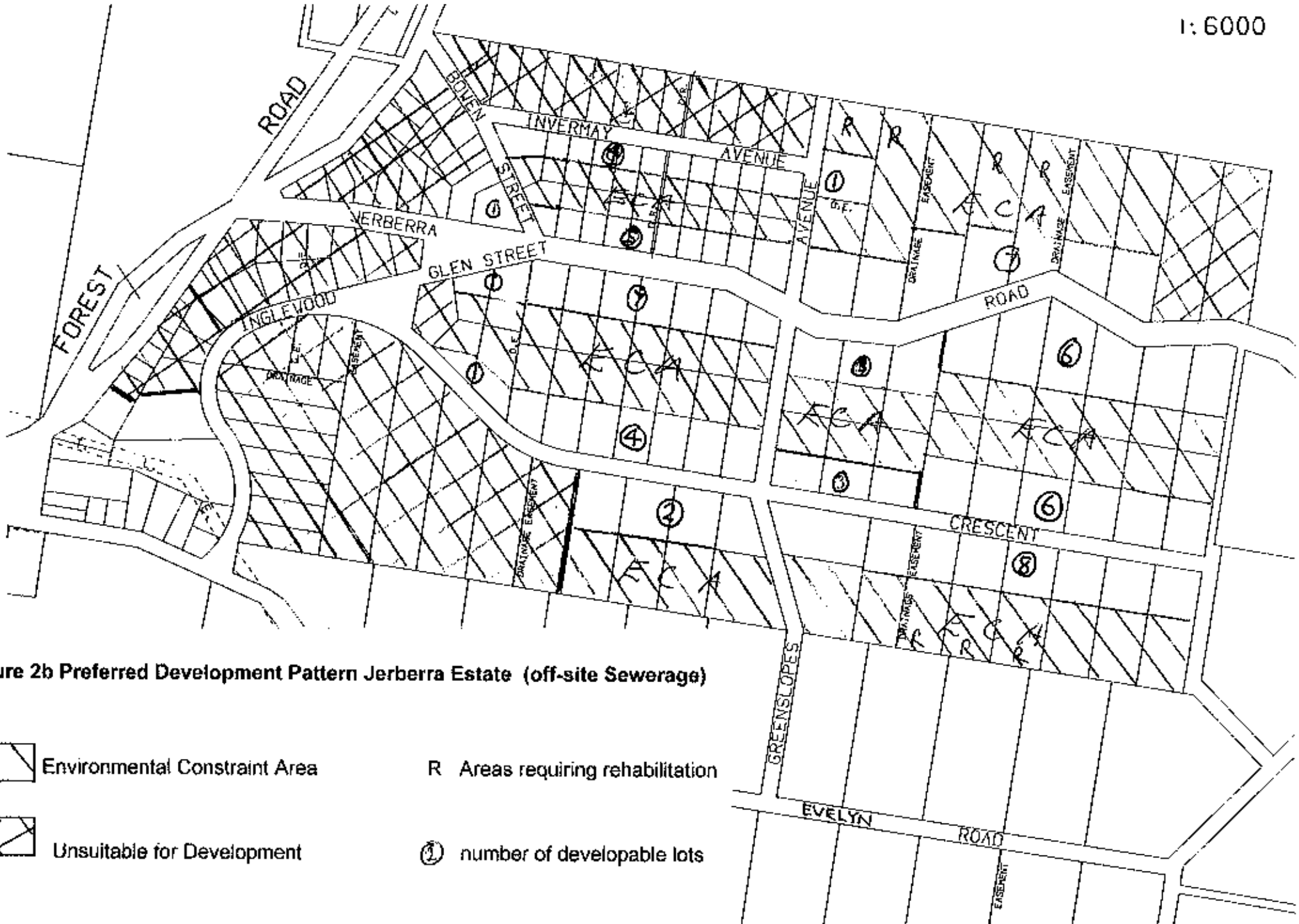

Figure 2b Preferred Development Pattern Jerberra Estate (off-site Sewerage)

Key

Environmental Constraint Area

Unsuitable for Development

R Areas requiring rehabilitation

① number of developable lots

Scale 1: 6000 (approx)

6.2 Impacts on Vegetation and Flora Species

The four vegetation communities represented on the site are inadequately conserved at a state level. Furthermore, the Blue Gum and Spotted Gum Open Forests are inadequately conserved in the Jervis Bay area[6] This is because both the NSW and Commonwealth Jervis Bay National Parks better sample communities underlain by coastal sands and sandstone rather than the Wandrawandian siltstone of the hinterland.

The likely result of full-scale residential development of the estate would be thinning of the canopy and removal of most. if not all, of the understorey. Apart from the loss of diversity due to removal of a range of groundcover and shrub species there would be an eventual decline in the canopy cover due to ageing of trees, increased exposure to wind and inadequate recruitment of young trees. This would result in a "parkland" effect already apparent in some parts of the estate. The end result of this would be that the site's vegetation would not be self-sustaining.

A consequence of any residential development is increased nutrient and sediment loads in receiving waterways. Such changes could compromise the integrity of riparian vegetation communities in the Moona Moona Creek catchment including the designated wetlands south of Huskisson. These areas are already under pressure from wide-scale land clearing practices elsewhere in the catchment.

A number of flora species found at Jerberra Estate reach the limits of their distribution in the Jervis Bay area. The conservation status of these species within local conservation reserves is unknown. Full-scale development would likely result in long term declines of these species' populations in the estate.

6.3 Impacts on Fauna

The estate currently supports a diverse fauna assemblage. The impacts on vegetation described above would result in a significant reduction in fauna diversity as the availability of a range of habitat features would be diminished. Eventually, the estate would only be suitable to those species adapted to residential areas eg magpies, noisy miners, kookaburras, brushtail possums. There would be a decline in populations of forest dependent species such as greater gliders, ringtail possums and a variety of reptiles and frogs.

6.4 Impacts on Habitat Corridors

The draft Jervis Bay REP illustrates a system of habitat corridors in the region. The north-east corner of the estate is within one of these corridors (HC3). The balance of the site is not within the corridor although it demonstrably functions in that manner ie it joins bushland to the west with that to the east. Therefore, the principles stated in the Draft REP should be followed when considering development of the estate. These are

- preservation and enhancement of the existing structure and species composition of the native vegetation communities
- allowing native fauna and flora to feed. breed, disperse, colonise or migrate
- regeneration and revegetation of degraded lands with local native species

[6] further information regarding the conservation status of the vegetation is forthcoming from the NPWS Southern Zone

Due to direct removal of habitat, fragmentation of remaining habitat and other factors such as increased traffic loads, full-scale development of the estate would significantly reduce the ability of species to move between habitat areas to the east and west.

7 Mitigation of Impacts

The estate is ecologically significant in that it supports habitat for a range of threatened fauna species and contains four vegetation communites that are poorly conserved at either local or state levels.

The current situation where uncontrolled land clearing and construction is gradually degrading the ecological significance of the estate is clearly untenable. The ecological significance of the estate clearly indicates that full-scale residential development is not a reasonable option. The best way to ensure conservation of the ecological significance of the estate is to either zone it for environmental protection or turn it over to public ownership.

Should Council reject these options, then it is recommended that the following section act as a guide for development practices to ensure significant ecological features are retained.

7.1 Habitat Retention

Figures 2a and 2b illustrate a preferred development pattern for the estate should rezoning proceed. Two alternatives have been prepared depending on whether on-site or off-site sewerage treatment is adopted. The principles guiding these plans are:

- the need to retain sufficient habitat to allow local threatened fauna populations to remain viable
- the retention of vegetation communities and flora species of conservation significance
- the need to protect the vegetation along Moona Moona Creek (particularly the designated wetland) from urban run-off

Features common to both plans are[7]:

- the exclusion of development from the Blue Gum Open Forest and the western sections of the Spotted Gum Open Forest
- low density development in the balance of the Spotted Gum Open Forest. This will involve consolidation of those lots situated between Invermay Road and Jerberra Road
- exclusion of development in the Paperbark Scrub and some its adjacent Woodland.
- general allowance of development within the Woodland south of Jerberra Road

The most likely option is on-site sewerage. In this event, it is recommended that in addition to the above, there be:

- no development in the area south of Inglewood Crescent and west of Lot 151
- no development north of Invermay Road
- nine developable lots between Invermay and Jerberra
- no development on lots 99 and 100 in the north-west of the estate

[7] n.b This plan does not include locations of wet retention basins.

Should On-site Sewerage treatment be opted it is recommended there be

- no development south of Inglewood Crescent and west of Greenslopes Avenue
- no development on lots 97-100 in the north-west of the estate due to proximity to creekline wetlands
- three developable lots north of Invermay Road
- five lots between Invermay and Jerberra Roads

Whether on site or off-site sewerage is adopted, it is considered that the Blue Gum Open Forest should be excluded from development. This is due to the fact this community is poorly conserved in the Jervis Bay region; the need to protect local watercourses from increased levels of sediment and nutrient; and the retention of threatened fauna habitat

To maintain the viability of the local Yellow-bellied Glider population it is considered that there should be restrictions on development within the Spotted Gum Open Forest. Firstly, it is necessary to retain the western and northern sections free of development. The retention of this forest and the Blue Gum Open Forest will maintain a continuum of habitat for both threatened and protected fauna.

In the case of off-site sewerage it is recommended that those lots north of Invermay Road not be developed so as to conserve an equivalent amount of habitat as would be retained in the on-site treatment situation Invermay Road could then be used as a perimeter road cum fire break.

It is also considered that the conservation status and fauna habitat significance of the Spotted Gum Open Forest and Woodland warrant limitations of development within the these communities of the estate. As on-site sewerage disposal dictates the need for lots to be a minimum of one hectare, there is also scope for vegetation retention within the developable parts of these communities.

Were it feasible to connect the site to an off-site sewerage treatment works, it is recommended that lots either be consolidated or the number of developable lots be restricted. This is because the number and size of the lots (particularly in Spotted Gum Open Forest) is such that development of all of them would lead to excessive degradation of vegetation both on-site and off-site (due to run-off and erosion). However, if off-site disposal was available, lots would not need to be as large as 1ha; and 0.5ha would be reasonable providing adequate stormwater retention basins are provided on the estate.

The overall result of this vegetation retention pattern will be the creation of a ring of retained habitat around the developable parts of the estate. This should result in adequate bushfire protection and sustainability of habitat.

7.2 Zoning/Development Control Plan Stage

There will necessarily be consolidation of lots to achieve the 1ha minimum required by the EPA for on site sewerage treatment.. Once the pattern of consolidation has been formulated it is recommended that 40% of the land within a resultant lot be retained as an Environmental Constraint Area. The aim of this is to retain vegetation within the estate as well as around its perimeter.

When this consolidation has been achieved it is recommended that a certain percentage of each lot be defined as an "environmental constraint area". Due to the risk of bushfires "spotting" within the estate it would be necessary to maintain ground fuel levels at less than 8 tonnes/ha. This will necessarily result in some loss of understorey diversity. However, it will allow for the retention of a canopy that will serve to act as habitat for species such as Yellow-bellied Gliders and the threatened insectivorous bats.

The following activities would be classed as "disturbances" that are not permitted within the ECA:

- direct removal of vegetation
- removal/deposition of soil
- any construction
- grazing
- planting of non-endemic plant species
- dumping of rubbish and
- unapproved bush fire hazard reduction.

Removal of introduced plant species and provision of reasonable pedestrian access (walking tracks) would not be considered disturbances.

Should a disturbance occur, Council could then order restitution of the land. Non-compliance would be liable to court action.

To ensure minimisation of disturbance to vegetation applicants should demonstrate that the following aims have been achieved in their proposal:

- location of dwellings towards their access roads..
- boundary fencing should only be allowed up to the edge of the retained vegetation The retained vegetation should be fenced off from the balance of the lot.
- habitat rehabilitation zones. The following lots have been almost entirely cleared:. To provide a continuum of vegetation through the estate rehabilitation of the rear of these lots should be stipulated as part of development consent. To expedite canopy establishment those species occurring in adjacent lots should be planted in those areas. A spacing of 5-8m between trees would be appropriate. Lots where unassisted rehabilitation is occurring have been excluded from this provision

A disturbance would be defined as "removal or modification of the vegetation resulting in changes to its natural ecology."

The disadvantage of this option is that encroachment and disturbance of the zone may occur without Council knowledge. Therefore, routine ground inspection (say on a yearly or biennial basis) of the ECA or assessment from aerial photos, would be required. Furthermore, landholders may fear the retained vegetation will represent a fire risk. To allay such fears, Council could arrange a meeting on site involving the landholders, the council's fire officer and an ecologist to discuss fire management.

Alternatives to an "ECA "are

- acquisition of the retained vegetation for public open space. This would ensure Council control over the retained vegetation and greatly reduce the risk of

encroachment. However, considerable costs would be borne by Council in initial purchase and ongoing maintenance.

- enforcement of Council's tree preservation order (TPO) over the whole of each lot This would result in a scattering of trees with no understorey and hence a loss of a variety of habitat resources and disruption to paths of movement.
- establishment of conservation agreements between the individual owners and the National Parks and Wildlife Service that cover the retained vegetation. These agreements are voluntary and are negotiated between the landholder and the service. They have the advantages of being attached to the title of the land and the service may assist the landholder with management of the retained vegetation eg fencing and ecological surveys. The large number of individual landowners, some of whom may not wish to enter such and agreement, is a major complication involved in this instance. Also, Council is not directly involved in this process and would have no power to compel such an agreement. However, landholders could be made aware of this provision and it may be useful in conjunction with Council powers.

It is therefore considered the delineation of an environmental constraint area (ECA), with a vegetation preservation order placed over it, would be the best approach to conserving vegetation within developable lots. To ensure future understanding and compliance with the vegetation preservation order it is recommended that it, and the ECA, are registered on the title of the land.

7.3 Development/ Building Application Stage

Details that should accompany a DA/BA are

- clear identification of where buildings are to be situated and their relation to retained vegetation.
- Identification of the type of on-site sewerage disposal system to be used and its location in relation to retained vegetation and any ephemeral watercourses.
- measures to protect retained vegetation. Prior to construction protective fencing should be placed at the dripzone of the outer edge of the retained vegetation. Trees to be retained within the development zone should be protected by tree guards.
- To ensure vegetation is not damaged at this stage financial bonds could be deposited with the council by the owner
- demonstration that soil disturbance is minimised. Concrete slab and cut/fill activities should be minimised
- identification of a single access route for machinery associated with clearing or building. This access route would then be used for the dwelling's driveway. Preferably, material used for driveway construction should be of a porous nature to reduce run-off.
- measures to control sediment and run-off in the study should strictly follow those set out in the Draft LEP
- stock-piling of stripped topsoil and vegetation to remain within the designated development area. Cleared vegetation should be mulched and used on site
- All development applications should include a landscape plan. Species listed for planting only be locally occurring native species or non-invasive introduced species.
- stipulation that all dwellings have attached rain water tanks to catch roof run-off. This would mitigate the impact of the proliferation of hard surfaces which contribute to run-off velocities and hence erosion potential

The site should be routinely visited by council officers during the development stage to ensure compliance with development guidelines.

7.4 Infrastructure Development

As the estate is currently unserviced, extensive work associated with provision of roads and services will be necessary.

Considering the volume of traffic, the existing unsealed roads within Jerberra Estate are excessively wide, particularly Jerberra Road. Sealing of roads and adjacent installation of above ground electricity wiring could therefore be achieved without creating significant gaps in the tree canopy. It is recommended that all roads only be constructed to the width necessary to carry their projected load of traffic. All shoulders should be revegetated upon completion. Yellow-bellied gliders can glide up to 100m where trees are of a sufficient height. Planting of road margins with rapidly growing trees (eg spotted gum) could mitigate this impact in the long term. Non-invasive exotic trees could also be used if eucalypts are considered too much of a hazard to electricity wires.

In regard to services (telephone , water etc) trenches should be common, or as close to each other as possible to minimise habitat disturbance. All vegetation removed should be mulched *in situ* and used in replanting.

The development of water quality control ponds represents potential habitat for green and golden bell frogs. To encourage use by this and other frog species, ponds could include design features (eg thick vegetated margins, scattered rocks and timber) which would provide protective niches.

7.5 Fencing

To allow continued movement of fauna through the estate the DCP should stipulate the extent of fencing allowed and the type of materials to be used. Fencing to delineate common boundaries should only be allowed as far as the edge of the ECA. The boundary between the ECA and the developable area of the lot should be fenced to prevent encroachment into the ECA.

Barb-wire fencing, which is commonly used in rural-residential subdivisions, has the potential to kill or maim fauna attempting to move through it. Anecdotal evidence suggests sugar gliders are particularly susceptible to this problem. Nor should "Cyclone" fences be allowed as these also restrict movement. Post and rail fencing would be preferable as it would allow continued fauna movement. Some residents, however, may object to allowing kangaroos and wallabies on their properties due to their destructive effect on cultivated plants and crops. Plant guards, or internal fencing of those crops, would overcome this problem.

7.6 Domestic Pets

Studies done in the region indicate the effects domestics pets have on a range of native fauna. Although it is not considered that yellow-bellied gliders would be significantly affected by the presence of more cats and dogs, the ground dwelling fauna species would be seriously affected.

It is not considered practicable for a council the size of the Shoalhaven City to attempt to control this problem by restrictions on ownership. A more reasonable approach would be

a campaign highlighting to local residents the wealth of native fauna in the area and the range of environmental pressures upon them (including dogs and cats, excessive clearing and agricultural chemicals). This could be achieved by including pamphlets with this information in rates notices or other standard council correspondence. A regional Landcare or catchment management committee could be established or encouraged to provide a forum for environmental education and conservation projects.

7.7 Fire Hazard

Council's Bushfire Control Officer has indicated that the main threat of bushfire is from the crown land to the north of the estate and to a lesser extent from forests to the west of Pine Forest Road. Due to this there would need to be a hazard reduction zone of at least 30m between developed areas and any bushland. He also advised that the retention of large tracts of natural bushland within the estate could allow development of spot fires. Therefore, fuel loads would have to be reduced to less that 8 tonnes/ha. Unfortunately, this will result in a loss of diversity of species in the understorey and ground cover layers of retained vegetation within lots.

7.8 Traffic

The endangered species that would be most susceptible to road mortality is the Spotted-tailed Quoll. Powerful Owls have also been known to be killed in this manner. During the field inspection a Bronzewing Pigeon and Swamp Wallaby were found nearby killed by traffic

The estate contains a number of long straight stretches of road. Traffic speeds along these roads could be slowed by the use of chicanes or speed bumps. It is also recommended "wildlife crossing" signs (or similar warnings) be erected in the area.

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Appendix A Flora Species List Jerberra Estate, Tomerong.

* - denotes introduced species

Scientific name	Common name
FILICOPSIDA	**FERNS**
ADIANTACEAE	
Adiantum aethiopicum	Maidenhair fern
DENNSTAEDTIACEAE	
Pteridium esculentum	Bracken Fern
DICKSONIACEAE	
Calochlaena dubia	Rainbow Fern
SELAGINELLACEAE	
Selaginella uliginosa	
MAGNOLIOPSIDA	**FLOWERING PLANTS**
LILIIDAE	MONOCOLTYLEDONS
COLCHICACEAE	
Burchardia umbellata	Milkmaids
CYPERACEAE	
Baumea sp	
Cyperus eragrostis *	
Elaeocharis sphacealata	Spike-rush
Gahnia clarkei	Saw-sedge
Lepidosperma filiforme	Rapier Sedge
L.laterale	Sword Sedge
Ptilothrix deusta	
Schoenus melanostachys	Black Bog-rush
IRIDACEAE	
Patersonia sericea	Silky Purple Flag
JUNCACEAE	
Juncus cognatus *	A rush
LOMANDRACEAE	
Lomandra gracilis	Mat-rush
L.multiflora	Mat-rush
L.longifolia	Mat-rush
L. obliqua	Fishbones
ORCHIDACEAE	
Dendrobium speciosum	Rock Lily
Glossodia major	Wax-lip Orchid
Pterostylis nutans	Nodding greenhood
Thelymitra ixioides	Sun-orchid
PHORMIACEAE	
Dianella caerulea	Flax Lily
POACEAE	
Andropogon virginicus *	Whiskey Grass
Anisopogon avenaceus	Spear Oat Grass
Aristida vagans	Three-awn Spear Grass
Cynodon dactylon	Common Couch
Danthonia sp	Wallaby Grass

Scientific name	Common name
Echinopogon caespitosus	Tufted-Hedgehog Grass
Entolasia marginata	Wiry Panic
E.stricta	Wiry Panic
Eragrostis brownii	Brown's Love Grass
Imperata cylindrica	Bladey Grass
Paspalum dilatatum*	Paspalum
Phragmites australis	Native Reed
Themeda australis	Kangaroo Grass
POTOMAGETONACEAE	
Potomageton tricarinatus	
RESTIONACEAE	
Empodisma minus	Spreading Rope-rush
Leptocarpuas tenax	
Lepyrodia scariosa	Scale-Rush
SMILACACEAE	
Smilax glyciphylla	Native Sarparilla
TYPHACEAE	
Typha orientalis	Cumbungi
XANTHORRHOEACEAE	
Xanthorrhoea media	Forest Grass-tree
MAGNOLIOIDEA	**DICOTYLEDONS**
APIACEAE	
Centella asiatica	Pennywort
Paltysace lienarifolia	Carrot Tops
Xanthosia tridentata	
APOCYNACEAE	
Parsonsia straminea	Common Silkpod
ASCLEPIADACEAE	
Marsdenia suavelones	
ASTERACEAE	
Bidens pilosa*	Cobbler s Pegs
Cassinia aculeata	
Conyza albida *	Fleabane
Senecio linearifolius	Fireweed Groundsel
S.madagascariensis*	Variable groundsel
Taraxacum officianale*	Dandelion
CASSYTHACEAE	
Cassytha glabella	Devil's Twine
CASUARINACEAE	
Allocasuarina littoralis	Black She-Oak
CUNONIACEAE	
Callicoma serratifolia	Black Wattle
DILLENIACEAE	
Hibbertia empetrifolia	Guinea Flower
H.riparia	"

Scientific name	Common name
H.scandens	Twining Guinea Flower
DROSERACEAE	
Drosera paniculata	A Sundew
ELAEOCARPACEAE	
Elaerocarpus reticulatus	Blueberry Ash
EPACRIDACEAE	
Brachyloma daphnoides	
Epacris microphylla	A Heath
Leucopogon juniperinus	Beard-heath
L.lanceolatus	Lance-leaf Beard-heath
Monotoca scoparia	Broom Heath
EUPHORBIACEAE	
Breynia oblongifolia	Thyme Spurge
Glochidon ferdinandi	Cheese Tree
FABACEAE	
Sub-Family Faboideae	
Bossiaea obcordata	Spiny Bossiaea
Daviesia ulicifolia	Bitter-pea
Dillwynia floribunda	Parrot-pea
Glycine clandestina	
Gompholobium grandifolium	Giant Wedge-pea
G.pinnatum	Wedge-pea
Hardenbergia violacea	Hardenbergia
Kennedia rubicunda	Dusky Coral-pea
Mirbelia rubiifolia	
Phyllota phyllicoides	
Platylobium formosum	
Pultanaea daphnoides	
P flexilis	Bush-pea
P linophylla	"
P retusa	"
P.rosmarinifolia	
P.villosa	"
Trifolium sp*	Clover
Viminaria juncea	Native Broom
Sub-Family Mimosoideae	
Acacia baileyana *	Cootamundra Wattle
A binervata	Two-veined Hickory
A.brownei	Prickly Moses
A.floribunda	Sally Wattle
A.decurrens	Black Wattle
A.irrorata	Green Wattle
A.longifola	Sydney Golden Wattle
A.myrtifolia	Myrtle Wattle
A.parramattensis	Parramatta Green Wattle
A.suaveolens	Sweet-scented Wattle
A.terminalis	Sunshine Wattle
GOODENIACEAE	
Dampiera purpurea	Purple Dampiera
D.stricta	Blue Dampiera
Goodenia bellidifolia	Hop Goodenia

Scientific name	Common name
HALORAGACEAE	
Gonocarpus teucrioides	Raspwort
LOBELIACEAE	
Pratia purpurascens	White Root
LORANTHACEAE	
Amyema congener ?	a Mistletoe
MYRTACEAE	
Callistemon linearis	Bottlebrush
Corymbia gummifera[1]	Red Bloodwood
C.maculata	Spotted Gum
Eucalyptus globoidea	White Stringybark
E.paniculata	Grey Ironbark
E pilularis	Blackbutt
E piperita ssp urceolata	Sydney Peppermint
E.resinfera	Red Mahogany
E.saligna x botryoides	Rough-barked Blue Gum
E.scias ssp callimastha	Large-fruited Red Mahogany
E.sclerophylla	Hard-leaved Scribbly Gum
Kunzea ambigua	Tick Bush
Leptospermum juniperinum	Prickly Tea-tree
L.polygalifolium	Yellow Tea-tree
Melaleuca biconvexa	Paperbark
M ericifolia	
M.linarifolia	Snow-in-summer
M thymifolia	Thyme-leaved Paperbark
Syncarpia glomulifera	Turpentine
OLEACEAE	
Notelaea longifolia	Mock Olive
PITTOSPORACEAE	
Billardiera scandens	Apple Berry
Pittosporum undulatum	Sweet Pittosporum
POLYGALACEAE	
Persicaria sp	Knotweed
PROTEACEAE	
Banksia ericifolia	Heath-leaved Banksia
B oblongifolia	Fern-leaved Banksia
B. serrata	Saw Banksia
B.spinulosa	Hairpin Banksia
Conospermum ericinum	Smoke-bush
Hakea dactyloides	Finger Hakea
H.teretifolia	Dagger Hakea
Isopogon anemonifolius	Drumsticks
Lambertia formosa	Mountain Devil
Lomatia ilicifolia	
Persoonia levis	Broad-leaf Geebung
P.linearis	Pine-leaved Geebung
P.mollis ssp leptophylla	A geebung
Petrophile pulchella	Conesticks

[1] formerly *Eucalyptus*

Scientific name	Common name
ROSACEAE	
Rubus ulmifolius *	Blackberry
RANUNCULACEAE	
Clematis aristata	Travellers joy
Ranunculus sp	Buttercup
RUBIACEAE	
Opercularia aspera	Stink Weed
RUTACEAE	
Boronia pinnata	
SANTALACEAE	
Exocarpus cupressiformis	Acid Drops
SAPINDACEAE	
Dodonaea triquetra	Hop Bush
THYMELIACEAE	
Pimelea linifolia	Rice Flower
TREMANDRACEAE	
Tetratheca thymifolia	Black-eyed Susan
VERBENACEAE	
Verbena boniariensis*	Purple-top

Appendix B Fauna Species List, Jerberra Estate, Tomerong.

* - denotes introduced specie L - species listed as likely to occur
bold print - threatened species

Scientific name	Common name
BIRDS	
Anas superciliosa L	Black Duck
Chenonetta jubata	Maned Duck
Hieraaetus morphnoides L	Little Eagle
Lophoictinia isura L	**Square-tailed Kite**
Accipiter fasciatus L	Brown Goshawk
Streptopelia chinensis " L	Spotted Turtledove
Geopelia striata L	Peaceful Dove
Leucosarcia melanoleuca L	Wonga Pigeon
Phaps chalcoptera	Common Bronzewing
Cacatua galerita	Sulphur-crested Cockatoo
Callocephalon fimbriatum	Gang-gang Cockatoo
Calyptorhynchus funereus	Yellow-tailed Cockatoo
C.lathami	**Glossy-black Cockatoo**
Trichoglossus haematodus	Rainbow Lorikeet
Glossopsitta pusilla	Little Lorikeet
Alisterus scapularis L	King Parrot
Platycercus elegans	Crimson Rosella
P eximius	Eastern Rosella
Cuculus pyrrhophanus	Fan-tailed Cuckoo
Chrysococcyx lucidus L	Shining Bronze-cuckoo
Eudynamys scolopacea L	Koel
Scythrops novaehollandiae L	Channel-billed Cuckoo
Ninox novaeseelandiae	Southern Boobook
N.strenua L	**Powerful Owl**
Tyto alba	Barn Owl
T.novaehollandiae L	**Masked Owl**
Podargus strigoides L	Tawny Frogmouth
Dacelo novaeguineae	Kookaburra
Halcyon sancta L	Sacred Kingfisher
Eurystomus orientalis L	Dollarbird
Menura superba L	Superb Lyrebird
Hirundo neoxena	Welcome Swallow
Anthus novaeseelandiae	Richard's Pipit
Coracina novaehollandiae L	Black-faced Cuckoo-shrike
Climacteris leucophaea	White-throated Treecreeper
Petroica rosea L	Rose Robin
Eopsaltria australis	Eastern Yellow Robin
Microeca leucophaea	Jacky-winter
Pachycephala pectoralis	Golden Whistler
P.rufiventris L	Rufous Whistler
Colluricincla harmonica	Grey Shrike-thrush
Rhipidura fuliginosa	Grey Fantail
R.leucophrys L	Willie Wagtail
R.rufifrons L	Rufous Fantail
Psophodes olivaceus	Eastern Whipbird
Malurus cyanea	Superb Blue Wren
M.lamberti L	Variegated Wren
Sericornis frontalis	White-browed Scrub-wren
G.olivacea L	White-throated Warbler
Acanthiza pusilla	Brown Thornbill
A.lineata L	Striated Thornbill
A.nana	Yellow Thornbill
Manorina melanocephala L	Noisy Miner
Anthochaera carunculata	Red Wattlebird

Scientific name	Common name
A.chrysoptera L	Little Wattlebird
Philemon corniculatus	Noisy Friarbird
Meliphaga lewinii L	Lewin's Honeyeater
Lichenostomus chrysops	Yellow-faced Honeyeater
L.leucotis L	White-eared Honeyeater
Melithreptus brevirostris L	White-naped Honeyeater
Phylidonyris nigra L	White-cheeked Honeyeater
P novaehollandiae	New Holland Honeyeater
Acanthorhynchus tenuirostris	Eastern Spinebill
Zosterops lateralis	Silvereye
Pardalotus punctatus	Spotted Pardalote
Poephila bichenovi L	Double-barred Finch
Emberna temporalis L	Red-browed Firetail
Oriolus sagittatus L	Olive-backed Oriole
Ptilorhynchus violaceus L	Satin Bowerbird
Artamus personatus L	Masked Woodswallow
A.cyanopterus L	Dusky Woodswallow
Cracticus torquatus L	Grey Butcherbird
Corcorax melanorhamphos	White-winged Chough
Grallina cyanoleuca	Mudlark
Gymnorhina tibicen	Australian Magpie
Strepera graculina	Pied Currawong
Corvus coronoides	Australian Raven
MAMMALS	
Dasyurus maculatus L	**Spotted-tailed Quoll**
Antechinus stuartii	Brown Antechinus
Antechinus flavipes	Yellow-footed Antechinus
Perameles nasuta L	Long-nosed Bandicoot
Petaurus australis	**Yellow-bellied Glider**
P.breviceps	Sugar Glider
Petauroides volans	Graeter Glider
Pseudocheirus peregrinus	Common Ringtail Possum
Trichosurus vulpecula	Common Brushtail Possum
Macropus giganteus	Eastern Grey Kangaroo
Wallabia bicolor	Swamp Wallaby
Pteropus poliocephalus	Pale-headed Flying Fox
Vespadelus vulturnus L	Little Forest bat
Chalinolobus gouldii L	Gould's Wattled Bat
Mormospterus sp L	A Mastiff-Bat
Nyctophilus gouldi L	Gould's Long-eared Bat
Miniopterus schreibersii L	**Common Bent-wing bat**
Rattus fuscipes	Bush Rat
R.rattus *	Black Rat
Mus domesticus *	House Mouse
Oryctagalus cuniculus *	Rabbit
Canis familiaris * L	Dog
Felis catus * L	Cat
Vulpes vulpes *	Fox
REPTILES	
Chelodina longicollis L	Eastern Snake-necked Turtle
Physignathus lesueurii L	Eastern Water Dragon
Pseudonaja textilis L	Eastern Brown Snake
Pseudechis porphyriacus L	Red-bellied Black Snake
Demansia psammophis	Yellow-faced Whip Snake
Pogona barbata L	Bearded Dragon
Oedura lesueurii L	Lesueur's Gecko
Cryptoblepharus virgatus L	Fence Skink

Scientific name	Common name
Ctenotus taeniolatus L.	Copper-tailed Skink
Egernia whitii L.	White's Skink
Pygopus lepidopodus L.	Common Scaly Foot
Eulamprus quoyii	Eastern Water Skink
Lampropholis delicata	Garden Skink
L.guichenoti L.	Grass Skink
Saiphos equalis L.	Three-toed Skink
Saproscincus mustelina L.	Weasel Skink
Tiliqua scincoides L.	Blue-tongued Lizard
FROGS	
Crinia signifera	Eastern Common Froglet
Limnodynastes peroni	Brown-striped Frog
L.tasmaniensis	Spotted Grass Frog
Litoria caerulea L.	Green Tree Frog
L.fallax L.	Dwarf Tree Frog
L verreuxii	Bleating Tree Frog
L. peroni L.	Peron's Tree Frog

Addendum A - Section 5A Assessment - Full-scale Residential Development Jerberra Estate

Each of the eight factors that are required to be taken into account when deciding if "there is likely to be a significant effect on threatened species, populations or ecological communities or their habitats" are addressed below.

Two threatened fauna species were detected on the site. These were
- Yellow-bellied Glider and
- Glossy Black-cockatoo

The following threatened fauna species are considered likely to occur on the site:
- Square-tailed Kite
- Powerful Owl
- Masked Owl
- Spotted-tailed Quoll
- Common Bent-wing Bat
- Greater Broad-nosed Bat
- Large Pied Bat
- Great Pipistrelle

Each of the eight factors that are required to be taken into account when deciding if "there is likely to be a significant effect on threatened species, populations or ecological communities or their habitats" are addressed below.

(a) in the case of threatened species, whether the life cycle of the species is likely to be disrupted such that a viable local population of the species is likely to be significantly compromised
- Yellow-bellied Glider. Full-scale residential development of Jerberra Estate would lead to a diminution of the species' feed trees in the short term and a reduction in recruitment of eucalypts to the canopy in the long term. Furthermore, there is the possibility the species breeds or shelters within tree hollows in the study area. On this basis, it is considered the viability of the local population would be significantly compromised by development of the whole of the estate.
- Glossy Black-cockatoo. Development would reduce the availability of Black She-oaks and possible breeding hollows for the local population. However, the local population would cover a large amount of territory in which these resources are plentiful.
- Square-tailed Kite. This species preys on canopy-dwelling honeyeaters whose numbers would likely be reduced by development of the site. The Square-tailed Kite has huge territories. Therefore, the loss of prey availability would be insignificant and would not compromise the local populations viability
- Powerful Owl. Development would significantly affect the availability of prey items (gliders and possums) to the local population of Powerful Owls. The study area represents more than 10% of a typical powerful owl territory. Significant reductions in prey availability could affect the ability of the local population to breed successfully
- Masked Owl. It is considered the availability of this species prey would not be significantly affected by development of the estate. This is because it takes a wide array of prey including introduced rats and mice which are likely to become more common with development.
- Spotted-tailed Quoll. The availability of prey for this species would be likely to be significantly reduced. Although this may be compensated by an increased availability

of domestic fowl, there would be an increased likelihood of predation by domestic pets The Quoll's viability at a local level would, therefore, be significantly compromised

- Common Bent-wing Bat. This species' maternity sites are in caves and it forages over large distances. The local population's viability would not be compromised
- Greater Broad-nosed Bat. The Greater Broad-nosed Bat roosts in tree hollows (Richards in Strahan [ed], 1983) a resource which would be reduced by development and the viability of the local population could be compromised.
- Large Pied Bat. This species also roosts in caves. mines and abandoned martin's nests. These resources are not represented on the site. The local population would not be compromised by development
- Great Pipistrelle. This species roosts in tree hollows. The local population could therefore be compromised by development

(b) in the case of an endangered population, whether the life cycle of the species that constitutes the endangered population is likely to be disrupted such that the viability of the population is likely to be significantly compromised

No endangered populations occur in the vicinity.

(c) in relation to the regional[1] distribution of the habitat of a threatened species, population or ecological community whether a significant area of known habitat is to be modified or removed,

- Yellow-bellied Glider. This species habitat is eucalypt forest on higher nutrient soils. This habitat type is abundant in the region and the study area does not constitute a significant area of known habitat.
- Glossy Black-cockatoo. This species habitat is forest and woodlands containing Casuarinas (She-oaks). This habitat type is abundant in the region and the study area does not constitute a significant area of known habitat.
- Square-tailed Kite. This species habitat is Eucalypt open forests and woodlands in which it prey on passerines (perching birds). This habitat type is abundant in the region. In relation to its regional distribution the study area does not constitute a significant amount of habitat.
- Powerful Owl. This species inhabits open forest and woodland where it prey on arboreal mammals. This habitat type is abundant in the region, and the study area does not constitute a significant area of habitat.
- Masked Owl. The Masked Owl occurs in a range of habitats including tall open forest, open forest, and wooded farmlands. These habitat types are abundant in the region. and the study area does not constitute a significant area of habitat.
- Spotted-tailed Quoll. This species occurs in a wide range of habitats including swamps and woodlands though it prefers moist forests. These habitat types are abundant in the region, and the study area does not constitute a significant area of habitat.
- Common Bent-wing Bat. This species' foraging habitat - open forests - is abundant in the region. In relation to the regional distribution of this habitat the study area is not significant. The study area is not a possible roost site.
- Greater Broad-nosed Bat. This species forages for insects in open areas on the edges of forests or along tree-lined creeks and utilises tree hollows for diurnal roosting sites. The study area does not constitute a significant area of habitat in relation to its regional occurrence.

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[1] on advice from the Threatened Species Unit of NPWS regional' refers to those areas defined by the CSIRO's Interim Bioregional Assessment Jerberra Estate is within the Sydney Basin region.

- Large Pied Bat. This species forages over open water and along tree-lined creeks. The study area does not constitute a significant area of habitat in relation to its regional occurrence.
- Great Pipistrelle. This species forages in tall eucalypt forests. The study area does not constitute a significant area of habitat in relation to its regional occurrence

(d) whether an area of known habitat is likely to become isolated from currently interconnecting or proximate area of habitat for a threatened species, population or ecological community.

- Yellow-bellied Glider. Due to canopy thinning, development of the estate would compromise the ability of the Glider to move between habitat areas. Eventually this could lead to isolation of habitat areas down to a size where viability is no longer feasible
- Spotted-tailed Quoll. Thinning of the ground cover would make this species more vulnerable to predators and compromise its ability to move between habitat areas.

For all the other threatened species it is considered there would be no isolation of habitat as they are all able to fly across modified forest areas It would however contribute to fragmentation of forest cover in the area.

(e) whether critical habitat will be affected.

Critical habitat is yet to be defined by the Director-general of NPWS

(f) whether a threatened species, population or ecological community, or their habitats, are adequately represented in conservation reserves (or other similar protected area) in the region

The Sydney Basin region contains significant areas of conservation reserves including large tracts of land in the following National Parks : Morton, Kanangra-Boyd, Blue Mountains, Wollemi, Royal, Ku-ring-gai Chase, Marramarra, Dharug. There is no detailed information on population number of threatened species in these reserves However, it would appear that habitat for the all the threatened species likely to occur at Jerberra Estate is adequately conserved by the reserves in the region.

The exception to this is the Square-tailed Kite. Most of the forests of the Sydney Basin Region are on infertile soils. Subsequently, there are few records from the region, apart from the regular sightings at Nowra and Jervis Bay. It is considered that the coastal lowland forests south from Nowra are not conserved at a level to support the Square-tailed Kite

(g) whether the development or activity proposed is of a class of development or activity that is recognised as a threatening process,

Threatening processes are yet to be defined under the Act. However, it is generally accepted that habitat removal and modification are threatening processes to all species. For all the threatened species likely to occur on the estate development represents modification and removal of habitat. The degree to which this impacts on each species varies greatly. For instance for the resident/sedentary Yellow-bellied Glider modification

(as indicated in (a) above) would be of a greater degree than that experienced by a migratory wide-ranging species such as the Square-tailed Kite.

(h) whether any threatened species, population or ecological community is at the limit of its known distribution.

None of the species are at the limits of their known distribution. Their ranges are as follows

- Yellow-bellied Glider - North Queensland to western Victoria
- Glossy Black-cockatoo - Queensland to the Victoria-NSW border and west to the Pilliga
- Square-tailed Kite - throughout mainland Australia
- Powerful Owl - Mackay (Qld) to the Grampians (Vic)
- Masked Owl - North Queensland to Tasmania
- Spotted-tailed Quoll - North Queensland and South-east Queensland to Tasmania
- Common Bent-wing Bat - Cape York to South-east South Australia
- Greater Broad-nosed Bat - North Queensland to North-east Victoria
- Large Pied Bat - Rockhampton to Canberra
- Great Pipistrelle - South-east Queensland to Tasmania

In consideration of the above factors it is considered the residential development of the Jerberra Estate would have a significant effect on the habitat of the Yellow-bellied Glider and possibly the Spotted-tailed Quoll.

Addendum B Sample Section 5A Assessment for a Typical Lot in Jerberra Estate's Woodland

Two threatened fauna species were detected within Jerberra Estate during the flora and fauna assessment carried out as part of the local environment study. These were

- Yellow-bellied Glider and
- Glossy Black-cockatoo

On the basis of local records and habitat assessment, the following threatened fauna species are also considered likely to occur on the site:

- Square-tailed Kite
- Powerful Owl
- Masked Owl
- Spotted-tailed Quoll
- Common Bent-wing Bat
- Greater Broad-nosed Bat
- Large Pied Bat
- Great Pipistrelle

Each of the eight factors that are required to be taken into account when deciding if "there is likely to be a significant effect on threatened species, populations or ecological communities or their habitats" are addressed below.

(a) in the case of threatened species, whether the life cycle of the species is likely to be disrupted such that a viable local population of the species is likely to be significantly compromised

- Yellow-bellied Glider. The yellow-bellied glider would be likely to use the woodland areas of the estate on an occasional basis eg during dispersal to other habitat areas or to feed when red bloodwoods are flowering. The retention of tree cover both within the ECA and provision of the Tree Preservation Order within the developable part of the lot will enable ongoing utilisation of the site and provide for movement of individuals between habitat areas. It will also result in the retention of hollow-bearing trees which may harbour family groups.
- Glossy Black-cockatoo. Retention of vegetation within the ECA will result in Black She-oak (the species' food source locally) remaining abundant within the lot. Furthermore, the species has large foraging territories and the site represents a small proportion of that available.
- Square-tailed Kite. This species preys on canopy-dwelling honeyeaters. Development of the lot would result in the loss of some foraging and nesting resources for these birds and hence effect prey abundance for the Square-tailed Kite. The retention of habitat within the ECA will mitigate against this impact. The Square-tailed Kite has huge territories, in the order of tens of thousands of hectares. Therefore, the loss of prey availability would be insignificant and would not compromise the local populations viability..
- Powerful Owl. The retention of vegetation within the ECA on the lot and adjoining lots should result in the Owl's prey population (possums, gliders) maintaining densities close to their existing levels. Therefore the ability of the species to adequately provide young with food should not be compromised. The negative results recorded for the species during the AES field survey and the existing level of disturbance that would be experienced by nesting owls means that it is unlikely the species nests within Jerberra Estate.

- Masked Owl. It is considered the availability of this species prey would not be significantly affected by development of the lot. This is because it takes a wide array of prey including introduced rats and mice which are likely to become more common with development. As with the Powerful Owl, the negative results recorded for the species during the AES field survey and the existing level of disturbance that would be experienced by nesting owls means that it is unlikely the species nests within Jerberra Estate.
- Spotted-tailed Quoll. It is considered the woodland areas of Jerberra Estate are less likely to be utilised by the Quoll, than surrounding habitats. This because there is less vegetative cover and prey is likely to be scarcer. In consideration of the amount of habitat to be retained and its unsuitability for the Quoll it is unlikely development of the lot will compromise the viability of the local population
- Common Bent-wing Bat. This species' maternity sites are in caves and it forages over large distances. The local population's viability would not be compromised as adequate tree cover will be retained to allow continued foraging on the site
- Greater Broad-nosed Bat. The Greater Broad-nosed Bat roosts in tree hollows. Retention of vegetation within the ECA will conserve this resource on site.
- Large Pied Bat. The species is unlikely to roost on the site. Foraging habitat will be retained within the ECA
- Great Pipistrelle. This species also roosts in tree hollows. Retention of vegetation within the ECA will conserve this resource on site.

(b) in the case of an endangered population, whether the life cycle of the species that constitutes the endangered population is likely to be disrupted such that the viability of the population is likely to be significantly compromised

No endangered populations have been declared for the local area

(c) in relation to the regional[2] distribution of the habitat of a threatened species population or ecological community, whether a significant area of known habitat is to be modified or removed.

- Yellow-bellied Glider. This species habitat is eucalypt forest on higher nutrient soils. This habitat type is abundant in the region and the site does not constitute a significant area of known habitat.
- Glossy Black-cockatoo. This species habitat is forest and woodlands containing Casuarinas (She-oaks). This habitat type is abundant in the region and the site does not constitute a significant area of known habitat.
- Square-tailed Kite. This species habitat is Eucalypt open forests and woodlands in which it prey on passerines (perching birds). This habitat type is abundant in the region. In relation to its regional distribution the site does not constitute a significant amount of habitat.
- Powerful Owl. This species inhabits open forest and woodland where it prey on arboreal mammals. This habitat type is abundant in the region, and the site does not constitute a significant area of habitat.
- Masked Owl. The Masked Owl occurs in a range of habitats including tall open forest, open forest, and wooded farmlands. These habitat types are abundant in the region and the site does not constitute a significant area of habitat

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[2] on advice from the Threatened Species Unit of NPWS "regional" refers to those areas defined by the CSIRO s Interim Bioregional Assessment. Jerberra Estate is within the Sydney Basin region.

- Spotted-tailed Quoll. This species occurs in a wide range of habitats including swamps and woodlands though it prefers moist forests. These habitat types are abundant in the region, and the site does not constitute a significant area of habitat.
- Common Bent-wing Bat. This species' foraging habitat - open forests - is abundant in the region. In relation to the regional distribution of this habitat the site is not significant. The site is not a possible roost site.
- Greater Broad-nosed Bat. This species forages for insects in open areas on the edges of forests or along tree-lined creeks and utilises tree hollows for diurnal roosting sites. The site does not constitute a significant area of habitat in relation to its regional occurrence.
- Large Pied Bat. This species forages over open water and along tree-lined creeks. The study area does not constitute a significant area of habitat in relation to its regional occurrence.
- Great Pipistrelle. This species forages in tall eucalypt forests. The site does not constitute a significant area of habitat in relation to its regional occurrence

(d) whether an area of known habitat is likely to become isolated from currently interconnecting or proximate area of habitat for a threatened species, population or ecological community.

- Yellow-bellied Glider. Retention of vegetation within the ECA will result in known and likely habitat areas remaining linked thereby avoiding isolation of habitat areas. There will however, be some fragmentation of habitat.
- Spotted-tailed Quoll. Thinning of the ground cover would make this species more vulnerable to predators and compromise its ability to move between habitat areas.

For all the other threatened species it is considered there would be no isolation of habitat as they are all able to fly across modified forest areas

(e) whether critical habitat will be affected

Critical habitat is yet to be defined by the Director-general of NPWS

(f) whether a threatened species, population or ecological community or their habitats, are adequately represented in conservation reserves (or other similar protected area) in the region

The Sydney Basin region contains significant areas of conservation reserves including large tracts of land in the following National Parks: Morton, Kanangra-Boyd Blue Mountains, Wollemi, Royal, Ku-ring-gai Chase, Marramarra, Dharug. There is no detailed information on population numbers of threatened species in these reserves. However, it would appear that habitat for the all the threatened species likely to occur at Jerberra Estate is adequately conserved by the reserves in the region.

The exception to this is the Square-tailed Kite. Most of the forests of the Sydney Basin Region are on infertile soils, which do not support adequate prey populations for the Square-tailed Kite. Subsequently, there are few records from the region, apart from the regular sightings in the coastal forests of the Nowra and Jervis Bay areas. It is considered that the coastal lowland forests south from Nowra are not conserved at a level to support the Square-tailed Kite. Therefore, the retention of forest on privately-owned land will be essential for the conservation of this species in the region

(g) whether the development or activity proposed is of a class of development or activity that is recognised as a threatening process

Threatening processes are yet to be defined under the Act. However, it is generally accepted that habitat removal and modification are threatening processes to all species For all the threatened species likely to occur on the estate development represents modification and removal of habitat. The degree to which this impacts on each species varies greatly. For instance for the resident/sedentary yellow-bellied glider modification (as indicated in (a) above) would be of a greater degree than that experienced by a migratory wide-ranging species such as the Square-tailed Kite.

(h) whether any threatened species, population or ecological community is at the limit of its known distribution.

None of the species are at the limits of their known distribution. Their ranges are a s follows

- Yellow-bellied Glider - North Queensland to western Victoria
- Glossy Black-cockatoo - Queensland to the Victoria-NSW border and west to the Pilliga
- Square-tailed Kite - throughout mainland Australia
- Powerful Owl - Mackay (Qld) to the Grampians (Vic)
- Masked Owl - North Queensland to Tasmania
- Spotted-tailed Quoll - North Queensland and South-east Queensland to Tasmania
- Common Bent-wing Bat - Cape York to South-east South Australia
- Greater Broad-nosed Bat - North Queensland to North-east Victoria
- Large Pied Bat - Rockhampton to Canberra
- Great Pipistrelle - South-east Queensland to Tasmania

In consideration of the above factors it is considered the residential development of the lot will not significantly affect any threatened species nor their habitats

Addendum C - Sample Section 5A Assessment for a Typical Lot in Jerberra Estate's Spotted Gum Open Forest

Two threatened fauna species were detected within Jerberra Estate during the flora and fauna assessment carried out as part of the local environment study. These were

- Yellow-bellied Glider and
- Glossy Black-cockatoo

On the basis of local records and habitat assessment, the following threatened fauna species are also considered likely to occur on the site:

- Square-tailed Kite
- Powerful Owl
- Masked Owl
- Spotted-tailed Quoll
- Common Bent-wing Bat
- Greater Broad-nosed Bat
- Large Pied Bat
- Great Pipistrelle

Each of the eight factors that are required to be taken into account when deciding if" there is likely to be a significant effect on threatened species, populations or ecological communities or their habitats" are addressed below.

(a) in the case of threatened species, whether the life cycle of the species is likely to be disrupted such that a viable local population of the species is likely to be significantly compromised

- Yellow-bellied Glider. It is considered residential development on the lot will not affect the local population such that its viability is compromised. This is because retention of tree cover both within the ECA and provision of the Tree Preservation Order within the developable part of the lot will allow the species to move between existing habitat areas. It will also result in the retention of hollow-bearing trees (and of younger trees to eventually replace them) which may harbour family groups
- Glossy Black-cockatoo. Retention of vegetation within the ECA will result in Black She-oak (the species' food source locally) remaining abundant within the lot. Furthermore, the species has large foraging territories and the site represents a small proportion of that available.
- Square-tailed Kite. This species preys on canopy-dwelling honeyeaters whose numbers would likely be reduced by development of the site. The Square-tailed Kite has huge territories. Therefore, the loss of prey availability would be insignificant and would not compromise the local populations viability.
- Powerful Owl. The retention of vegetation within the ECA on the lot and adjoining lots should result in the Owl's prey population (possums, gliders) maintaining densities close to their existing levels. Therefore the ability of the species to adequately provide young with food should not be compromised. The negative results recorded for the species during the AES field survey, and the level of disturbance that would be experienced by nesting owls, means that it is unlikely the species would be nesting within Jerberra Estate.
- Masked Owl. It is considered the availability of this species prey would not be significantly affected by development of the estate. This is because it takes a wide array of prey than the Powerful Owl, including introduced rats and mice which are likely to become more common with development. As with the Powerful Owl, the

negative results recorded for the species during the LES field survey and the level of disturbance that would be experienced by nesting owls means that it is unlikely the species would be nesting within Jerberra Estate.

- Spotted-tailed Quoll. The aim of establishing an Environmental Constraint Area at the rear of each lot is to conserve all strata of the open forest community. Should the Quoll occur locally it will be able to continue preying on the variety of fauna present in the groundcover and lower strata of the vegetation. The main risk to the species local viability will be the introduction of domestic pets
- Common Bent-wing Bat. This species' maternity sites are in caves and it forages over large distances. The local population's viability would not be compromised as adequate tree cover will be retained to allow continued foraging on the site
- Large Pied Bat. The species is unlikely to roost on the site. Foraging habitat will be retained within the ECA
- Greater Broad-nosed Bat. The Greater Broad-nosed Bat roosts in tree hollows. Retention of vegetation within the ECA will conserve this resource on site.
- Great Pipistrelle. This species also roosts in tree hollows. Retention of vegetation within the ECA will conserve this resource on site.

(b) in the case of an endangered population, whether the life cycle of the species that constitutes the endangered population is likely to be disrupted such that the viability of the population is likely to be significantly compromised

No endangered populations have been declared for the local area.

(c) in relation to the regional[3] distribution of the habitat of a threatened species, population or ecological community, whether a significant area of known habitat is to be modified or removed,

- Yellow-bellied Glider. This species habitat is eucalypt forest on higher nutrient soils. This habitat type is abundant in the region and the site does not constitute a significant area of known habitat.
- Glossy Black-cockatoo. This species habitat is forest and woodlands containing Casuarinas (She-oaks). This habitat type is abundant in the region and the site does not constitute a significant area of known habitat.
- Square-tailed Kite. This species habitat is Eucalypt open forests and woodlands in which it prey on passerines (perching birds). This habitat type is abundant in the region. In relation to its regional distribution the site does not constitute a significant amount of habitat.
- Powerful Owl. This species inhabits open forest and woodland where it prey on arboreal mammals. This habitat type is abundant in the region, and the site does not constitute a significant area of habitat.
- Masked Owl. The Masked Owl occurs in a range of habitats including tall open forest open forest, and wooded farmlands. These habitat types are abundant in the region, and the site does not constitute a significant area of habitat.
- Spotted-tailed Quoll This species occurs in a wide range of habitats including swamps and woodlands though it prefers moist forests. These habitat types are abundant in the region, and the site does not constitute a significant area of habitat.

[3] on advice from the Threatened Species Unit of NPWS "regional" refers to those areas defined by the CSIRO's Interim Bioregional Assessment. Jerberra Estate is within the Sydney Basin region

(g) whether the development or activity proposed is of a class of development or activity that is recognised as a threatening process.

Threatening processes are yet to be defined under the Act. However, it is generally accepted that habitat removal and modification are threatening processes to all species. For all the threatened species likely to occur on the estate development represents modification and removal of habitat. The degree to which this impacts on each species varies greatly. For instance, for the resident/yellow-bellied glider habitat modification (as indicated in (a) above) would be of a greater degree than that experienced by a migratory wide-ranging species such as the Square-tailed Kite.

(h) whether any threatened species, population or ecological community is at the limit of its known distribution.

None of the species are at the limits of their known distribution Their ranges are a s follows

- Yellow-bellied Glider - North Queensland to western Victoria
- Glossy Black-cockatoo - Queensland to the Victoria-NSW border and west to the Pilliga
- Square-tailed Kite - throughout mainland Australia
- Powerful Owl - Mackay (Qld) to the Grampians (Vic)
- Masked Owl - North Queensland to Tasmania
- Spotted-tailed Quoll - North Queensland and South-east Queensland to Tasmania
- Common Bent-wing Bat - Cape York to South-east South Australia
- Greater Broad-nosed Bat - North Queensland to North-east Victoria
- Great Pipistrelle - South-east Queensland to Tasmania
- Large Pied Bat - Rockhampton to Canberra

In consideration of the above factors it is considered the residential development of the lot will not significantly affect any threatened species nor their habitats

- Common Bent-wing Bat. This species' foraging habitat - open forests - is abundant in the region. In relation to the regional distribution of this habitat the site is not significant. The site is not a possible roost site.
- Greater Broad-nosed Bat. This species forages for insects in open areas on the edges of forests or along tree-lined creeks and utilises tree hollows for diurnal roosting sites. The site does not constitute a significant area of habitat in relation to its regional occurrence
- Large Pied Bat. This species forages over open water and along tree-lined creeks. The study area does not constitute a significant area of habitat in relation to its regional occurrence.
- Great Pipistrelle. This species forages in tall eucalypt forests. The site does not constitute a significant area of habitat in relation to its regional occurrence

(d) whether an area of known habitat is likely to become isolated from currently interconnecting or proximate area of habitat for a threatened species population or ecological community,

- Yellow-bellied Glider. Retention of vegetation within the ECA will result in known and likely habitat areas remaining linked thereby avoiding isolation of habitat areas. There will however, be some fragmentation of habitat.
- Spotted-tailed Quoll. Thinning of the ground cover would make this species more vulnerable to predators and compromise its ability to move between habitat areas.

For all the other threatened species it is considered there would be no isolation of habitat as they are all able to fly across modified forest areas.

(e) whether critical habitat will be affected,

Critical habitat is yet to be defined by the Director-general of NPWS

(f) whether a threatened species, population or ecological community, or their habitats, are adequately represented in conservation reserves (or other similar protected area) in the region

The Sydney Basin region contains significant areas of conservation reserves including large tracts of land in the following National Parks: Morton, Kanangra-Boyd, Blue Mountains, Wollemi, Royal, Ku-ring-gai Chase, Marramarra, Dharug. There is no detailed information on population numbers of threatened species in these reserves. However, it would appear that habitat for the all the threatened species likely to occur at Jerberra Estate is adequately conserved by the reserves in the region.

The exception to this is the Square-tailed Kite. Most of the forests of the Sydney Basin Region are on infertile soils, which do not support adequate prey populations for the Square-tailed Kite. Subsequently, there are few records from the region, apart from the regular sightings in the coastal forests of the Nowra and Jervis Bay areas. It is considered that the coastal lowland forests south from Nowra are not conserved at a level to support the Square-tailed Kite. Therefore, the retention of forest on privately-owned land will be essential for the conservation of this species in the region.