As indicated in Table 3, a number of hollow-bearing trees are present within the development area (the "*subject site*") at Mundamia, within the proposed APZs (Figure 6). More hollow-bearing trees are present (at similar densities) within the areas not surveyed and which are to be zoned *E2 – Environmental Conservation*, especially in the northeastern and eastern portions of the subject land, and on lands beyond, particularly the substantial reserved land to the east along Flat Rock Creek (Figures 2 and 4).

Table 3 Summary of tree-hollows recorded on the subject site and in APZs

Tree Species	Number Surveyed	Hollow Size				Total
		Small	Medium	Large	Owl	
Corymbia gummifera	9	7	11	7	0	25
Eucalyptus agglomerata	2	1	1	0	0	2
Eucalyptus pilularis	2	3	3	0	0	6
Eucalyptus punctata	20	28	15	4	0	47
Eucalyptus sclerophylla	14	10	17	16	1	44
Stag trees	13	9	12	17	3	41
Total	60	58	59	44	4	165

A total of 60 hollow-bearing trees, containing at least 165 hollows, were recorded in the development and APZ areas, with the majority of hollows in the Grey Gum *Eucalyptus punctata*, Scribbly Gum *E. sclerophylla* and stag trees. Of these, 39 hollow-bearing trees would need to be removed to accommodate future residential development (Figure 6). However the proposal will involve the implementation of a '*Hollow-Bearing Tree Protocol*' (See Chapter 17) which will ensure that there is no nett loss of tree-hollows as a consequence of the proposal .

Further, all hollow-bearing trees are to be retained within the APZs, and a substantial number of hollow-bearing trees will also be retained with the *E2 – Environmental Conservation* area. In addition, there are substantial hollow-bearing tree resources in the immediate vicinity and locality, including for example in the Triplarina Reserve (to the southeast) and along Flat Rock Creek (to the immediate east).

5.3 Fauna Species

Field investigations on the subject land and on adjoining lands by SLR Ecology and by Environmental InSites and others (including BES) over a number of years have identified a fauna assemblage of 120 native species (7 amphibians, 7 reptiles, 74 birds and 25 mammals) and 7 introduced/domestic mammal species (Appendix F).

The number of species recorded is reflective of the habitat types present on the subject land and in the immediate vicinity. The forested sections of the subject land and adjoining lands in particular provide resources for forest-dependent fauna species (such as gliders and many of the bird species), whilst the cleared pasture areas provide habitat and resources for only a limited suite of native species.

Amphibians

Amphibian habitats on the subject land consist of two small farm dams and one large 'sediment' dam, an area of swampy ground and impeded drainage in the central part of the site, and the small sandstone creekline in the northeastern of the subject land (Figures 2 and 5). As noted above, seven amphibian species have been recorded within and surrounding the subject land, all of which are common in the habitat types present.

Two threatened amphibian species are known to occur in the local area (DECC 2008). Whilst the small sandstone creekline provides some limited potential habitat for the Giant Burrowing Frog, surveys by both BES (2004) and Environmental InSites (2008) have not recorded this species. In any case, potential habitat for this species would be retained within the proposed *E2 – Environmental Conservation Area*.

No evidence for the Green & Golden Bell Frog has been recorded from the Mundamia area during any investigations undertaken to date (BES 2004a, b, c, 2007, 2011; Environmental InSites 2009a, b, 2010, 2011; SLR Ecology - this *Report*). Whilst it is theoretically possible for Green & Golden Bell Frogs to utilise the farm dams present on the subject land, there has been no evidence on any such activity to date.

Reptiles

Seven reptile species have been recorded on and around the subject land (Appendix F), all of which are common in the area. Given the structural diversity of habitats across the subject land, particularly within the eastern section along the sandstone escarpment, the reptile assemblage is likely to be more diverse than so far identified.

Two threatened reptile species are known from the locality (Rosenberg's Goanna and the Broad-headed Snake).

With respect to Rosenberg's Goanna, none of the development area on the subject land supports any termite mounds (or 'termitaria'), and this species has not been recorded in the vicinity (BES 2004a, c, 2007, 2011; Environmental InSites 2008, 2009, 2010; SLR Ecology - this *Report*). Investigations for Rosenberg's Goanna on the adjoining land to the immediate west (BES/ELA 2011), and specifically for the access road required for the Mundamia residential area (Environmental InSites 2009), as well as for this *Report*, provide no evidence of this species at this location. In addition, there are no records of Rosenberg's Goanna in the vicinity, or even nearby (Appendix C; Sass 2008).

With respect to the Broad-Headed Snake, there are no records of this species on subject land or on other lands in the vicinity. Potential habitat for the Broad-Headed Snake on the subject land is of marginal quality, and in any case is essentially confined to the *E2 - Environmental Protection* area.

Avifauna

Seventy-four bird species have been recorded within and surrounding the subject land (Appendix F), the vast majority of which are common to abundant, and widespread, and would utilise relevant habitats present within and adjoining the subject land.

The broad guilds of birds that have been recorded on or around the subject land at Mundamia include:

- species characteristic of open grasslands and agricultural pastures (*eg* the Masked Lapwing, Australian Magpie, Magpie-lark, Willie Wagtail and Galah);
- species typical of woodland environments (such as the Crimson Rosella, Glossy Black Cockatoo, Gang Gang Cockatoo, Rainbow Lorikeet, honeyeaters, thornbills and butcherbirds);
- raptores and carnivorous species (such as the Powerful Owl, Southern Boobook, Kookaburra and Square-tailed Kite);
- the smaller and more cryptic bird species which utilise dense shrubs and mid-storey vegetation for shelter (*eg* the Eastern Yellow Robin and Superb Fairy Wren); and
- wetland birds (ducks, grebes and herons), which would utilise the farm dams and areas of flooded pasture following heavy rains.

An array of additional bird species, beyond those listed in Appendix F, would be likely to utilise the subject land over a period of decades, particularly under different climatic or seasonal circumstances. However, given that the majority of the area proposed for development activities is cleared pasture, the number of such additional species which would be dependent upon those parts of the site proposed for development purposes is extremely limited.

Mammals

Thirty-one mammal species have been recorded within and adjacent to the subject land (Appendix F). Of these, four are listed as "*vulnerable*" pursuant to the TSC Act, one of which is also listed as "*vulnerable*" pursuant to the EPBC Act (Table 6). Of the mammals recorded, 23 are native, three are feral introduced species and five are domestic mammal species.

Of the 23 native mammal species recorded on the subject land and in the vicinity by BES and by Environmental InSites:

- two are macropods, which would utilise the forest and woodland for shelter and the open pasture for grazing purposes;
- the three small terrestrial mammals (the Agile Antechinus, Swamp Rat and Long-nosed Bandicoot) would predominantly utilise areas of open forest and woodland;
- arboreal species (the Sugar Glider, Yellow-bellied Glider, Common Brushtail Possum and Common Ringtail Possum) would utilise woodland and forest areas for both shelter (hollow-bearing trees for the gliders and Brushtail Possum, and dense canopy for the Ringtail Possum) and areas of trees and shrubs for foraging purposes; and
- the Grey-headed Flying Fox would utilise the land to only an extremely limited extent, possibly when some trees are in flower; and
- the remaining 12 species are microchiropteran bats which would utilise the forest and woodland canopy for foraging purpose. In addition, most (but not all) of those microchiropteran bats would utilise tree-hollows on the subject site (as well as other such resources which are widely distributed through the landscape) for roosting purposes.

As indicated, six microchiropteran bat species were positively identified within the subject land, and a further six species were recorded to a lesser degree of certainty (Table 4). For most of these species, tree-hollows and or exfoliating bark on large trees constitutes the preferred or required roosting habitat, and the forest canopy constitutes appropriate foraging habitat. Only a small proportion of such resources on the subject land, and a minute proportion of those present in the vicinity, will be affected by the proposed development.

Two threatened microchiropteran bat species were recorded on the land, although there is only a low level of certainty in respect of the Common Bent-wing Bat, due to the poor quality of the call sequences (Table 4). In any case, little or no potential roosting habitat for this species would be disturbed as a result of the proposed development. Extensive foraging habitat for this and other microchiropteran bat species will be retained in the proposed *E2 - Environmental Conservation Zone* on the periphery of the land, and in the substantial other forested lands in the vicinity.

Table 4 Summary of results of ultrasonic bat detection surveys.

Common Name	Scientific Name	Status	Calls	Accuracy		
				Def	Pro	Pos
Eastern Free-tail Bat	*Mormopterus norfolkensis*	V	2	1		1
White-striped Free-tail Bat	*Tadarida australis*		1	1		
Eastern Horseshoe Bat	*Rhinolophus megaphyllus*		5	5		
Gould's Wattled Bat	*Chalinolobus gouldii*		10	3	7	
Chocolate Wattled Bat	*Chalinolobus morio*		1		1	
Common (Eastern) Bent-wing Bat	*Miniopterus schreibersii oceanensis*	V	5			5
Long-eared Bat	*Nyctophilus* sp.		6	6		
Lesser Long-eared Bat	*Nyctophilus geoffroyi*					6
Gould's Long-eared Bat	*Nyctophilus gouldi*					6
Large Forest Bat	*Vespadelus darlingtoni*		43			43
Southern Forest Bat	*Vespadelus regulus*		3			3
Little Forest Bat	*Vespadelus vulturnus*		27	15	11	1

Key to Accuracy

Def	No doubt about the identification of the species making the call (Definite)
Pro	Most likely the species named, but there is a low probability of confusion with other species with similar calls (Probable)
Pos	The call is comparable with the listed species, but there is a moderate to high probability of confusion with species that emit similar calls (Possible)

5.4 Threatened Fauna Species

Four threatened bird species have been recorded utilising the subject land (Table 5), each of which are wide-ranging and highly mobile. None of these species (nor indeed even an individual of any such species) could be dependent on the subject site for their survival at this location. In any case, most of the highest quality habitat for these species would be retained in the proposed *E2- Environmental Conservation Zone* on the subject land, complementing the extensive areas of such habitat in the immediate vicinity and in the locality.

Table 5 Threatened bird species recorded within the subject site at Mundamia

Family	Species	Common Name	TSC	BES 2004	InSites 2008-2011
Accipitridae	*Lophoictinia isura*	Square-tailed Kite	V	x	
Cacatuidae	*Callocephalon fimbriatum*	Gang Gang Cockatoo	V	x	
Cacatuidae	*Calyptorhynchus lathami*	Glossy Black Cockatoo	V	x	x
Strigidae	*Ninox strenua*	Powerful Owl	V	x	

*TSC = *Threatened Species Conservation Act* (TSC Act) V = Vulnerable

The threatened mammal species recorded on the subject land at Mundamia are all forest-dependent, indicating that the most important habitat within the subject land is that within the northern and eastern portions of the subject land. The majority of that habitat will be retained in the proposed *E2 - Environmental Conservation Zone* on the land (Figure 4), with significant additional areas of suitable habitat on surrounding lands (Figure 2).

Of the four threatened species identified, the Yellow-bellied Glider is likely to be a long-term resident of the subject land and surrounding lands. The other three species are highly mobile and more wide-ranging, although some microchiropteran bats could readily reside within the subject land.

Table 6 Threatened mammals recorded within the subject land at Mundamia

Family	Scientific Name	Common Name	Legal status*	BES 2004	InSites 2008
Petauridae	*Petaurus australis*	Yellow-bellied Glider	V (TSC)	x	x
Pteropodidae	*Pteropus poliocephalus*	Grey-headed Flying Fox	V (TSC) V (EPBC)	x	
Molossidae	*Mormopterus norfolkensis*	East-coast Free-tail Bat	V (TSC)		x
Vespertilionidae	*Miniopterus schreibersii oceanensis*	Common Bent-wing Bat	V (TSC)	x	x

*TSC = *Threatened Species Conservation Act 1995* (TSC Act) V = Vulnerable
EPBC = *Environmental Protection & Biodiversity Conservation Act 1999* (EPBC Act) V = Vulnerable

Both the Yellow-bellied Glider and East-coast Free-tail Bat utilise tree-hollows for denning or roosting purposes. There are extensive tree-hollow resources within the northern and eastern portions of the subject land, the majority of which would be retained in the *E2 - Environmental Conservation Zone.* Further, as detailed in Chapter 17, the *Hollow-Bearing Tree Protocol* will ensure that there is no nett loss of tree-hollows as a result of the proposal. Qualitative assessment of the adjacent land further to the east and north (and elsewhere in the vicinity) indicates that there are also extensive tree-hollow resources surrounding the subject land.

As indicated above, a total of 8 threatened fauna species have been recorded within and surrounding the subject land (Appendix F). Habitat for these species within the subject land is largely confined to the forest and woodland vegetation in the eastern and northern portions of the land, the majority which will be retained in the proposed *E2 - Environmental Conservation Zone.* Significant areas of additional habitat for these species is also located on other lands to the east, north and southeast of the subject land, and in DECC and Forest NSW estates within 10-15km of the subject land (involving approximately 6,700ha of forested habitat).

6 ENVIRONMENTAL CONSTRAINTS

6.1 Fundamental Considerations

Development of the subject land at Mundamia will inevitably involve the imposition of some impacts upon elements of the natural environment in general, including on individuals of and/or habitat for a number of threatened biota.

On the other hand, the planning and impact assessment process requires the determination of an appropriate balance between development opportunities and biodiversity conservation outcomes. This approach involves the consideration of benefits which may be derived from the appropriate management of relevant portions of the land, as well as consideration of the adverse impacts (including the loss of habitat or resources for threatened biota) which will or may arise.

In this regard, it is not a requirement of any legislation that there be no adverse impacts on either the natural environment in general or upon threatened biota in particular. The mere presence of individuals of threatened species, or of habitat for such species, does not constitute an absolute constraint to development opportunities. Rather, these matters need to be taken into account when considering the extent of development (including the clearing of or loss of specimens or habitat for such biota which would ensue) and appropriate balance between the necessary urban development and biodiversity conservation aspirations.

6.2 Potential Ecological Constraints

The potential ecological constraints to development opportunities on the subject land at Mundamia include:

- individuals and patches of the threatened Nowra Heath-myrtle *Triplarina nowraensis*;
- the potential presence of the Spring Tiny Greenhood orchid, although this species has not been recorded on the site either by Council or by the authors of this *Report*;
- hollow-bearing trees, which provide potential habitat for a number of threatened species;
- the loss (albeit relatively small) of foraging habitat and/or some potential roosting habitat (open forest/woodland and tall shrubland) for a number of threatened fauna species; and
- the potential direct and indirect impacts upon habitat for or individuals of a number of threatened biota.

Whilst *Groundwater Dependent Ecosystems* (GDEs) may theoretically constitute a constraint to development activities, the areas of vegetation which could potentially constitute GDEs on the subject land either are not solely dependent upon that water source or are not of particular significance.

The Swamp Paperbark Forest in the northeastern part of the land would not be entirely dependent upon groundwater discharges. The 'moss gardens' along the eastern side of the subject land are considered likely to be more dependent on groundwater (given their location), but would also be dependent (in drier times) on incipient rainfall. However, neither ecosystem is (in any case) restricted to the subject land.

Given the circumstances on the subject land, the presence of possible GDEs is not regarded as a constraint proposed to the development activities. The potential areas to be affected are small, and the ecosystems present are neither restricted in distribution nor restricted to the subject land. In any case, the stormwater management regime for the project includes measures designed specifically to maintain groundwater regimes downslope of the development.
It should be noted that the majority of the development area (approximately 70%) is already cleared and highly disturbed agricultural land. That portion of the subject land does not represent a relevant constraint to the development activities as proposed.

Further, that part of the proposed development footprint which contains either individuals of or habitat and resources for threatened species (predominantly confined to the eastern and north-eastern portions of the proposed development footprint) represents only an extremely small proportion of such species, populations or habitats in the immediate vicinity or locality (Figures 1 and 2). Given the extent of adjoining and nearby conservation reserves, the area of any resources or habitat for any such species to be affected is extremely small.

6.3 Strategic Approach

Consideration of the likely or probable biodiversity constraints to development opportunities on the subject land, and the assessment of impacts which will or may arise from the proposed development, are discussed in further detail in subsequent chapters of this *Report*.

In the first instance, however, it needs to be noted that the majority of the development activities are to be undertaken within the existing highly disturbed and modified agricultural parts of the subject land (69%) and/or in disturbed vegetation around the periphery of the agricultural areas. Most of the high quality habitats and/or resources for threatened biota present on the subject land have been retained within those parts of the land to be zoned *E2 - Environmental Conservation* along the eastern and northern boundaries (Figure 4).

There are no relevant or significant riparian issues associated with the proposed development of the subject land at Mundamia. A single small drainage line is located in the northeastern part of the subject land, through a stand of Paperbarks and draining more steeply in the northeastern part of the land (which is to be conserved).

However, the upper parts at least of that drainage line do not relevantly constitute a "*river*" pursuant to the *Water Management Act 2000*. The drainage line is small, gentle and does not have a defined bed or banks, other than below the proposed development area. It is located within a broad drainage swale through this part of the land, although once the 'drainage line' reaches the areas of sandstone rock outcropping, there are elements of a 'watercourse' or 'river' present. These elements of the 'drainage line', however, occur outside the proposed development area.

Nevertheless, the issues of stormwater quality, water volume discharges and the maintenance of ecological values along that watercourse downstream of the subject land have been taken into account in the design of the stormwater management system for the project (for details, see the *Water Cycle Management Report* by Storm Consulting 2012).

Further, and consistent with the *Nowra-Bomaderry Structure Plan* (see Chapter 16), the proposed development of the subject land at Mundamia "*will achieve a considered balance between urban development and the protection of environmentally significant areas*". The proposal has been designed

and amended by the applicant (on the basis of input from *inter alia* the authors of this *Report*) to reduce or minimise potential adverse impacts upon threatened biota and their habitats on the land.

A substantial area of land (9.49ha or 21.9% of the subject land) is to be dedicated for biodiversity conservation purposes, in the most appropriate parts of the land (the northern and eastern portions). These areas are adjacent to existing reserved or substantially vegetated lands, and will provide a 'buffer' to those conserved lands. They will also contribute in a positive manner to biodiversity conservation by maintaining areas of native vegetation (including habitat for and populations of threatened biota) which are to be managed for biodiversity conservation purposes.

Thus, the proposed development of the subject land at Mundamia, as currently designed, achieves an appropriate balance between development opportunities and biodiversity conservation outcomes (see following Chapters of this *Report*).

7 POTENTIAL ENVIRONMENTAL IMPACTS

7.1 General Environmental Impacts

The proposed development of the subject site at Mundamia for residential purposes (Figure 4) predominantly involves the loss of agricultural (poor quality) pasture and weeds, as well as the removal of a relatively small area (8.9ha) of mostly modified open forest and heathland (Figure 7). A minor tributary to Flat Rock Creek is present in the northeastern section of the subject land, flowing in a northeasterly direction (Figure 2). The proposed *E2 - Environmental Conservation Zone* on the land occupies a total of 9.49ha, a small part of which will need to be maintained as an APZ (Figures 4 and 7).

The removal of approximately 8.9ha of open forest and heathland (some of which is in a disturbed condition) is insignificant in relation to the large areas of high quality biodiversity value land proposed to be retained in the *E2 - Environmental Conservation Zone,* and in the undisturbed Crown Land and Reserves surrounding the subject land. The area to be removed constitutes only a minute proportion of habitat in the immediate locality (*ie* within approximately 10km) of the land.

As noted above, the majority of the vegetation which is to be removed from the proposed development portions of the subject site at Mundamia (69%) has long been highly modified for agricultural purposes. Further, much of the native vegetation which is to be removed has been disturbed by 'edge-effects' and by incursions (of weeds and stock) from the adjoining agricultural land. Higher quality vegetation within the northern section of the land and along the eastern boundary will be retained and managed, and would likely ultimately be dedicated to Council.

Whilst the proposed development (as noted above) will require the removal of some areas of native vegetation from the subject land, there are a number of relevant considerations in assessing the potential or likely impacts of the proposal. Such considerations include *inter alia*:

- the modified nature of much of the native vegetation to be removed;
- the incorporation of measures to maintain native habitats and resources on the subject land, and to ensure their long-term viability, as a direct consequence of the project design (by retaining a large area of retained vegetation in the northern and eastern parts of the v), and by the management of the project (including *inter alia* the implementation of appropriate design and stormwater management and treatment measures);
- the protection of 9.49ha of native habitats and vegetation for biodiversity conservation purposes within the proposed *E2 - Environmental Conservation Zone* along the eastern and northern sides of the land;
- the implementation of a *Vegetation Management & Habitat Restoration Plan* (VMHRP) within the proposed *E2 - Environmental Conservation Zone* to control and/or limit adverse impacts; and
- controls on indirect impacts by the avoidance of inappropriate plant species in landscaping, and by the application of appropriate stormwater and APZ management regimes.

An important further consideration is that there is no requirement or imperative for the implementation of any habitat management, protection or enhancement measures under the current land management regime. By contrast, the proposed development concept will facilitate the implementation of a comprehensive management regime over approximately 9.49ha of the subject land (or 21.9%), and its dedication for biodiversity conservation purposes in perpetuity.

As discussed in detail above (Chapter 4), that portion of the subject land at Mundamia proposed for development is characterised predominantly by open farmland. High quality vegetation is limited to the northern periphery and a narrow strip along the eastern boundary. The majority of this vegetation will be retained and managed for conservation purposes in the proposed *E2 - Environmental Conservation Zone* as part of the re-zoning of the land.

The proposed development (Figure 4) includes a perimeter road along the boundary to the *Environmental Conservation Zone.* Whilst no residential activities will be located outside the proposed perimeter road, which provides a clearly defined management and land use boundary:

- adjacent woodland in the *E2 - Environmental Conservation Zone* will be managed in places (in an environmentally sensitive manner) for bushfire protection purposes, in accordance with the requirements of the *Bush Fire Report* (ELA 2012), and in accordance with the *Vegetation Management & Habitat Restoration Plan* (VMHRP); and
- a peripheral bioretention swale system will be located on the outer edge of the perimeter road system, to maintain the existing moist soil regime by infiltration and 'over-topping' during major rainfall events(see Storm Consulting 2012; Chapter 9; Figure 9).

Given those circumstances, and given the large areas of forested and riparian areas to be retained, it cannot be construed as likely that development of the land as proposed would adversely affect native biota (flora, fauna, habitats or communities) to any significant extent.

It is also to be noted that the potential impacts arising or which may arise from development of the subject land as proposed are to be considered in the light of the impact amelioration and environmental measures for the project, which are detailed in Chapter 17 of this *Report*. It is also to be assumed and anticipated that development of the subject land (including all necessary excavation, land clearing, construction and bushfire management requirements) will be undertaken in an environmentally sensitive manner, applying all appropriate current "*best practice*" methods and measures to maintain water quality, to protect adjoining natural vegetation, and to control sediment discharge and runoff.

7.2 Vegetation to be Removed or Modified

Whilst the majority of that area proposed for residential development activities on the subject land at Mundamia (Figure 7) consists of existing cleared pasture and areas of degraded vegetation (modified open woodland with a degraded understorey and/or scattered trees or regenerating scrub), the development footprint also includes areas of extant native vegetation in poor to good condition.

All of these areas of native vegetation are located along the eastern and northern peripheries of the proposed development area (Figure 7), with the whole of the western and southern parts of the subject land (within which development activities are to occur) having long been cleared and modified for agricultural purposes. The narrow bands of 'woodland' along fencelines on the eastern side of the land and through the centre (Figures 5 and 7) are not regarded as of any conservation value.

The proposed residential development footprint (not including the *Asset Protection Zones* – APZs) will require the removal (Figure 7; Table 7) of:

- a narrow band of Scribbly Gum - Bloodwood Woodland along the western boundary fenceline (approximately 0.41ha);