ACKNOWLEDGEMENTS

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1.0 INTRODUCTION AND BACKGROUND

This report is a management plan which applies to the Narara Ecovillage. The land, which is subject to this management plan is an area of 40.2 hectares known as Lot 13 in DP1126998 (Figure 1) and lies at the upper end of Research Road Narara. Initial flora and fauna assessments were undertaken for the project by Andrews-Neil (2006a, 2006b) and these surveys and associated reporting covered mostly around the cleared land associated with the valley floor. Thus the original focus of these surveys was placed upon the alluvial riparian environment which encompassed remnant vegetation patches and fauna habitat along Narara Creek, on cleared alluvial flats. Fauna survey sites were restricted to lower slopes that had been cleared. More recently, Payne (2013) encapsulated this detail and upgraded the flora and fauna survey to include the slopes and ridges.

Since partial completion of the upgraded flora and fauna survey further microbat surveys of the dam and the ridge area are still required. These surveys will be upgraded during this oncoming spring as the weather became too cold to further this component during the upgraded survey and some equipment needed servicing (Payne, 2013). From the overall component of the flora and fauna surveys completed so far the following threatened species were determined to be present or were identified from anecdotal evidence (eg. The Yellow-bellied Glider).

- The Eastern Bent-wing Bat, *Miniopterus schreibersii oceanensis*
- The Powerful Owl, *Ninox strenua*
- The Sooty Owl, Tyto tenebricosa
- The Grey-headed Flying Fox, *Pteropus poliocephalus*
- Evidence of the Yellow-bellied Glider, *Petaurus australis*
- The Magenta Lilly Pilly *Syzygium paniculatum*
- The Red-crowned Toadlet *Pseudophryne australis*
- The Glossy Black-cockatoo *Calyptorhynchus lathami*
- Black Bittern *Ixobrychus flavicollis*

During the previous surveys the entrenched boulder strewn gullies on the Narrabeen slopes were likely to be an example of the Lowland Rainforest endangered ecological community in the NSW Sydney Basin and North Coast bioregions (Payne, 2013) whilst the gallery rainforests found on the alluvial flats were not (Andrews-Neil, 2006a, b). Further work on the alluvial flats revealed the presence of a freshwater wetland endangered ecological community.

Although this project is for a residential development these threatened species and their associated key threatening processes will form the basis of this management plan and furthermore it will be tied legislatively to the Property Vegetation Plan (PVP) also currently being prepared by the Hunter-Central Coast Catchment Management Authority. Additional issues that have been recognized as a result of the surveys are the preparation of a weed management strategy, care and control during landscaping involving the Magenta Lilly Pilly and riparian grasses, the restriction of artificial night lighting and the ultimate impacts on nocturnal fauna.

The subject land was rezoned in 2008 for residential purposes in conjunction with Development Control Plan (DCP) 175. The DCP requires that a PVP must be prepared which then is underpinned by this management plan. Within the PVP, reference is made to the management plan which must set out the ameliorative measures which emerged as a result of the flora and fauna investigations.

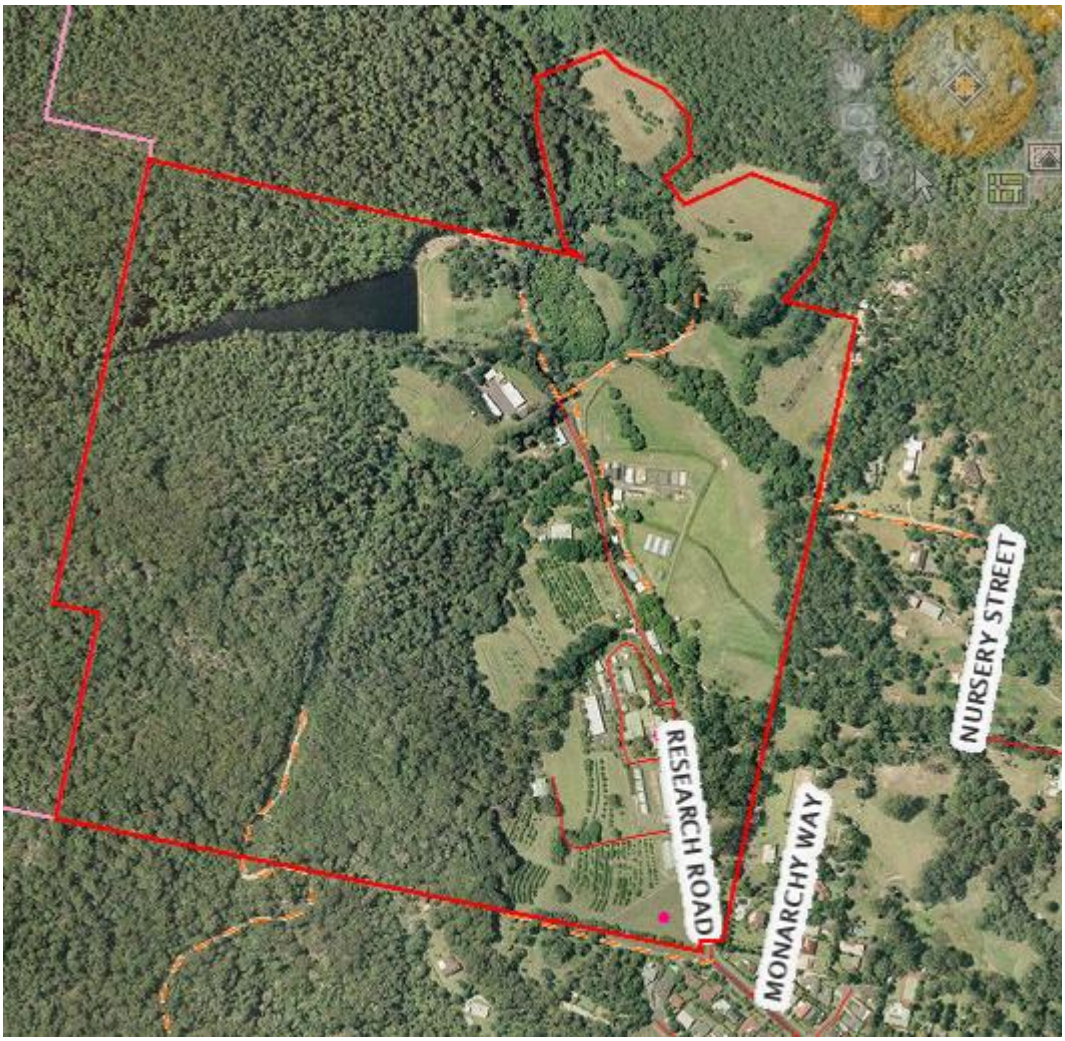

Figure 1 Aerial photograph showing Lot 13 in DP1126998 which is the subject land of this flora and fauna management plan.

1.1 Catchment description

The study area is shown on Figure 1 and occurs at the end of Research Road Narara. On the Gosford 1:25000 topographical mapsheet the ecovillage study area can be located at Australian Map Grid (Australian Geodetic Datum) co-ordinates $_{3}$ 44 280E, $_{63}$ 04 125N. The study area is also found within the Parish of Gosford, the County of Northumberland and the Shire of Gosford.

At a finer scale the surveyed boundaries of the study area can be found on Lot 13 DP 1126998 which is found from the end of Research Road Narara and extends north to Strickland State Forest.

Through the centre of the property is Narara Creek draining from the north-west to the south-east through Quatarnary alluvium and on either side are the hillside slopes formed from the Narrabeen Group of Rocks (Terrigal Formation Unit). In the north-western and southwestern corners, the Narrabeen Sandstone, in the form of rocky cliffs and caves outcrop on the drier upper slopes.

The valley floor is mostly cleared of its original vegetation (Figure 1). This includes the floodplain although the riparian areas are intact. Part of this valley floor is a freshwater wetland with *Typha orientalis* Cumbungi and other freshwater wetland species but those areas around the riparian corridor have either been converted to paddock grasses or have been developed into a nursery with several facilities. The riparian vegetation is a *"Moist Closed Forest with emergents: Eucalyptus saligna–Syncarpia glomulifera-Cryptocarya glaucescens".*

On the eastern side of the alluvial flat upon the Narrabben slopes are the re-entrants which have formed deeply entrenched boulder strewn gullies. These gullies are disturbed in the lower sections but retain their original flora in good condition in the upper part. The vegetation in these gullies as described by Payne (2013) is *Palm gully open to closed forest and sometimes Gallery Rainforest: Livistona australis-Cryptocarya glaucescens-Acmena smithii.* These gullies are partly palm dominated with a specialised lithophytic fern flora. Between the gullies on the slopes the area has been converted to paddock grasses but adjoining the gully riparian vegetation is a remnant of riparian grassland dominated by *Ottochloa gracillimus* (Figure 2).

These re-entrants are repeated on the western hillslope and whilst they retain remnants of the *Palm gully open to closed forests* they are heavily disturbed by the intrusion of the weed *Lantana camara* Lantana. The Lantana extends onto the moist Narrabeen slopes as a very dense cover and obviously will become a major management issue in this report. The vegetation on these moist slopes, outside the gully areas, is a *Moist Closed Forest with emergents: Eucalyptus saligna–Syncarpia glomulifera-Cryptocarya glaucescens* but as the slopes become drier with higher elevation the Lantana is absent and a slightly different vegetation community is apparent. Payne (2013) has referred to this upper slope community as *Exposed Hawkesbury Woodland on ridges and slopes: Angophora costata-Eucalyptus scias-Eucalyptus umbra-Eucalytpus agglomerata-Corymbia gummifera* and it extends onto the upper rocky ridgetops and outcrops.

1.2 Fauna habitat description

With respect to fauna surveys the main focus has been upon a census of birdlife and mammals through diurnal and nocturnal bird surveys as well as longer term trapping surveys. This is due to the large extent of the vegetation which incorporates a large artificial wetland, drainage lines, low lying paddocks, slopes and ridges. Paddocks in particular, are important because they are similar to grasslands and also function as bird foraging habitat (Photo 2).

One of the main focus points was the large dam which regularly supports a variety of duck species, although it is unknown if breeding occurs. Large counts of Wood Duck and Pacific Black Duck and on one occasion the Freckled Duck was recorded. Vegetated wetlands with shallow water occur at the upper end of the dam and along the main riparian section of Narara Creek. The White-faced Heron and the White-necked Heron are found in the rushland/sedgeland wetland along the Narara Creek floodplain which may also support a different guild of species, such as the Tawny Grassbird, Golden-headed Cisticola, the Little Grassbird and the Clamorous Reedwarbler. Such drainage lines are inhabited invariably by Herons, Purple Swamphens, Dusky Moorhens, Straw-necked Ibis's, Eurasian Coots and several species of ducks.

The Black-shouldered Kite was observed foraging over the paddocks, wetlands and riparian areas but no migratory waders such as Latham's Snipe have been reported. Another

vulnerable species, the Black Bittern occurs along the timbered waterway of Narara Creek, while the endangered species, the Black–necked Stork could also appear.

Notwithstanding these species, Parrots and Lorikeets appear in the flowering season of individual eucalypt species and Pigeons (Wonga Pigeon, White-headed Pigeon and Brown-Cuckoo-Dove) appear in April as rainforest trees and Camphor Laurels bear fruit, whilst the Australian King Parrott was recorded feeding on *Cissus antarctica* Native Grape fruits and they would also seek out fruits of *Elaeocarpus reticulatus* Blueberry Ash.

The area has a high presence of owls and the Powerful Owl, Barn Owl, Sooty Owl, White-throated Nightjar and Tawny Frogmouth have all been recorded. This is due to the relatively high number of suitable trees with hollows apparent on the ridge both within and outside of the property (Figure 3). The dry slope forests, within the study area, grow on shallow skeletal soils overlying sandstones/shales at shallow depth, even amongst rock outcrops and the trees represented within these forests have numerous dead branches, perch sites, hollows and insects beneath the bark. Large trees with hollows are found at the end of the access track along the ridge. Owls will also use dead trees as observation points and branches and perch sites are used by other birds such as robins and cuckoo shrikes. Insects are eaten by insect eating birds and decaying wood and flaking bark are particularly rich sites. Sitellas will take advantage of these habitats especially dead branches and treecreepers will preen live branches. Cuckoos use dead branches for singing. Some bird species will construct their nests solely on dead branches, such as sittellas, which require those that are vertical whilst flycatchers and cuckoo shrikes require dead horizontal branches. Hollows are used by many groups of fauna, such as birds, bats, reptiles, amphibians, mammals and invertebrates. Twigs are required by several species as a nesting material (Recher, 1991).

Dead wood is an excellent roost site for bats and a study of the Lesser Long-eared Bat showed that most of its roost sites occurred in dead trees or dead sections of living trees and this is likely to be because of the superior insulating qualities. Bats consume insects and keep them under control. The rock outcrops contain numerous caves, overhangs, clefts and intercises, which house numerous insects. Shelter and habitat in these caves is used by small reptiles, cave dwelling micobats in some circumstances, larger snakes, goannas, amphibians and even some birds such as the Rock Warbler.

The initial Narara Ecovillage surveys (Andrews-Neil, 2006a,b) recorded the Grey-headed Flying Fox, *Pteropus poliocephalus* but they were more than likely foraging on orchard trees which are prominent in the developed area of the property. There are no other noticeable nectariferous eucalypt species that would attract the Grey-headed Flying.

Microbats are present as stated from the information presented in the Andrews-Neil (2006b) report and this would be due to the hollow bearing trees and dead parts of trees present on the property and furthermore because of the rocky outcrops which could also support bat roosting habitat. It is also noted that the large dam could be foraging habitat for the Large-footed Myotis *Myotis macropus*. The Eastern Pigmy Possum, *Cercatenus nanus* also occurs on the slopes and ridges in this area.

Several frog species would occur including lotic and lentic adapted species in the fast flowing streams and the large dam respectively. The lotic species may include the Stuttering Frog *Mixophyes balbus* which has been recorded in nearby State Forests. Less mobile species such as the Red-crowned Toadlet, *Pseuopryne australis* have been found and the Giant Burrowing Frog, *Heleioporus australiacus* is also likely to occur on the ridgetops.

2.0 BOTANICAL DESCRIPTION OF THE VEGETATION COMMUNITIES

The revised descriptions are given for the vegetation communities on the property (Figure 2):-

Alluvial flats forming the Yarramalong SLU

Closed Forest with emergents: *Livistona australis-Doryphora sassafras-Cryptocarya glaucescens* (Taken from Andrews Neil 2006a; b)

Structure: Remnant Closed Forest

Habitat: Alluvial flats along valley floors

Distribution: Narara Creek only as the subsidiary drainage lines occur on a different geology.

Floristic composition: The emergent is *Eucalyptus saligna* Sydney Blue Gum, *Livistona australis* Cabbage Palm and *Doryphora sassafras* Sassafras make up the main closed canopy composition, but other canopy species can include *Cryptocarya glaucescens* Jackwood, *Acmena smithii,* Lilly Pilly and *Sloanea australis* Maidens Blush. A few species form the taller mid stratum layer occur as scattered individuals, such as *Eupomatia laurina* Bolwarra and *Ficus coronata* Sandpaper Fig but the lower midstatum layer comprises *E. laurina, Gymnostachys anceps* Settler's Flax*, Neolitsea dealbata* White Bolly Gum, *Cyathea australis* Rough Treefern, *Archontophoenix cunninghamiana* Bangalow Palm, *Hymenosporum flavum* Native Frangipani*, Glochidion ferdinandi* Cheese Tree, *Diploglottis cunninghamii* Native Tamarind*, Alectryon subcinereus* Native Quince *Rhodamnia rubescens* Scrub Turpentine*, C. glaucescens* and *Synoum glandulosum* Scentless Rosewood. A ground layer also occurs and is made up of *Calochlaena dubia* Common Ground Fern, *F. coronata* Sandpaper Fig, *L. australis,* Cabbage-tree Palm and *Ligustrum sinense,* Small-leaved Privet. There is a also a vine layer of *Morinda jasminoides, Cephalaralia cephalobotrys* Climbing Panax, *Smilax australis* Lawyer Vine*, Melodinus australis* Southern Melodinus, *Palmeria scandens* Anchor Vine, *Cissus antarctica* Water vine and *Ripogonum fawcettianum* Small Supplejack.

Disturbance: *Ligustrum sinense,* Small-Leaved Privet seedlings were recorded in both quadrats and the second quadrat had an invasion of *Tradescantia fluminensis* Wandering Jew. The southern strip of vegetation in study area 1 (Figure 2) had a high degree of weed infestation including *Pinus radiata* Radiata Pine, *Lantana camara* Lantana, *Solanum mauritianum* Wild Tobacco and *Asparagus aethiopicus* Asparagus fern. Along the most northern drainage line in study area 2 exotic species were also present such as Radiata Pine and Lantana.

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Related mapping units: E1a-Coastal Warm Temperate Rainforest of Bell (2004) and MU 49 Lilly Pilly/Sydney Blue Gum wet sclerophyll rainforest of coastal ranges and tablelands escarpment. Refer to quadrats AN1, AN2. Equivalent to biometric vegetation type HU 639 Sydney Blue Gum moist shrubby open forest on coastal ranges of the north coast and northern Sydney Basin.

Photo 1 - Closed Forest with emergents of Sydney Bluegum growing along the alluvial flats of Narara Creek.

The following descriptions were derived from this survey.

Remnant Freshwater grassland with rushland/sedgeland: *Paspalum distichum-Juncus articulatus ?-Isolepis prolifer-Typha orientalis*

Structure: Remnant freshwater wetland with aquatic herbs and aquatic grasses up to 0.2m high and with a dense cover of prominent sedges amongst the main paddock grass.

Habitat: Permanently inundated alluvial flats along the Narara Creek floodplain.

Distribution: Narara Creek floodplain.

Floristic composition: The main introduced paddock grass is *Axonopus fissifolius* Narrow-leaved Carpet Grass. Herbs mainly comprise *Callitriche stagnalis* Common Starwort and *Persicaria decipiens* Slender Knotweed in areas of inundation whilst the main native grass appears to be *Paspalum distichum* Water Couch. Sedges are *Juncus articulatus ?, Isolepis prolifer,* are the main species between the drain and Narara Creek. *Typha orientalis* occurs as a taller rushland along the drain.

Disturbance: This vegetation community occurs as a remnant amongst a paddock between Narara Creek and the drain (see photo 2).

Related mapping units: E 46a Freshwater Typha Wetland of Bell (2004); MU 200 Typha rushland of Somerville (2009). Equivalent to biometric vegetation type HU 673 *Phragmites australis* and *Typha orientalis* coastal freshwater wetlands of the Sydney Basin.

Photo 2 - Closed remnant freshwater grassland with sedgeland/rushland along the alluvial flats of Narara Creek.

Narrabeen slopes forming the Watagan SLU

Moist Closed Forest with emergents: *Eucalyptus saligna–Syncarpia glomulifera-Cryptocarya glaucescens*

Structure: Closed Forest.

Habitat: Lower moist slopes on the Narrabeen Group of rocks.

Distribution: North facing slopes west of the access road.

Floristic composition: *Eucalyptus saligna* Sydney Blue Gum occurs on the lower slopes and beside streams. This species together with *Syncarpia glomulifera* Turpentine, *Angophora floribunda* Rough-barked Apple, *Cryptocarya glaucescens* Jackwood and *Pittosporum undulatum* Sweet Pittosporum are the main canopy dominants forming emergents. The sub-closed canopy is made up of *Acmena smithii* Lilly Pilly, *C. glaucescens* Jackwood, *Livistona australis* Cabbage Tree-palm and *Rhodamnia rubescens* Brush Turpentine but other sub-canopy species can be present such as *Diospyros australis* Black Plum, *Wilkiea huegeliana* Veiny Wilkiea, *Diploglottis australis* Native Tamarind, including *A. smithii* Lilly Pilly . The ground layer is a very sparse cover of *Lomandra longifolia* Spiny-headed Mat-rush and sometimes *Dianella caerulea* and *Gahnia melanocarpa*. Grasses are very poorly represented and where present it is mainly *Oplismenus imbecillis* Basket Grass. Climbers are well represented and those that were commonly recorded were *Morinda jasminiodes* Morinda, *Smilax australis* Barbed-wire Vine, *and Geitonoplesium cymosum* Scrambling Lily and *Dioscorea transversa* Native Yam.

Disturbance: *Ligustrum sinense* Small-Leaved Privet seedlings are poorly represented, but the open floor area is very heavily invaded by *Lantana camara* Lantana and could be considered impenetrable. This weed occurs throughout most of the lower slope area and probably originated from the clearing for the transmission line. This weed favours the moist Narrabeen soils

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Related mapping units: E1a-Coastal Warm Temperate Rainforest of Bell (2004) and MU 49 Lilly Pilly/Sydney Blue Gum wet sclerophyll rainforest of coastal ranges and tablelands escarpment. Refer to quadrat NAECSL1. Could possibly form part of the lowland rainforest endangered ecological community. Equivalent to biometric vegetation unit HU 529 Coachwood-Crabapple warm temperate rainforest of thenorth coast and norther Sydney basin bioregions.

Photo 3 Moist Closed Forest with emergents: *Eucalyptus saligna–Syncarpia glomulifera-Cryptocarya glaucescens* on the Narrabeen Group at the northern end of the site.

Narrabeen gullies forming the Watagan SLU

Palm gully open to closed forest and sometimes Gallery Rainforest: Livistona australis-Cryptocarya glaucescens-Acmena smithii

Structure: Open to closed forest (gully and gallery rainforest).

Habitat: Deeply entranced boulder strewn gullies on the Narrabeen Group of rocks.

Distribution: Confined only to hillslope drainage lines leading into Narara Creek and part of Narara Creek.

Floristic composition: *Livistona australis* Cabbage-tree Palm, *Cryptocarya glaucescens* Jackwood, *Syncarpia glomulifera* Turpentine and *Eucalyptus saligna* Sydney Bluegum form the main canopy and sub-canopy species with a sparser representation of *Glochidion ferdinandi var. ferdinandi* Cheese Tree, *Acmena smithii* Lilly Pilly, *Wilkiea heugeliana* Veiny Wilkiea, *Syncarpia glomulifera* Turpentine, *C. glaucescens, L. australis, Pittosporum revolutum* Hairy Pittosporum, *Ceratopetalum apetalum* Coachwood, *Neolitsea dealbata* White Bolly Gum, *Doryphora sassafras* Sassafras, *Trochocarpa laurina* Tree Heath, *Allocasuarina torulosa* Forest Oak, *Eupomatia laurina* Bolwarra and *Guioa semiglauca* Guioa. Sometimes the gully floor has pockets of a fern cover comprising *Blechnum cartilagineum* Gristle Fern, *Calochlaena dubia* Common Ground Fern, *Lastreopsis decomposita* Trim Shield

Fern and *Adiantum hispidulum* Rough Maidenhair. A dense pocket of *Lantana camara* Lantana, *Ochna serrulata* Ochna surrounds most of these gullies but within the boulder strewn gully sections a lithophytic flora is dominant and comprises *Carex maculata*, *Doodia aspera* Rasp Fern, *Hymenophyllum cupressiforme* Common Filmy Fern, *Platycerum bifurcatum* Elkhorn, *Asplenium australasicum* Bird's Nest Fern and *Peperomia tetraphylla.* Pockets of *Pittosporum multflorum* Orange Thorn also occur. Climbers include *Smilax australis* Barbed Wire Vine, *Palmeria scandens* Anchor Vine and *Aphanopetalum resinosum* Gum Vine.

Disturbance: The surrounding area of the gullies has been invaded with Lantana and Ochna and in downstream sections the Small-leaved Privet.

Related mapping units: Bell (2004) includes these units within E6ai Narrabeen Coastal Moist Forest but there is a different understorey flora present. MU8 Bangalow Palm/Coachwood/Sassafras gully rainforest of the Central Coast of Somerville (2009) also applies. Refer to quadrats NAECG1 NAECG2, NAECG3, NAECG4 and NAECRIP1. Could possibly form part of the lowland rainforest endangered ecological community. Equivalent to biometric vegetation unit HU 529 Coachwood-Crabapple warm temperate rainforest of thenorth coast and norther Sydney basin bioregions.

Photo 4 Palm dominated gully open to closed forest and sometimes Gallery Rainforest: *Livistona australis-Cryptocarya glaucescens-Acmena smithii.* This type of forest is found along all drainage lines on the slopes.

Photo 5 A lithophytic fern flora occurs in the boulder strewn palm dominated gullies. *Asplenium australasicum forma australasicum* and Grammitis *billardierei* can be clearly seen.

Tall Rushland pockets along Narara Creek: *Eleocharis sphacelata*

Structure: Tall open to closed rushland along the dam on Narara Creek.

Habitat: Siltation areas that become colonized by rushes.

Distribution: On the large dam only in the north of the study area.

Floristic composition: *Eleocharis sphacelata* Spiny-headed Mat Rush is the only species present in areas of shallow water that have become silted.

Disturbance: No disturbance noted.

.

Related mapping units: Not identified in Bell (2004) but is equivalent to MU 203 Eleocharis sphacelata freshwater wetland of Somerville (2009). No quadrat survey undertaken. Equivalent to biometric vegetation type HU 673 *Phragmites australis* and *Typha orientalis* coastal freshwater wetlands of the Sydney Basin.

Photo 6 Tall rushland pockets colonizing the edge of the waterway.

Exposed Hawkesbury Woodland on ridges and slopes: *Angophora costata-Eucalyptus scias-Eucalyptus umbra- Eucalytpus agglomerata-Corymbia gummifera*

Structure: Open woodland.

Habitat: Ridges, cliffs and dry slopes on the Narrabeen Group of rocks.

Distribution: East and west of the transmission line near the southern boundary.

Floristic composition: *Angophora costata* Sydney Red Gum, *Eucalyptus scias* Large-fruited Mahogany, *Eucalyptus umbra* Bastard Mahogany, *Eucalyptus agglomerata* Blue-leaved Stringybark and *Corymbia gummifera* Red Bloodwood make up the main canopy composition but *Syncarpia glomulifera* Turpentine and *A. costata* Sydney Red Gum and *Allocasuarina torulosa* Forest Oak also form the sub-canopy. The taller and mid shrub layers are mainly *Banksia serrata* Old Man Banksia, *Persoonia laevis, Persoonia linearis* Geebungs, *Leptospermum polygalifolium* Yellow Ti-tree and *Xanthorrhoea resinifera* a grass tree, which can occur as a dense layer. The ground layer can sometimes be absent but when present is tall and includes *Lomandra Longifolia* Spiny-headed Mat-rush*, Lepidosperma laterale* and at times grasses and ferns such as *Imperata cylindrica var. major* Blady Grass, *Entolasia stricta* Wiry Panic and *Calochlaena dubia* Common Ground Fern

Disturbance: East of the transmission line the vegetation is pristine, but west of the transmission line *Phytophthora cinnamomi* is evident.

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Related mapping units: E26a–Exposed Hawkesbury Woodland of Bell (2004) and MU 97 Turpentine/Forest Oak/Smooth-barked Apple Shrubby Open Forest on ranges of the Central Coast of Somerville (2009). Refer to quadrats NAECRD1, NAECRD2 and NAECSL2.Equivalent to biometric vegetation unit HU 622 Smooth-barked Apple-Sydney Peppermint-Turpentine heathy open forest on plateaux areas of the southern central coast, Sydney basin.

Photo 7 Exposed Hawkesbury Woodland (Bell, 2004) found on the ridges and western drier slopes of the property.

Remnant riparian grassland on slopes: *Ottochloa gracillimus*

Structure: Open grasssland.

Habitat: Remnant disturbed areas between palm gully forests and paddock areas on the Narrabeen Group of rocks.

Distribution: Found only in one area on the eastern slope.

Floristic composition: *Ottochloa gracillimus* is the only species present beside the main paddock grass *Axonopus fissifolius* Narrow-leaved Carpet Grass.

Disturbance: The native grass is being outcompeted by the Narrow-leaved Carpet Grass and requires recovery.

Related mapping units: No known related mapping units. No known biometric vegetation unit equivalent.

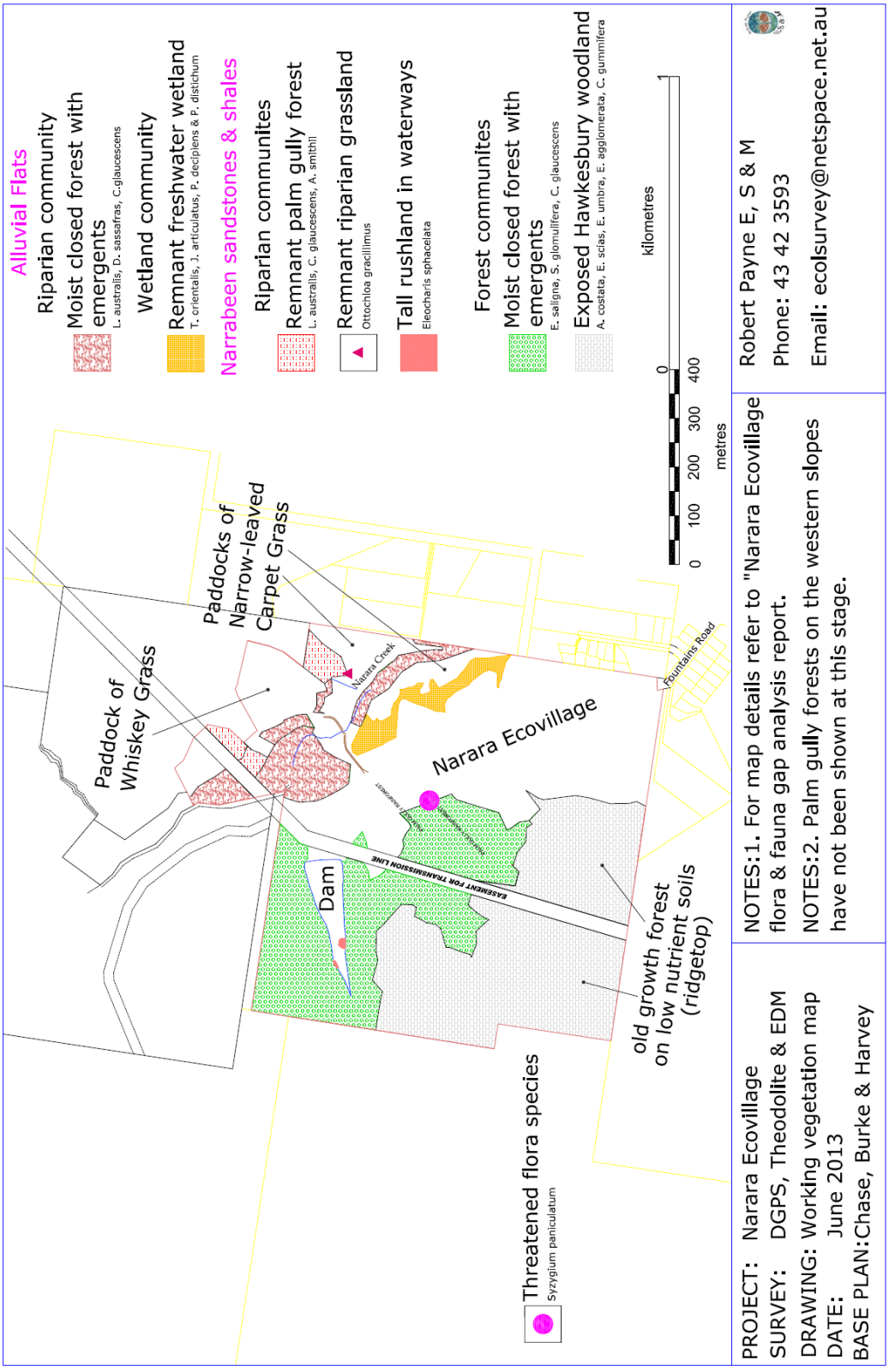

Figure 2 Map showing vegetation communities of the Narara Ecovillage property.

3.0 HOLLOW-BEARING TREES

Tree locations are shown on Figure 3 together with a schedule of the trees with hollows (also see Payne, 2013). The ridge, where they are located is considered to be an example of "old growth forest on low nutrient soils" and this notation has been added to the map. Within this area some of the trees have old large vertical hollows suitable as habitat for owls.

All of the large trees with hollows are found within the Conservation 7(a) zone established by DCP175. Not all trees with hollows have been located as it is expected that more will be found as access onto the lower slopes becomes possible. Additional trees with hollows, if any, can therefore be located from time to time and added to the plan. Additional trres have also been located on the lowland section.

There are individual hollow stags present in the dam having been permanently inundated after the dam was constructed. These stags have not been shown.

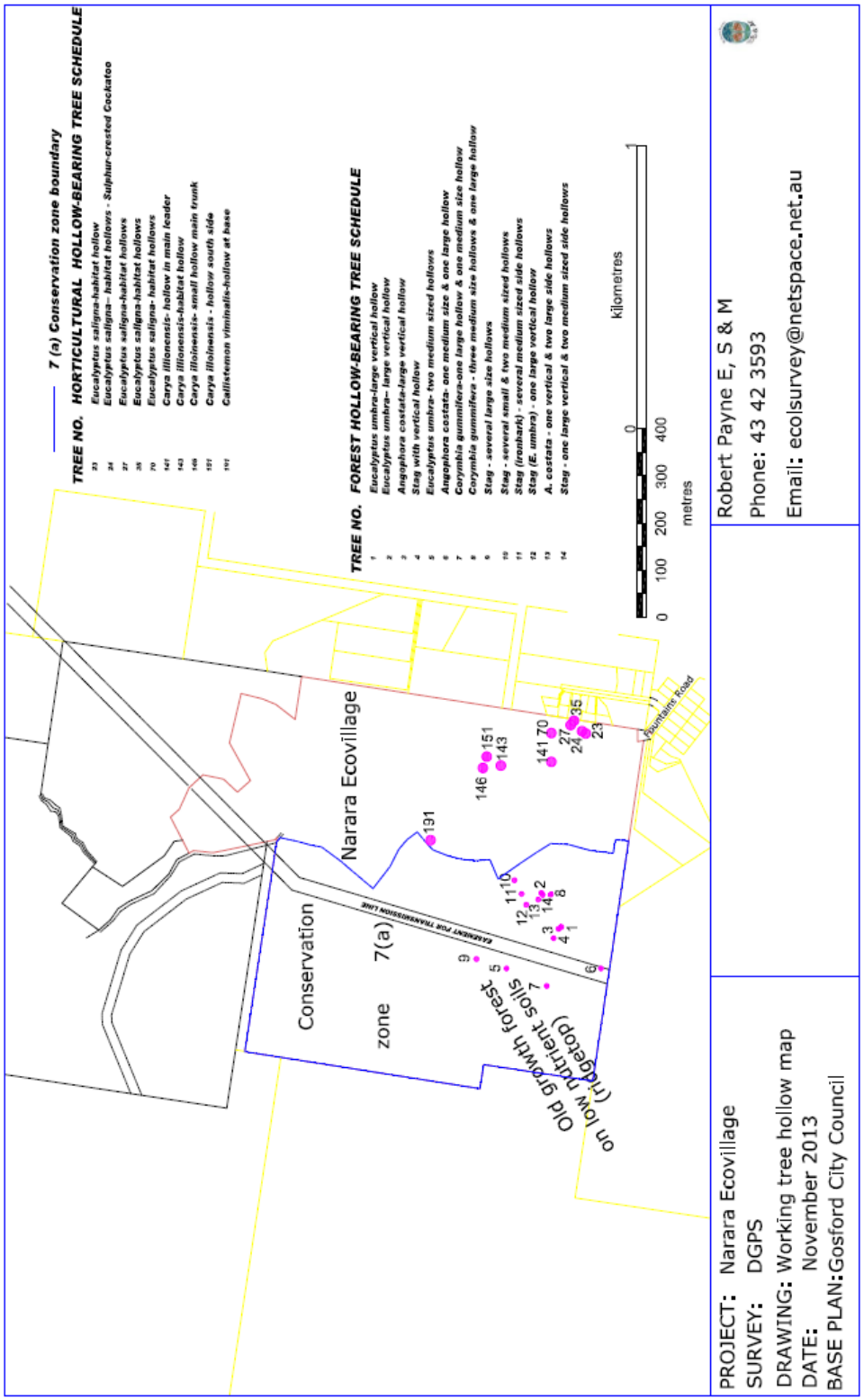

Figure 3 Map showing hollow-bearing trees on the Narara Ecovillage property.

4.0 THREATENED SPECIES

The following threatened species were recorded during the surveys and habitat details are included hereunder to understand management requirements for this ecological restoration plan. All of the threatened species, except for the Black Bittern, the Sooty Owl and the Grey-headed Flying Fox, given their location, can be managed together as one unit in the DCP 175 area. The Grey-headed Flying presumably was found feeding in orchards, whilst the Sooty Owl was recorded off site and the Black Bittern was found in the Freshwater Wetland.

4.1 The Powerful Owl

Distribution

The Powerful Owl is the largest of the forest owls and is a solitary species of wet sclerophyll forest, dry sclerophyll forest, woodland and riverine woodland (Debus, 2009). Roost and nest sites are usually found along gullies, where there is a dense cover of midstorey trees. The species is distributed from mid eastern coastal Queensland to western Victoria where it inhabits the area between the coast and Great Divide sometimes extending to the inland slopes. Pairs of Powerful Owls can be found remote from or with nesting sites in gullies beneath a leafy tree canopy to protect them from being mobbed by other birds.

Home range and diet

However, they have large permanent home ranges up to 600 ha in coastal forest and up to 3000 ha in inland forest. Breeding occurs in autumn-winter and pairs breed solitarily. They feed on possums, gliders, other arboreal mammals, flying foxes and a range of birds.

Habitat requirements

In the context of this study the Powerful Owl occupies coastal forest and escarpment habitats (NSW DECC, 2006) and there is no seasonal variation in distribution. They also forage in urban areas from adjoining forested areas. The species is widespread throughout its range but its habitat is becoming fragmented due to urbanisation, mining, agriculture and other infrastructural developments. It is possible that the habitat of the Powerful Owl has suffered a decline varying between 25-50% since European settlement. The Powerful Owl occupies a range of forest and woodland types due to its extensive range in NSW. Habitat clearing and fragmentation, especially on the coastal lowlands and foothills, is listed as a threatening process to the Powerful Owl by NSW DEC (2006) because fragmentation decreases its foraging range and breeding habitat.

At a finer scale the higher quality foraging habitat for the Powerful Owl occurs along the riparian zone of Narara Creek and its tributaries. This area also supports dense canopy and tall understorey vegetation providing roost sites for the Powerful Owl. Additional roost habitat for the Powerful Owl exists along the upper parts of several small drainage lines. The subject site also supports large to very large tree hollows on the ridge and those close to gullies could be utilized by the Powerful Owl.

4.2 Yellow-bellied Glider

Distribution and habitat

The Yellow-bellied Glider was not recorded on the property during the nocturnal surveys that were carried out but a sap-site tree was found (Andrews-Neil, 2006b). This species also has a patchy distribution in a wide range of forest habitats throughout eastern Australia, extending into southern Queensland and north-eastern Victoria. The species is commonly found in tall open forests where the forest canopy comprises old growth trees containing large hollows and other eucalypts and mosaic habitats that are used to provide them with a diversity of food resources. In the Gosford area the species can be found amongst *Eucalyptus saligna* Sydney Blue Gum and *Eucalyptus punctata* Grey Gum and at least the former tree species occurs on the lower moist slopes of the property. Home ranges are in the vicinity of 53Ha (Henry & Craig, 1996) and thus the reason for their loud vocalized call to defend their territory.

Diet

Specifically they require specialist food resources such as nectar and pollen from autumn-winter flowering eucalypts, trees that will provide phloem (sap)also in autumn-winter and those with shredding bark to gather insects especially arthropods. Insects provide most of their protein and much of their time is spent foraging for these insects. Honeydew and manna gum is also eaten in summer (Henry & Craig, 1996). Combined, nectar, honeydew, sap and manna provide their sugar requirements.

One sap site tree was found during the survey, so a small population could be present on the property (see Photo 1). Medium - sized hollows are required for roosting and breeding.

Photo 8 Example of Yellow-bellied Glider sapsite tree – *Eucalyptus maculata* Spotted Gum-showing V shaped scars from where phloem is extracted. Carnarvon Gorge National Park.

4.3 The Glossy Black-Cockatoo

The Glossy Black Cockatoo was recorded on the subject site during the investigations. Isolated sightings of the species, as a group, during each of the fauna surveys suggest the Glossy Black Cockatoo infrequently visits parts of the subject site for foraging resources. It does not appear to be a permanent resident.

Distribution and habitat

The distribution of the Glossy Black Cockatoo is patchy between eastern Victoria and central Queensland on the coast and inland to the tablelands with a small population in the Riverina area of NSW. It is found in woodlands and forests in these areas where there is an abundance of *Allocasuarina littoralis* Black she-oak, *A. torulosa* Forest She-oak and *A. verticillata* Drooping she-oak. The birds extract the seeds from the casuarina cones for food and are dependant upon large eucalypts with hollows for breeding and raising young. The area of high quality foraging habitat for the Glossy Black Cockatoo occurs on the mid to upper western slopes of the escarpment on the property.

Specific requirements

The species breeds in tree hollows or large limbs with hollows. It appears the birds have specific feed trees which are mature but sparsely foliaged and between 2-10 metres tall. Sometimes these trees may occur amongst dense undergrowth. Roosting is known to occur in the canopy of live leafy trees, usually eucalypts, which are located 30m from the hollow bearing tree. Their movements are poorly known (Higgins, 1999).

NSW DEC lists nine recovery actions for the species and those that apply to this property include the reduction of burning practices to promote the longevity of she-oak trees, protect existing and future hollow bearing trees, protect the areas where the she-oaks grow and establish corridors for movement.

At a finer scale the upper slopes of the subject site support foraging habitat, with stands of high density trees, or isolated individual feed trees. The Glossy Black Cockatoo also utilises large to very large tree hollows for nesting and potential nesting sites (large to very large tree hollows) are only found on the ridge. No evidence of breeding behaviour was noted during fauna investigations over the survey period in 2013.

4.4 The Eastern Bent-wing Bat

Distribution

This species is widely distributed from the coast and ranges of eastern Australia, extending from Cape York Peninsula, through eastern Queensland, New South Wales and Victoria. Other subspecies occur in western Victoria and south-eastern South Australia and north Western Australia and the Northern Territory. In New South Wales, it is found from the coast to the western slopes of the Great Dividing Range. This species is widespread and can be locally common where suitable caves or tunnels are available as roost sites.

Threats

However, the major threat to this species is the loss of roost sites, particularly nursery caves. Their dependence upon relatively few nursery caves suggests that threats to the

existence or structural integrity of these may place regional populations in jeopardy. Frequent disturbance of roosts used for winter hibernation or periods of torpor is known to significantly increase winter mortality (Hoye and Hall, 2008). Toxic accumulation of agricultural chemicals in body fat used during winter torpor may also reduce populations. Habitat loss through clearing for development or agriculture and subsequent reductions in insect prey availability may also adversely affect this species. The Eastern Bent-wing bat is reportedly preyed upon by feral cats and occasionally foxes (Churchill 2008).

Habitat

Eastern Bent-wing bats are known to forage within a variety of habitat types adjoining roost sites. Dwyer (1995) regarded typical habitat as well-timbered valleys, however this species is often recorded utilising bushland remnants as well as developed land in urban areas where it often forages around street lights (Ray Williams, Ecotone pers. obs.). Eastern Bent-wing bats are known to feed mainly on moths as well as cockroaches, beetles and flies and forages above the tree canopy (Churchill 2008). This is a mobile species and is estimated to forage within a 20km radius of the roost site with a known distance of 65km recorded in a single night (Churchill 2008).

Breeding requirements

The limiting factor for this species is availability of roost sites. Suitable caves, mines, tunnels, road culverts and buildings are essential. Maternity roosts are particularly important and are known from limestone and sandstone caves, disused gold mines, concrete bunkers and lava tubes (Hoye and Hall 2008). Long migrations between roost sites, according to seasonal needs or reproductive status, have been recorded (Hoye and Hall, 2008). Recorded nursery caves are few in number and widespread, which leaves this species vulnerable should any of these areas be destroyed. Within nursery caves, large populations of females, numbering up to 100,000 individuals gather prior to the birth of their young in December (Churchill 2008). In New South Wales mating occurs in late May and early June, just prior to winter. Delayed implantation occurs and development of the young does not commence until late August. A single young is born in December and juveniles are independent between February and March when nursery colonies disband and individuals disperse over long distances. They are sexually mature in their second year and may live to over 17 years of age (Hoye and Hall 2008).

The Eastern Bent-wing bat has been recorded over the years at a number of sites within the Gosford local government area and appears to be relatively well represented. A known roost site occurs in the nearby state forest.

4.5 The Little Bent-wing Bat

Distribution

The national distribution of this species occurs along the coast and ranges of eastern Australia from Cape York to near Wollongong in New South Wales. Populations in the south of the range are predominantly limited to coastal areas.

Threats

As for the Eastern Bent-wing Bat, the major threat to the Little Bent-wing Bat is also the loss of roost sites, particularly nursery caves. Their dependence upon relatively few nursery

caves suggests that threats to the existence or structural integrity of these may place regional populations in jeopardy. Frequent disturbance of roosts used for winter hibernation or periods of torpor is known to significantly increase winter mortality (Hoye and Hall, 2008). Toxic accumulation of agricultural chemicals in body fat used during winter torpor may also reduce populations. Habitat loss through clearing for development or agriculture and subsequent reductions in insect prey availability may also adversely affect this species.

Habitat

The Little Bent-wing Bat roosts in caves, stormwater drains and tunnels, with populations sometimes numbering into the thousands. Roosts are often shared with the larger Eastern Bent-wing Bat (Hoye & Hall 2008b). This species has also been observed roosting in the base of a hollowed out tree and within dense foliage (Schulz 1997), thereby increasing the significance of large mature trees in forest situations. This species has been reported to feed on small insects beneath the canopy in well timbered forest, but has also been reported utilising coastal swamps and rainforest. A nightly foraging range of 20 km from roost sites has been reported.

Breeding requirements

The Little Bent-wing Bat has been recorded roosting in the old mine workings and caves Larger more permanent roosts are also known to occur in a disused mine on the mid north coast, a road tunnel near Raymond Terrace and a sea cave on the coastal headland nearby (Ecotone 2000).

4.6 The Southern Myotis

Distribution

The Southern myotis is known to occur in a wide coastal band from northern Western Australia, Northern Territory, Queensland, New South Wales, Victoria, and into far south-eastern South Australia. The distribution of this species extends inland from coastal South Australia, along the Murray River (Churchill 2008). The species is considered to be common over its limited national range (Richards *et al.* 2008).

Threats

Roost sites are often over or near water within caves and man made structures, such as tunnels, buildings, culverts and bridges, as well as tree hollows (Churchill 2008). The use of man made structures gives the potential for a high incidence of disturbance, particularly where maternity roosts are involved.

Habitat

The Southern myotis has a strong affinity to open water, including farm dams, where it flies low over the water, feeding on flying insects as well insect larvae and small fish, raked from the water surface (Robson 1984). Within the locality, there are many large water bodies (the large dam, tributaries, wetlands, farm dams and pools within ephemeral creek lines) and these provide ideal foraging habitat for this species. Long movements between the roost site and foraging area have been recorded. In Victoria, Caddle and Lumsden (1999) found that the Southern Myotis travelled up to 20 km from the roost site to a feeding site despite both locations being over water. In southern Queensland, Barclay *et al*. (2000) found that individual myotis travelled up to 10 km from the roost site in a disused railway

tunnel to the foraging area over a man made lake and that two journeys were often made in one night.

Breeding requirements

Colonies usually number between 10 and 30 individuals, but up to several hundred individuals have been reported in a single roost (Richards *et al.* 2008). Small breeding clusters form within colonies, consisting of a male and a harem of females. This territory is defended from other males by the dominant male (Dwyer, 1970), however, banding studies have shown that both individual male and female members of the colony frequently change indicating that more than one roost is used by the local population at any one time (Ecotone 2001). In NSW, births occur between October and February and from limited information, it appears that each female may produce only a single young per year. Births within the colony appear to be staggered through the breeding season, with peaks in late October and early February. It is possible that young from the previous year give birth later in the breeding season (Ray Williams, Ecotone Ecological Consultants, pers. obs.). When not breeding, dominant males roost alone, defending their territory, whereas, surplus males may form predominantly all male groups of up to 50 individuals. Lactation lasts some eight weeks and after weaning the young forms a strong bond with its mother for at least four weeks, when it is probably taught how to catch food (Richards *et al.* 2008). In the cool southern latitudes, individuals may enter extended torpor to survive adverse winter weather conditions, however, in warmer coastal areas this species is active on most nights throughout the year, although they appear to return to the roost earlier in the night during winter.

4.7 The Eastern Freetail-bat

Distribution

This bat has been recorded from the coast and adjacent ranges of south-eastern New South Wales, north from Pambula, to south-eastern Queensland.

Threats

The main threat to this species is believed to be the loss of tree hollows which are used as roost sites through clearing or apiary (honey bees taking over suitable hollows). Habitat modification through inappropriate burning regimes and grazing, and clearing for agriculture or urban development may reduce foraging habitat and insect prey availability. However, given the apparent preference for more open environments some habitat modification may be an advantage to this species.

Habitat

Although the habitat preferences are unclear, most records of this species have been reported from dry eucalypt forest and woodland on the eastern side of the Great Dividing Range. Individuals have, however, been recorded flying low over a rocky river in rainforest and wet sclerophyll forest and foraging in clearings at forest edges (Hoye *et al.* 2008). The species has also been recorded foraging over open paddocks and wetlands in the Hunter River catchment and north coast of NSW (Ray Williams, Ecotone pers. obs.) and a study of habitat use on a landscape scale found higher activity levels in cleared and semi-cleared landscapes than within forested and urban landscapes (McConville 2010).

It is a predominantly tree-dwelling species (roosting in hollows or behind loose bark in mature eucalypts), but one individual has been recorded roosting in the roof of a hut, together with a number of Gould's wattled bats and an eastern broad-nosed bat (Hoye *et al.* 2008). This species has recently been found roosting and breeding in hollow mangrove trees (Anna McConville pers. comm.). Females give birth in late November to early December and flying young enter the population in January (Hoye *et al.* 2008). The diet is thought to consist of small insects including leafhoppers, chafers, weevils and other beetles.

Breeding requirements

It is a predominantly tree-dwelling species (roosting in hollows or behind loose bark in mature eucalypts), but one individual has been recorded roosting in the roof of a hut, together with a number of Gould's wattled bats and an eastern broad-nosed bat (Hoye *et al.* 2008). This species has recently been found roosting and breeding in hollow mangrove trees (Anna McConville pers. comm.). Females give birth in late November to early December and flying young enter the population in January (Hoye *et al.* 2008). The diet is thought to consist of small insects including leafhoppers, chafers, weevils and other beetles.

4.8 Grey-headed Flying Fox

Distribution

Currently, the Grey-headed Flying Fox is found from Hervey Bay in Queensland to Melbourne in Victoria.

Habitat

This species requires foraging resources and roosting sites and is a canopy feeding fruitivore and nectarivore. Thus, it feeds throughout various vegetation communities such as rainforest, open forest, woodland, heath, melaleuca swamp and banksia woodland as well as introduced species on properties such as fruit crops. However, with primary food source is eucalyptus blossom, but in other areas it utilises rainforest fruit.

The reliable food resources for the Grey-headed flying Fox are only restricted to a small number of coastal vegetation communities in north New South Wales and Queensland. Mainly these resources are eucalyptus nectar which is produced seasonally according to climatic conditions. The Grey-headed Flying Fox roosts in small to large colonies beneath the tree canopy in branches. It is suggested that suitable roosting sites are the reason for the species restricted coastal range. A further reason for the species limited coastal range is the limited distribution for its food resources and as a result the species becomes vulnerable as land use decisions are made. Importantly, the winter flowering food resources such as Swamp Mahogany and Broad-leaved Paperbark are sought by the Grey-headed Flying Fox.

Threats

The main threat to this species is believed to be the loss of forest food trees including paddock fruit trees which are utilized as food resources. Loss of camp sites is not a threat at this location. Habitat modification through inappropriate burning regimes and grazing, and clearing for agriculture or urban development may reduce foraging habitat.

4.9 The Magenta Lilly Pilly

Identification

Syzygium paniculatum is a medium sized Lilly Pilly tree bearing magenta coloured fruits. It is a difficult species to recognise because it has similar features to *Syzygium australe,* but it can be differentiated from this species by the different shaped globose rather than oval fruits, having a pinkish to reddish brown platy bark rather than a brownish grey and softly scaly bark, small scattered distinct oil dots rather than small scattered indistinct oil dots in the leaves and rounded smooth branchlets rather than four angled or winged branchlets (NSW OEH, 2012).

Habitat

Attributes are mainly deep quartz alluvial sands extending from lake shores in the North Entrance area to riparian habitats in the Ourimbah Creek Valley and Martinsville Valley with some outlier specimens at McMasters Beach, Copacabana and Norah Head on Aeolian sand dunes. Coppicing of stems at North Entrance and at Norah Head shows that this species can withstand fire.

Co-associate trees include, in order of importance, is *Ceratopetalum apetalum* Coachwood, *Archontophoenix cunninghamiana* Bangalow Palm and *Euroschinus falcatus* Ribbonwood.

Pollination

Pollination experiments carried out by Payne (1997) showed the species has a variable breeding system and outcrossing can cause fertilization. The main pollination visitor to flowers is the European Bee *Apis mellifera* with peaks in activity at sunrise. European Bees mingle amongst flowers, brushing stamens and anthers against the stigma (and style) to effect pollination.

4.10 The Red-crowned Toadlet

Identification

The Red-crowned Toadlet *Pseudophryne australis* is a small frog of the family Myobatrachidae and, as the common name suggests, has a bright reddish-orange triangular or 'T' shaped patch on the top of its head extending to the tip of the snout. They also have a short reddish stripe or spot (coccygeal stripe) in the centre of the back above the hind limbs.

Breeding

The Red-crowned Toadlet has a unique terrestrial reproductive strategy. Small nests are formed within decomposing accumulated leaf matter; clutch sizes are small, consisting of around 20-24 large eggs; nests retain the eggs through the early stages of tadpole development, which occurs within a water-filled membranous capsule. Rainfall events flush the embryos from the nest in order that tadpoles can complete development within transient pools.

Recent studies have revealed a less than 0.1% reproductive success rate or in other words only 1 clutch in 50 achieves any survival from tadpole to metamorphling. Consequently, changes to flow regimes, hydrology and frequency of rainfall and availability/persistence of

breeding sites all play a role in successful breeding and ultimately recruitment into local populations (R. Wellington pers. comm.).

Distribution

This species was detected during investigation of the subject land and has also been found in the surrounding areas and general locality.

4.11 The Black Bittern

Habitat

The Black Bittern was recorded during the survey in the freshwater wetland on the alluvial floodplain. This species occurs in terrestrial wetlands, estuarine and littoral habitats at the edges of running or still water. Vegetation is generally dense but can be narrow.

Breeding and food requirements

The species will breed in dense vegetated wetlands which are secluded and nesting can also occur in leafy trees overhanging water. The Black Bittern will feed on small fish and freshwater crayfish and will stalk this prey by walking with retracted shoulders.

Nests are made of sticks, reeds and twigs with a shallow depression at the top

The call is described as a loud boom but the breeding cycle is poorly known.

5 MANAGEMENT OF THREATENED SPECIES

The management of threatened species is best achieved as a conservation reserve within the corridor (DCP 175), which must include the dam because most species that were found are within the vegetated western slope although one species, the Black Bittern, was found in the Freshwater Wetland (Figure 2). A number of threatened bat species were recorded feeding over the dam and obviously the dam is a significant feeding habitat for microbats. Extra precautionary measures have been identified and set out for microbats associated with the development phase (Payne, 2013).

Early attempts at achieving conservation of threatened fauna species occurred within State Forests in the 1980's when buffer zones were created along drainage lines (Recher, Rohan-Jones & Smith, 1980; Recher, Shields, Kavanagh & Webb, 1987). This was a response to the logging process known as "clearfelling" when the Australian Museum commenced studies to establish the impacts on wildlife and then provided future management guidelines to conserve fauna during the logging process. Models were developed on the basis that large reserves retain more species than small reserves and reserves with a small boundary in relation to its area retain more species of the original natural habitat than those with long or irregular boundaries. Linking reserves with corridors is an effective way to enhance the size of reserves and multiple reserves provide a hedge against the catastrophic loss of fauna.

Further work by the authors showed that in relation to birds, species were more abundant and there more species in the widest reserves than in the narrowest reserves. In relation to Yellow-bellied Gliders that were resident in an area, it was necessary for them to obtain supplementary food resources outside their territory during winter. In other words, Yellow-bellied Gliders depend upon a mosaic of forest resources including mature forests and in fact the Yellow-bellied Glider is strongly affected by forest fragmentation due to the fact that

it requires specialized resources in a specialized habitat. Greater Gliders, in contrast, are generally not affected by forest fragmentation because they only require a small home range, feeding primarily on the leaves of eucalypts and furthermore can feed on the foliage of a number different eucalypt species. Both species are likely to be present on rhe slopes associated with the Narara Ecovillage property.

Through this work a national conservation strategy was then developed which identified key principles for implementing such a scheme (Department of the Environment, and Sport and Territories, 1996). Scotts (2003) then developed the key habitat and corridors project at a NSW state level which refined the systematic consideration of fauna with a conservation focus across the landscape using priority fauna species. Geographic information systems coupled with habitat modeling was used to develop these key habitats and corridors for better management and planning.

Management of threatened species was then identified practically by creating a network of reserves with sensitive habitats isolated from human disturbance which at that was thought to be the best solution (Noss, 2006). It was also recognized at the same time that human activity was the biggest threat to biodiversity conservation through landscape change and habitat fragmentation (Lindenmayer & Fischer, 2006).

One of the main principles for implementing threatened species conservation was by the protection of contiguous habitat or stepping stone areas (Recher, Shields, Kavanagh & Webb, 1987). For example, one of the major threatened plant species (*Tetratheca juncea*) was planned to be protected using the stepping stone principle, which is now well underway within a planned system of reserves. With respect to regional and sub-regional corridors the recommended width was 500m and 300m respectively (Scotts, 2003).

A review of such a strategy with the Narara Ecovillage shows that the western slope and ridge is approximately 500m wide which achieves the regional corridor status of Scotts, (2003). Although the western slope and ridge of the property is only 32 ha, the approximate combined area with the adjoining Strickland State Forest amounts to 3.88 km^2, which forms a very large reserve.

The habitat for the Black Bittern is Narara Creek and its floodplain for feeding and the Freshwater Wetland for roosting. The two most significant influences expected from this development is the impact on water quality from urban run-off during construction and from lighting within the development area. The urban run-off is straight forward to address, by implementing sediment and erosion control measures before runoff overflows into the Freshwater Wetland. Lighting is a bit more difficult to address and if it is recognized that from overseas studies it can be shown lighting can have a small impact on wet tussocky grassland bird species (Mollenaar, Sanders & Jonkers 2006). This study showed that strong lights had no affect between the date of laying the first egg and land parcel suitability during the breeding season, but there was a strong correlation between distance to the light poles and egg laying dates with a later start of breeding period. This was more pronounced closer to the lighting than further away from it. The influence on nest choice was not caused by the illumination of lights as such because the measurable illumination is near zero at a distance of 50m from the road lights, but rather by the visibility of strong light sources and the illuminated space. Traffic volume did not influence the nesting. Installation of low level lighting is the best way of achieving this.

For management of the drainage the current proposal is for the water to exit the proposed bioretention systems and enter the current drainage lines which will convey water off the

slope and onto the floodplain. The water will then receive further polishing within the wetlands on the floodplain prior to entering Narara Creek.

The sewage treatment plant location will be above the 100 Y ARI flood line. It will have a series of buffer storage tanks and a wet weather storage pond. The system is designed to be compliant with the EPA guidelines in that it will not overtop in more than the 50 percentile wet year (i.e. it is designed to not overtop in more than 50 years/century). Under these conditions 95 to 99% of the effluent volumes are reused. Thus overtopping is permitted during extreme wet weather when the entire area is likely to be flooded and the additional percentage load due to effluent discharge will be minimal.

For management of the vegetation for the Black Bittern the Cumbungi should be restricted to the drainage line and curtailed as it expands into the freshwater wetland. The current practice of mowing the freshwater wetland should be maintained.

6 GENERAL MANAGEMENT

6.1 Drainage lines

The management of the waterways and wetlands should abide by the guidelines for both riparian corridors (NSW Department of Water, 2008) and vegetation management plans (NSW Department of Water, 2010) which outline the basic principles for re-vegetating drainage lines.

These documents state that the protection or restoration of vegetated riparian areas is important to maintain or improve the geomorphic form and ecological functions of watercourses through a range of hydrologic conditions in normal seasons and also in extreme events. When determining an appropriate width for a riparian corridor and how much riparian vegetation should be protected or re-established on a site, the following initial two riparian corridor zones should be considered.

- **A Core Riparian Zone (CRZ)** is the land contained within and adjacent to the channel. The Department will seek to ensure that the CRZ remains, or becomes vegetated, with fully structured native vegetation (including groundcovers, shrubs and trees). The width of the CRZ from the banks of the stream is determined by assessing the importance and riparian functionality of the watercourse (Table 1), merits of the site and long-term use of the land. There should be no infrastructure such as roads, drainage, stormwater structures, services, etc. within the CRZ.
- **A Vegetated Buffer (VB)** protects the environmental integrity of the CRZ from weed invasion, micro-climate changes, litter, trampling and pollution. There should be no infrastructure such as roads, drainage, stormwater structures, services, etc. within the vegetated buffer. The recommended width of the VB is 10 metres, but this depends on merit issues.
- **An Asset Protection Zone (APZ)** is a requirement of the NSW Rural Fire Service and is designed to protect assets (houses, buildings, etc.) from potential bushfire damage. The APZ is measured from the asset to the outer edge of the vegetated buffer (VB). The APZ should contain cleared land which means that it cannot be part of the CRZ or VB. The APZ must not result in clearing of the CRZ or VB. Infrastructure such as roads, drainage, stormwater structures, services, etc. can be located within APZs.

Table 1 - Recommended core riparian zone widths of all watercourses.

Types of watercourses	CRZ width
any first order watercourse and where there is a defined channel where water flows intermittently	**10 Metres** Applies to the three southernmost drainage lines on the western side. Applies to the two northern most drainage lines on the eastern side
any permenantly flowing first order watercourse, or any second order watercourse and where there is a distinct channel where water flows intermittently or permanently.	**20 metres** Applies to the northernmost drainage line on the western side where the dam is located.
any third order or greater watercourse and where there is a defined channel where water flows intermittently or permanently. Includes estuaries, wetlands and any parts of rivers influenced by tidal waters.	**20 – 40 metres** Applies to the main section of Narara Creek flowing through the property.

6.2 Aboriginal heritage

The site falls within the boundaries of the Darkinjung Local Aboriginal Land Council with the Guringai people, under Native Title, registered as traditional owners. An appraisal of the land in 2007 identified no Aboriginal objects however there is potential for identification of cultural material particularly following dismantling of dense weed incursions. Landscape features indicative of the presence of where Aboriginal objects may be found include;

- within 200m of water
- located on a ridge top or ridgeline
- within 200m below or above a cliff face
- within 20m of or in a cave, rock shelter or cave mouth
- and is on land that is not disturbed.

These features are applicable to this site and whilst undertaking restoration activities in the context of protecting Aboriginal cultural heritage, reasonable and practical measures to determine whether your actions will harm an Aboriginal object should be put in place. This is known as "due diligence".

Additionally, as potential exists for an Aboriginal object to be located workers need to be broadly familiar with identification features. Training through participation in a *Cultural Heritage Awareness Workshop* would be beneficial to gain a greater understanding of "Due Diligence" relevant to the context of restoration work.

In the event that an Aboriginal object be identified or suspected of such, the object is to be left in-situ and work ceased in the immediate area. The Office of Environment and Heritage (OEH) is to be notified. If human skeletal remains are located work must stop immediately, the area secured to prevent unauthorised access until OEH and NSW Police are notified and have attended the site.

6.3 Artificial lighting

Street lighting may impact upon certain groups of fauna, if it is required. A review of the literature (Beier, 2006; Rydell, 1992 and Rydell, 2006) revealed that with respect to owls searching for prey, owls have higher prey catch efficiency in bright light, but prey remains in secure places under these conditions and on darker nights, owl capture of prey may be reduced. Artificial night lighting of similar intensity to moonlight can cause small mammals to respond, by a shift in foraging and ranging activity to areas with darker conditions. Unless the mammals abandon the lighted area, small mammals will become prone to risk of predation or they will lose body mass by restricting their foraging activities.

Intensity and type of street lighting may influence the probability of wildlife mortality collisions with vehicles on main roads. Some types of artificial lighting will make it difficult for a nocturnal animal to avoid a collision especially if the animal experiences a rapid shift in illumination. Owls are particularly prone to such accidents.

Insectivorous bats, in particular prefer to forage in the upper canopy under bright moonlight or under artificial night lighting conditions because in both cases insects become more abundant. Insectivorous microbats will, therefore, be attracted to these insects which now form a large part of their diet. Many species of microbats in New South Wales are listed as 'threatened', which is thought to be the result of habitat fragmentation. In turn, habitat fragmentation reduces the availability of roost sites and food resources. Insectivorous bats often feed on insects attracted to lights and such activity may indirectly influence the survival and reproductive performance and thus, the conservation status of these bat species.

Lights interfere with their navigation during both nocturnal migration and commuting flights or even may disrupt their circadian clocks. Feeding at lights may also influence their predation risk to owls.

Street lights are made in the form of mercury vapour lamps, low pressure sodium vapour lamps and high pressure sodium vapour lamps. The low pressure type has no affect on bats (Rydell, 1992). However, studies overseas have also found that densities of bat populations are between three and twenty times higher along roads with lights than in sections without lights. Some species, such as the Horseshoe Bats, *Rhinolophus sp. Myotis sp.* and those from the Vespertilionidae family (for example, *Miniopterus, Nyctophilus, Chalinolobus, Pipistrellus, Vespadelus* and *Scotorepens*) avoid street lights, but it is perhaps possible these species avoid open areas anyway and not just lighted areas directly.

Food intake at city lights is generally higher in town areas than in rural areas. The reason for this is that moths are very abundant at street lights and are heavier in weight than beetles, flies and mosquitoes. One of the factors that resulted from the research was that feeding activity on moths involved a low capture rate. Further, factors that may have an effect is the interaction between bat species with some species excluding others. For example, the Lesser European Horseshoe Bat became extinct in valleys in Switzerland when street lights were installed, being excluded by the Pipistrelle Bats. Both bat species feed on similar prey and probably competitive exclusion occurred.

With the emphasis of providing a corridor at a landscape scale for this project, it is known that any street lighting that is to be provided will negatively impact upon an animal's ability or willingness to cross or move through an area of artificial night lighting. Therefore as well as considering the width of the corridor, consideration should be given as to how bright it is. Overseas research shows that animal movement will be affected by night lighting from

adjacent areas of recreation fields, industrial parks, service stations and housing (Beier, 2006). For the purposes of this project the lowest lighting level consistent with human safety is the best for animal crossing needs and no lighting should be applied to the dam area which allows the surface water to be illuminated. Low level lighting should only be installed that is consistent with and meets public safety requirements and away from the water surface.

6.3 Eradication of feral animals

A feral Siamese Cat is present on the property along with domestic dogs and evidence of this can be seen with a Long-nosed Bandicoot kill. The European Fox was also observed. To take steps to remove the European Fox a representative of the Narara Ecovillage should attend the "1080" baiting course usually organized by the local Catchment Management Authority and take the appropriate steps. For the feral cat and domestic dogs further advice should be sought from Gosford City Council and the Cumberland Livestock, Health and Pest Authority (ph. 4655-9165) as recommended methods change from time to time (see also Payne, 2013).

7 ECOLOGICAL RESTORATION

7.1 Weed assessment

For this section of the report (Chenoweth EPLA & Bushland Restoration Services (2012) a preliminary weed map is presented as Figure 4 and flora and fauna species lists are shown in Appendices 1 and 2. In Figure 4 each vegetation community has a description of the weed invasion which can be used as a starting point for the assessment. Table 2 provides additional information.

Table 2 – Broad scale detail of weed invasion in the relevant vegetation communities

Vegetation community	**Weed invasion description**
Alluvial flats of Narara Creek	
Closed Forest with emergents:	*Ligustrum sinense,* Small-Leaved Privet as seedlings and young trees and *Tradescantia fluminensis* Wandering Jew, a herb are both deeply entrenched. The southern strip of this vegetation in study area 1 has a high degree of weed infestation including *Pinus radiata* Radiata Pine, *Lantana camara* Lantana, *Solanum mauritianum* Wild Tobacco and *Asparagus aethiopicus* Asparagus fern. Along the most northern drainage line in study area 2 the same exotic species were also present such as Radiata Pine and Lantana.
Remnant freshwater grassland with rushland/sedgeland	*Axonopus fissifolius* Narrow-leaved Carpet Grass and various rush species have dominated this habitat which need to be removed to restore the native Water Couch grassland.
Narrabeen slopes of the Watagan SLU	
Moist Closed Forest with emergents	*Ligustrum sinense* Small-Leaved Privet seedlings and *Ochna serrulata* Mickey Mouse Plant are poorly represented, but the open

	floor area is very heavily invaded by *Lantana camara* Lantana and could be considered impenetrable. This weed occurs throughout most of the lower slope area. This weed favours the moist Narrabeen soils. An assessment of the lower east facing slopes where agricultural land use with soil compaction is evident shows that natural regeneration potential has been compromised.
Palm gully open to closed forest and sometimes gallery rainforest	The surrounding area of the gullies has been invaded with Lantana and Ochna and in downstream sections the Small-leaved Privet.
Exposed Hawkesbury Woodland on ridges and slopes	East of the transmission line the vegetation is pristine, but west of the transmission line *Phytophthora cinnamomi* is evident.
Remnant riparian grassland on slopes	*Axonopus fissifolius* Narrow-leaved Carpet Grass has dominated this habitat which needs to be removed to restore the native grassland within the 10m riparian buffer zone.
Edge of development zone	Weed species such as *Thunbergia alata* Black-Eyed Susan, *Acetosa sagittata* Turkey Rhubarb and *Tradescantia fluminensis* Wandering Jew currently seen only as sporadic incursions along or within the development zone.
Paddocks	Weeds include the highly opportunistic species *Araujia sericifera* Moth Vine and *Andropogon virginicus* Whiskey Grass.

From a number of field assessments, including one with local bush regeneration personnel, further information is supplied relating to infestation of the structural components. Within the closed forest with emergents on alluvial flats dense stands of Small-leaved Privet as saplings were present in the mid layer whilst the ground layer was a carpet of Wandering Jew. Other large trees are present at the edges such as *Cinnamomum camphora* Camphor Laurel and Radiata Pine *Pinus radiata*. However, this infestation appears patchy and it should be noted there is an earthern levee along the extent of Narara Creek, restricting access.

The remnant freshwater grassland with rushland/sedgeland has a history of being mowed and a series of parallel furrows exist which are more or less permanently inundated. These furrows are the habitat for the ground hugging Slender Knotweed and the Water Couch. The ridges between the furrows have been colonized by Narrow-leaved Carpet Grass and various exotic rushes (see Photo 2).

The moist closed forest with emergents on the Narrabeen geology has been colonized by Lantana (Photo 8). This weed infestation is correlated with the moist lower slopes and occurs both in the ground and mid layers. Density varies, however, probably with the

degree of moisture determined by aspect. Isolated infestations of *Araucaria heterophylla* Norfolk Island Pine and *Araucaria bidwillii* Hoop Pine are also found in this vegetation especially north of the dam, where the ground and mid layer native vegetation is particularly thick. At this location access into the forest is difficult due to the vertical cliffs that occur parallel to the dam. The Lantana infestation on all of these moist slopes appears to extend upslope to the rocky steep vertical cliffs, but above this the soils are much drier (Figure 4).

Photo 9 Lantana invasion into the Narrabeen moist closed forest with emergents on the moist lower east facing slopes.

The vegetation described as *palm gully open to closed forest and sometimes gallery rainforest* occurs along the Narrabeen drainage lines which bisect the Narrabeen slopes. As shown in photos 4 and 5 these gullies on the upper slopes are pristine with large boulder strewn sections, but where this community meets and overlaps the alluvial flats in the downstream section Privet and Lantana have dominated the understorey. In most cases these species have replaced the mid and ground layers. The western side two gullies could not be investigated due to the degree of weed invasion.

At one location on the eastern slopes a patch of remnant riparian grassland was found beside the gully. The grass species is *Ottochloa gracillimus* and is now rarely recorded in the region as these riparian species are gradually disappearing. Where it would have originally grown, it has been replaced by Lantana, Privet and Narrow-leaved Carpet Grass.

Exposed Hawkesbury woodland on ridges and slopes has hardly been subject to any serious weed invasion except for isolated patches, although the Norfolk Island Pine was noted as a regenerating weed.

7.2 Future potential regeneration

Many natural areas have the ability to regenerate and the degree to which this can occur is dependent on many factors and include;

- an appropriate seed bank being present across all species
- processes for recruitment of seed are in place
- area cover is sufficient for this to be sustained.

The area covered under DCP175 has large areas of intact vegetation together with smaller varying degrees of degraded vegetation. Dense weed infestations, where structure and function is highly altered and related to the total area size for each vegetation community, is relatively small, the exception being the alluvial flats (vegetation communities are outlined in Figure 2).

A key aspect of any weed management or restoration program includes supporting conditions to allow the retention of an ecosystem in its natural condition or the provision of support for this to occur. The aim for the area would be to allow it to be self sustaining into the future and for this to occur in an environment that requires the least intervention. The time taken for this to occur varies greatly and is dependent on specific site conditions.

7.3 Restoration approach

Frequent on going assessment as works progress will then be required, despite pre-planning, to allow for management changes and approaches to be adapted as site conditions change. Therefore to fully address required processes for successful ecological conservation or restoration a structured program of monitoring will be required.

With respect to the Narara Ecovillage many areas will require little support for natural regeneration and for a healthy ecosystem to continue or progress. In some cases, erection of a simple fence will be required to prevent access and create protection for native plants. Other sections will require varying degrees of assistance such as weed eradication and control; this being highly dependent on the weed species present, their density and longevity of infestation together with the condition of the immediate or surrounding native vegetation. Other influences include past land use impacts.

The riparian grassland is an example of a community that will require high levels of rehabilitation and a reconstructive approach that will be heavily reliant of revegetation through plantings and other strategies together with weed eradication.

Stronger restoration approaches will be required for other areas such as degraded steep gully verges or creek banks prone to erosion where installation of erosion controls will be required. Edge areas in sections will require rehabilitation and strengthening through plantings or other strategies to provide for a long term protective buffer. Those sections that are intact will require no intervention other than monitoring. Some areas will require a combination of approaches to either restore attributes of value and again site specific conditions will determine and direct this. Restoration management will also require sound planning based on further localized assessments throughout the site with implementation sequenced accordingly to ensure restoration will be effective, reach desired outcomes and completed within predicted time frames. Frequent ongoing assessments as works progress will then be required, despite pre-planning, to allow for management changes and approaches to be adapted as site conditions change.

7.4 Management zones

Each zone is to be assessed to identify the condition of the vegetation and to determine degrees of restoration or rehabilitation required. There will be a need prioritise which zones, areas or sections to work first, leave till a later stage, work concurrently or to perhaps manage under the principle of "weed seeding containment" only. Whilst "best practice bushland management' can be itemised the key to successful outcomes will be heavily reliant on the ability to commence restoration works under a fine tuned weeding schedule directed by sound knowledge and familiarisation with the site.

Figure 5 presents the management zone map and Table 3 summarises the zones.

Table 3 – Suggested management zones in relation to the relevant vegetation communities

Vegetation community	**Management zone**
Alluvial flats of Narara Creek	
Closed Forest with emergents:	AF1, AF3 & AF4
Remnant freshwater grassland with rushland/sedgeland	AF2
Narrabeen slopes of the Watagan SLU	
Moist Closed Forest with emergents	MCF1, MCF2 & MCF3
Palm gully open to closed forest and sometimes gallery rainforest	PGF1, PGF2, PGF3 & PGF4
Exposed Hawkesbury Woodland on ridges and slopes	EHW1 & EHW2
Remnant riparian grassland on slopes	Not designated
Tall rushland along deges of dam	Not designated
Edge of development zone	Not designated
Paddocks	Not designated

7.5 Goals to target restoration

Given that the weed invasion is widespread over the property, but not extremely dense; the following goals have been set to target the restoration:-

- Weed control is to be implemented only where provision is assured for adequate follow-up treatment and installation of supports such as erosion controls where required.

- For the removal of Lantana the cut and paint method of eradication should be adopted. This is recommended due to the prime condition of the forests and potential for off target damage through foliar application of herbicide. In the event that foliar application is required such as on the steep cliffs where physical access is restricted application should be via splatter gun under the control of an experienced and qualified operator.

- Dense Lantana infestations, such as on the lower slopes (MCF 2 & 3) east of the development edge, will require a mosaic and staggered pattern of removal so as not to compromise fauna habitats particularly for small birds such as the Superb Fairy Wren. This method requires sections of Lantana left untreated to retain habitat values (nesting, roosting and shelter) whilst other sections are treated. When an assessment is made that those areas treated first have sufficiently regenerated, works are then progressed across the site. The mosaic or sectional approach is also

applicable to the riparian zone where potential for erosion exists if large lengths of creek line (AF1 & 4) are worked at any given time.

- Removing the dense Lantana understorey is likely to reduce the populations of Bell Minor and consequently enhance the environment and opportunity for an increase in small bird diversity.

- Revegetation should only be implemented following assessment and a clear need or benefit determined.

- Revegetation will require seed or plant material to be provenance specific to the valley. Sufficient diversity across the species is in place and this should not be problematic. Out sourcing from the nearest wetland community may be required for the rehabilitation of the riparian grasslands if an increase of species diversity is warranted.

- Natural materials that break down over times should be used where erosion control supports are required. Ecologs, coir matting and wooden stakes are examples.

- Remains of timber logs or felled trees should be recycled. Uses include mulch or logs to provide barriers to development edge sections, cleared paddock-gully interfaces, supports for control of erosion and in particular use a buffers for the riparian grasslands.

- Removal of Camphor Laurels should be staggered over a period of time- this up to 10 years. The Eco-village residents have purchased a mill that will allow recycling of as much of the material as possible.

- The village residents should be supported and encourage to participate in restoration activities from commencement through to completion of any structured project.

- Re-instatement of the existing moist closed forest vegetation could easily be achieved over a time period of say, between five and seven years.

- Overall the main goal is to apply the minimum intervention necessary to remove the main weeds.

- The main weed species is *Lantana camara* Lantana with subsidiary populations of *Ochna serrulata* Ochna, *Ligustrum sinense* Small-leaved Privet, *Tradescantia flumiensis* Wandering Jew and *Cinnamomum camphora* Camphor Laurel. Although Lantana is widespread on the moist Narrabeen slopes the infestation is not dense at all locations. On upper slopes near the cliffs it is present as a thin infestation. For the removal of this Lantana, a principle of cut and paint only has been adopted. Spraying is not recommended because of the prime condition of the forest, the widespread nature of chemical dispersal and the likelihood of killing some native species.

- The weed control to be implemented will require follow-up maintenance to reduce re-infestation.

- The existing moist forest whilst it is subject to weed invasion still supports a high degree of plant biodiversity and therefore will not require a large focus on replanting.

- A combination of weed removal approaches is suggested. That will require the formation of a number of sub-zones (Figure 5), where high levels of weed invasion exist, which can be targeted for removal first and using a reduced poison application scenario.

- As the slopes are steep coir logs will be required to reduce downslope soil movement and erosion, particularly along gully lines.

- A longer term maintenance team will be required, potentially made up from future ecovillage residents to undertake follow-up maintgenance weeding.

- For regeneration purposes, where re-planting is required (eg native grasses), the plan is conditional upon a hothouse-greenhouse facility be established on the property to grow necessary native species for the unwanted paddock areas.

7.6 Restoration procedures

The four most obvious general examples to be addressed at the initial stages of any weeding program for the Narara Ecovillage are the following;

- Assess the section of the lower east facing slopes upslope of the development area which demonstrates past agricultural land use with soil compaction. This area, due to the dense Privet infestation, has compromised natural regeneration potential and will continue to act as a source of further seed spread, particularly by birds. Direct weed treatments will be required for each weed species as well as designing a treatment sequence and determining which areas within the zone will need to be worked first or last (see zone MCF3 on Figure 5).

- Predict and factor in to any weeding program the time required to address the anticipated mass germination of *Ligustum sinsense* Small-leaved Privet seedlings in zones PGF1, PGF2, PGF3, and PGF4 and AF1 on Figure 5. This must involve post primary removal. Removal of the first flushes will be time consuming and a program of work must be created to be specific to these areas.

- All lower gully verges (zones PGF1, PGF2, PGF3 & PGF4 on Figure 5) are likely to be subject to high velocity water flows following heavy rains and therefore these areas will require stabilization techniques. Costs of materials as well as labour and planting support for each must be determined.

- The large area cover of Lantana (zones MCF2 and MCF3 on Figure 5) also functions to support habitat and nesting for fauna, particularly small birds. Any strategy at this location must consider avoiding peak nesting times and implement "best practice" strategies for dismantling the weed biomass such as sectional or mosaic weeding.

Due to multiple site conditions, challenging topography, together with the large area of weed cover a proportion of alluvial flat vegetated areas and the eastern and northern lower moist slopes will need to be worked by skilled and experienced Bushland Regeneration Contractors, particularly in the initial phases of any program. Opportunities for involvement from the local community can be implemented and those working in EEC areas will need to

be licensed through NSWOEH. This work should be strongly supported and factored into any works program with areas or specific target weeding allocated to the community. Supervision will be initially required during the "skilling up period" until confidence is gained to carry out weeding individually.

Known noxious weeds on site will require prioritising with any on ground works however other species warrant careful consideration and a systematic approach to eradication, as they pose a significant threat and if left will recruit into areas disturbed or opened up through weed eradication creating a "worse weed scenario". These species include the highly opportunistic species *Araujia sericifera* Moth Vine, *Andropogon virginicus* Whiskey Grass and *Cirsium vulgare* Spear Thistle. All of these species favouring disturbed ground and have wind born seeds.

Weed species such as *Thunbergia alata,* Black-Eyed Susan, *Acetosa sagittata,* Turkey Rhubarb and *Tradescantia fluminensis* Wandering Jew currently seen only as sporadic incursions along or within the development zone need to be eradicated at the first opportunity to prevent future management problems. These issues are ideally suited to and can in part be actioned by the community. However, the latter species is deeply entrenched within the Closed Forest with emergents: *Livistona australis-Doryphora sassafras-Cryptocarya glaucescens* (Photo 1) but this area will become the responsibility of Gosford City Council.

Given the size of the property, multiple native vegetation assemblages, fauna habitat values and varied topography a minimum of seven years is anticipated to to dictate the degree and extent of works. Multiple vegetation assemblages, fauna habitat values, varied topography, weed species diversity and densities, seed longevity and dynamics of successive germination, and recruitment have been factored into this recommendation. Whilst there will be a need to provide re-vegetation support or assistance to several zones this should be only used where a clear need has been identified or following a suitable period of time if natural regeneration has not been demonstrated. Highly degraded areas such as the degraded freshwater wetland will require an intense focus in this regard.

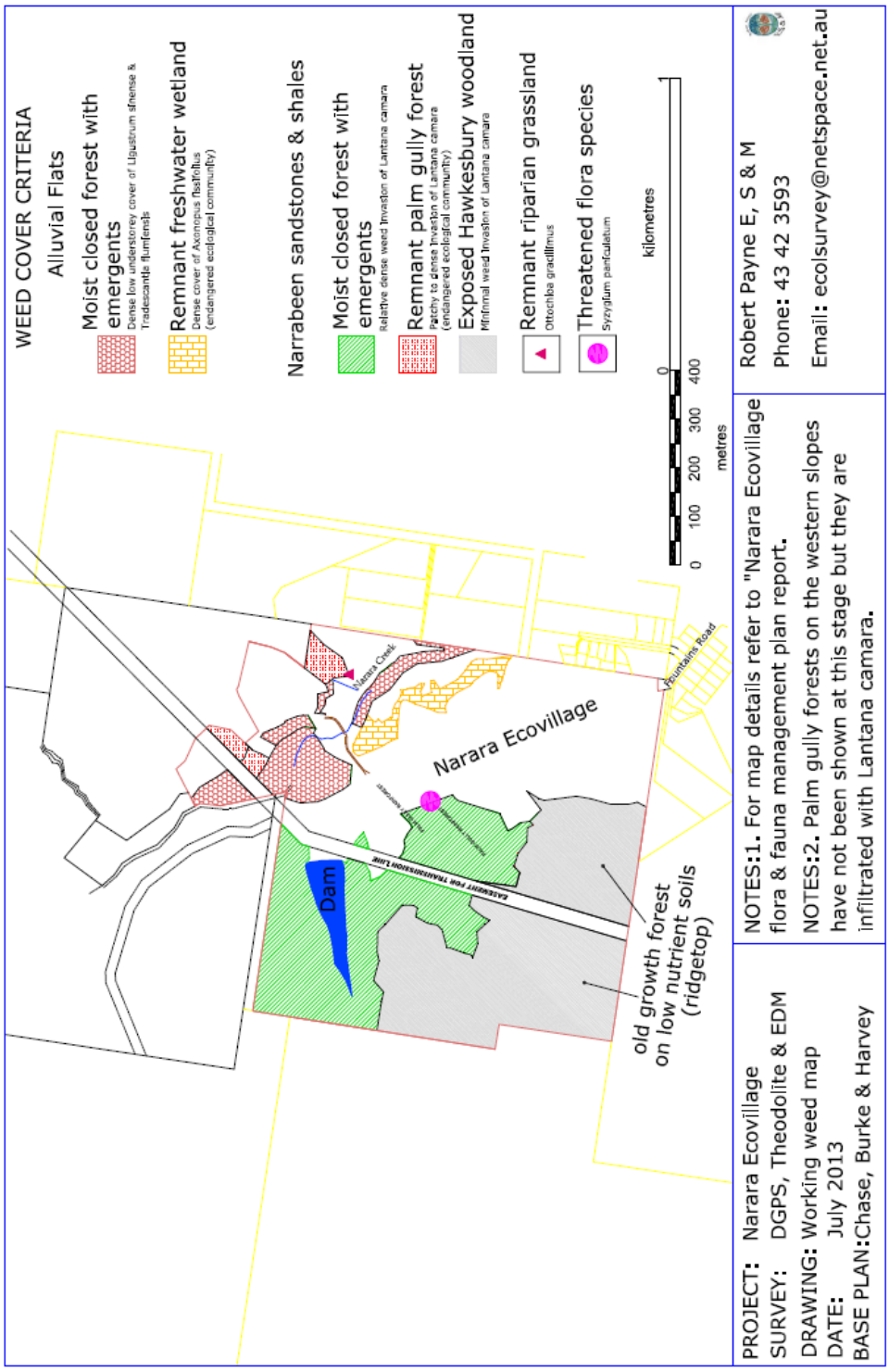

Figure 4 Map showing preliminary weed cover on the Narara Ecovillage property.

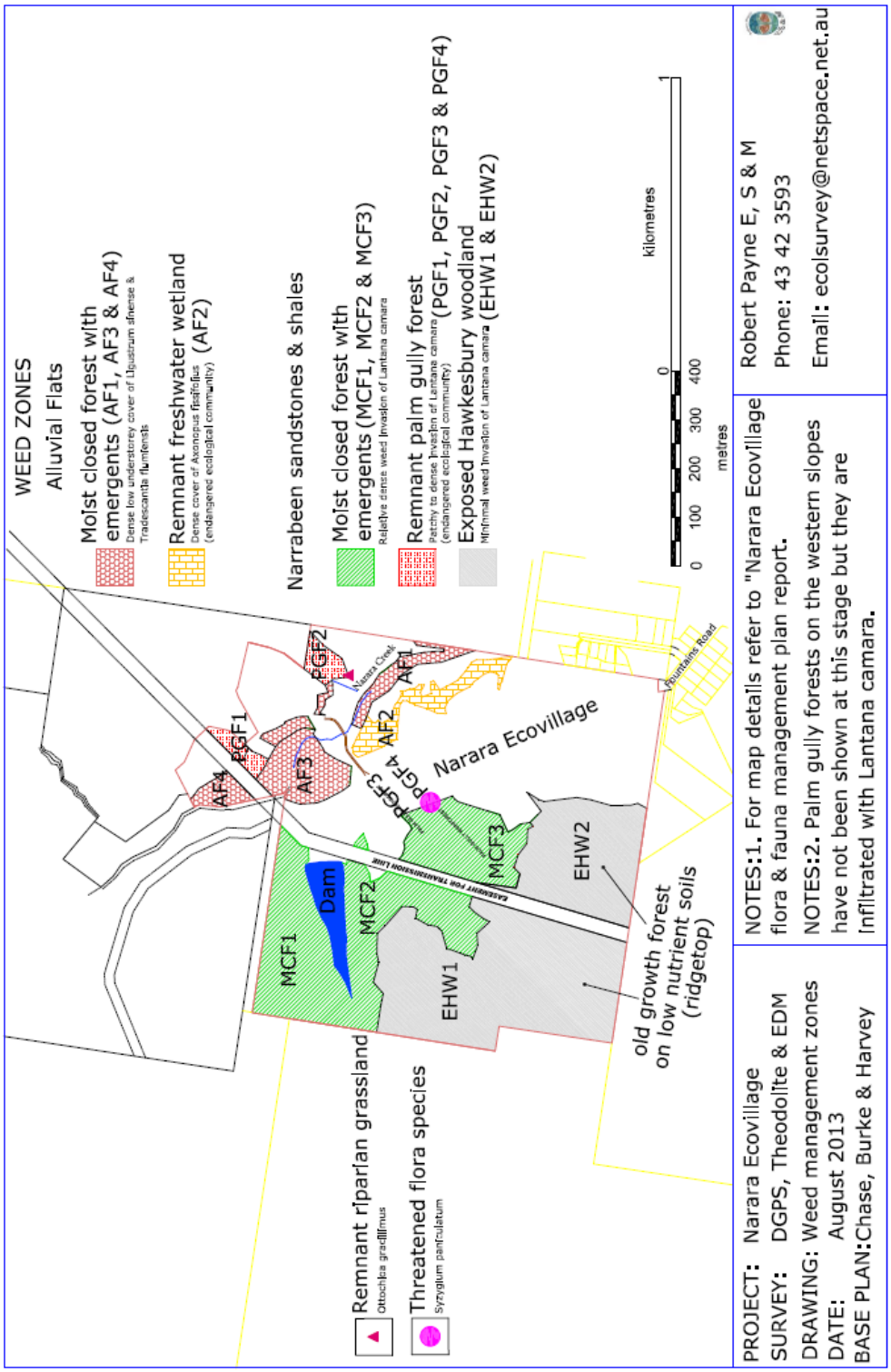

Figure 5 Map showing preliminary weed management zones on the Narara Ecovillage property.

A minimum of seven years should be considered for any broad scale bushland conservation program of the DCP 175 area and will require a carefully staged approach and one that will be ultimately directed by funding to dictate the degree and extent of works. Highly degraded areas such as the freshwater wetland are likely to require a longer time frame and a higher degree of urban runoff planning, although it lies outside of the DCP 175 area.

Prior to commencement of any broad scale weed management activities further assessment will be required to format a realistic onsite plan that is based on current and known best practice bush regeneration principles. As a starting point (Figure 4) mapping of weeds and densities together with areas of high and low resilience and areas requiring vegetation supports needs to be undertaken. This will provide a baseline from which to construct a broader and zone specific weed management plan and allow for costing.

Primary weed eradication particularly for large areas should only be progressed if adequate provisions can be assured for secondary and maintenance regimes to be effectively completed. Site conditions with direct initial response to weed reduction within a percentage of zones likely to require a lengthy primary regime, multiple secondary regimes before progression to maintenance.

7.7 Site specific strategies

Site specific strategies should include;

Edge Management; Planning should include the establishment of a long term protective edge for the DCP 175 boundary where it meets the cleared paddock and/or gully interface through strategic and appropriate native plantings. This will be required where dense woody weed stands will be removed (eg Privet) and require replacement with long lived species that support a dense weed retarding canopy cover. In addition such species will be required where there is no existing edge such as at the lower portion of the gullies on the western side. The "edge" should blend in with the existing vegetation and not have the appearance of a "landscaped row" and this may be achieved through careful selection of species together with placement. Physical barriers may be beneficial in reducing encroachment of weedy ground cover species such as *Tradescantia fluminensis,* Wandering Jew if eradication cannot be assured.

Opportunistic weeds in the development zone: Eradicate opportunistic weeds within the development zone and cleared paddock margins at the first opportunity. Highly opportunistic weed species include *Rubus spp. aggregate* Blackberry, *Araujia sericifera,* Moth Vine*, Acetosa sagittata,* Turkey Rhubarb and *Thunbergia alata,* Black-eyed Susan. The latter two species so far have not been identified to any great extent within the conservation zones. This situation provides an ideal opportunity for the community to begin direct involvement at an on ground level in the restoration of the site. However supervision will be required.

Regeneration Triggers at vegetation edges: Assess opportunities to assist in the germination of native flora species from ground stored seed by spot or pile burning. This strategy is appropriate for lower slopes east of the development boundary where re-establishment of key canopy species such as *Eucalyptus saligna,* Blue Gum is required or desirable (zones MCF2 and MCF3). The method has the added advantage of reducing the amount of weed biomass left on site particularly any cut *Ligustrum sinense,* Small-leaved Privet that has a relatively long breakdown time.

Weedy grass management on eastern slope (MCF3 under powerlines): Initially manage the weedy grass sections on the lower east facing slopes at vegetation edges with a high slash regime to reduce opportunities for recruitment of weed seed into adjacent areas that have been opened up and disturbed through weeding. A low slash regime is likely to promote conditions for growth of opportunistic annuals such as *Senecio madagascariensis* Fire Weed and *Cirsium vulgare* Spear Thistle. Incrementally, select spot spraying of tufted regrowth of species such as *Paspalum dilatatum* Caterpillar Grass and *Chloris gayana* Rhodes Grass together with sectional spraying of the *Pennisetum clandestinum* Kikuyu. This zone is likely to be highly labour intensive to manage, has been significantly disturbed and has a revegetation height restriction due to the power line easement. This area is suited to a "seeding containment approach" whilst other sections are managed. This action is applicable to all paddock zones and the development area.

Opportunistic native vine growth at vegetation edges: The pioneer *Kennedia rubicunda* Dusky Coral Pea and *Cissus antactica* and *C. hypoglauca* Native Grapes have potential to compromise the survival of naturally regenerating key canopy species particularly in the young seedling stages at edges. Containment of vine growth in such areas may be warranted. The vines do not need to be removed entirely but rather cut back until such times as the sapling has reached a sufficient height. This strategy is applicable to the lower to mid east facing slopes in zones MCF2 & MCF3.

Paddock management on the western slope: Investigate options to reduce potential for recruitment of weed seed from cleared paddocks into adjacent areas opened up and disturbed through weeding regimes. This action is particularly relevant to species with wind born seeds such as *Andropogon virginicus,* Whiskey Grass and *Cirsium vulgare,* Spear Thistle both favouring disturbed ground conditions. Strategies may include high slashing in paddock areas where the Whiskey Grass is prominant. Low slashing is likely to promote conditions for higher weed infiltrations particularly annuals. This is particularly relevant to reduce weed seed recruitment on the down slope highly degraded lower portion of the gullies on the eastern slope.

Natural regeneration of the DCP 175 land: Secondary to best practice weed management, a large percentage of the vegetated area in zones MCF1 and MCF2 will eventually return to its original or near natural condition and will not require any re-vegetation assistance. However, the area will require weed removal especially of Lantana. High weed areas, due to prior land impacts or steep gradients will, depending on site conditions, require focused levels of support. A combination of practices such as planting, seed dispersal and transplantation should be utilised but only in areas where a clear and demonstrated need has been identified. For example bare steep gully verges suited to transplantation of ground covers to assist in stabilisation.

Community participation**:** Promote and foster community participation, where it is possible. At realistic levels, through involvement in a variety of activities, the ecovillage community will be invaluable in the restoration and rehabilitation of the bushland and to provide for its long term care and management. Zones, areas or activities should be assessed and delegated to those having current skills, physical ability and available time commitment. Expansion of roles can occur as confidence and experience is gained. The engagement by the community of a highly skilled and experienced Bush Regeneration Contractor should be considered to assist in these processes and provide on ground supervision.

On-site nursery: With the current infrastructure there are opportunities for the establishment of a community onsite nursery which can be used for native plant

propagation. The existing facility has suitable space to enable ease of establishment and management at community levels. The focus should be on growing plants for edge and other areas requiring rehabilitation support. This will also provide the opportunity for increased participation and involvement together with being extremely cost effective. Additional benefits include stock is on hand in quantities per species to suit each of the zone's needs, availability at optimum seasonal planting times and local provenance can also be assured.

On site native grass seed orchard: Direct seeding has been proven to assist in rehabilitation and revegetation with many grass and sedge species suited to this strategy. As the propagation nursery infrastructure is in place for the establishment of a designated seed collection allotment. Essentially these are linear raised garden beds mass planted or seeded with provenance material with the seed then harvested on readiness, stored for use when required or directly dispersed. Benefits include; bypassing the need to collect from the conservation area and higher volumes of target species seed available with ease of collection. Seed is also at hand to disperse under optimal conditions for example; prior to rain with a higher lodgement of seed in the ground then occurring, reduction in predation rates, particularly from ants. Suitable species are *Microlaena stipoides,* Weeping Meadow Grass, *Cymbopogon refractus,* Barb-wire grass and *Carex appressa,* tussock sedge.

The orchard may also support propagation of other ground covers, grasses and ferns for transplantation use. Suitable species include *Viola hederacea* Native Violet, *Dichondra repens,* Kidney Weed and *Oplismenus imbecillis,* Basket Grass.

Cumbungi in the Freshwater Wetland: Whilst Cumbungi is a cosmopolitan species (Payne, 2001), in certain sensitive low-lying areas, the mass of stiff hard culms can give rise to enhanced flooding of private property. However in this case, it is recommended, that the Cumbungi be contained at its present limit to the drain because it supports the Black Bittern. The Cumbungi is also very gregarious and also has the ability of displacing other wetland communities and therefore the species should not be allowed to spread onto the grassland area within the Freshwater Wetland.

Water Couch restoration: Planting of *Paspalum distichum* should only require translocation of the existing grass or raising plants from seed and runners and planting it at the rate of one plant per m^2 elsewhere in the freshwater wetland.

Fruit Pigeons: At present *Cinnamomum camphora,* Camphor Laurel is present on the property. Some are large trees and would be sought after by flocks of Top-knot and other Pigeons and should be removed gradually. To implement a scenario for future native plants for fruit pigeons in the area cuttings and seed should be collected from *Elaeocarpus obovatus,* Hard Quandong and *Elaeocarpus reticulatus,* Blueberry Ash, located in the area and plants are grown into trees to provide a substitute food resource. Only after the planted trees reach maturity should all the mature Camphor Laurels be removed.

Both of these species can be grown from cuttings (Jones, 1986). Furthermore water bowls can be placed beneath the two native tree species. As birds feed on the fruit and then drink from the water bowls they pass the seeds and deposit them into the bowls. The seed is collected and a better germination success rate is achieved if the fruits are soaked for three to four months.

Other trees that should be considered for the same purpose are *Elaeodendron australe,* Red Olive Berry and *Pittosporum multiflorum,* Orange Thorn and both species can be grown from

fresh seed. With *Acronychia oblongifolia* the Common Acronychia a better success rate of re-establishment is achieved by cuttings (Jones, 1986).

The European Fox and the European Rabbit

The European Fox is present and to reduce the impact on the waterbird population a 1080 fox baiting program should be implemented, in consultation with the Authorities, until this impact is minimised.

Rabbits are present near the access road that leads into the property. Their eradication is required and further updated advice should be sought from the NSW Department of Primary Industries. Baiting carrots with 1080 also is a preferred method but the use of Pindone, Myxamatosis, Rabbit Calcivirus Disease (RCD) are also other preferred methods.

Both the European Fox and the European Rabbit are listed as key threatening processes under the *TSC Act, 1995.*

8 SPECIFIC WEED REMOVAL

Appendix 4 sets out in tabular form methods to remove the general weeds but the more difficult weeds are discussed below.

8.1 Noxious weeds

Rubus spp. aggregate Blackberry and *Acetosa sagittata,* Turkey Rhubarb are present and *Xanthium spp.* Burrs and *Ageratina adenophora* Crofton Weed are likely to be found. The following methods to eradicate these weeds are recommended.

Blackberry: *Rubus spp. aggregate* Blackberry is found as sporadic infestations. The control manual (NSW Department of Primary Industries Weed Management Unit, 2009) initially recommends mapping the infestation in the first instance and from this, establishing priority areas for treatment. Once mapping is completed the area is divided up into long term and short term goals. After treatment each area is re-assessed and further treatment undertaken that is considered necessary.

There are a range of options available to control this plant but herbicides appear to be the most effective. Foliar sprays and scrape and paint can achieve the desired results. Only herbicides registered for the control of Blackberry should be used and bush regenerators applying these herbicides should have the minimum industry standard of training. It is recommended that the use of Garlon on this property be prohibited due to the presence of groundwater saturated soils and its ability to move along waterways. It is also not suitable for use by untrained volunteers. In lieu of this the use of Roundup "bioactive" and spraying should be undertaken between flowering and fruit set with multiple follow up treatments. Foliar spraying should include upper and lower leaf surfaces to obtain a better affect.

Following dieback of the Blackberry, the area should be followed up by rehabilitation and revegetation using appropriate plant species recorded in the relevant vegetation community.

Burrs: The control of Bathurst Burr, Californian Burr, Cockle Burr and Noogoora Burr are referred to as simply *Xanthium spp.* in this document. All are class 4 noxious weeds although no infestations have been noted at this stage. Under the *Noxious Weeds Act, 1993,* the Narara Ecovillage must remove this weed if it is found. If this weed is found it is

recommended this weed be removed manually, bagged and deposited in an authorized landfill site.

Crofton Weed: *Ageratina adenohora.* Crofton Weed may be present along the drainage lines and is a class 4 noxious weed in the Gosford LGA. The weed is a low erect perennial comprising many stems arising from an underground crown.

The plants can also be removed manually, bagged and disposed of. However, the crowns must be dug out. If larger infestations are found and this is likely, slashing with a whipper snipper should be considered to reduce flowering and seed set. If so, the plants will need to be slashed, allowed to re-grow and only after that, sprayed with the recommended herbicide. Consideration with regards to the chemical and method is important given the presence of waterways.

Turkey Rhubarb: A non-woody vine with arrowhead shaped leaves, mature seed capsules are winged with a light papery texture enabling wind borne spread. The plant grows readily from seed and from an extensive rhizomatous underground tuber system, quickly colonising en-mass into newly disturbed areas. This species has often created a "worse weed scenario" when sufficient resources have not been in place. The use of herbicide for the management of this weed within the conservation areas is not appropriate given sensitivity of the bushland areas. As the species has not been identified to any great extent through field surveys undertaken for this report manual methods are recommended. This may warrant primary target eradication programs to be in place for each zone affected with control assured before commencing restoration activities that disturb or open up adjacent bushland areas. In all situations careful assessment will need to be in place to initiate and steer effective weed control with the ultimate goal of eradication.

If present removal of mature papery seed clusters to reduce area seed load is best actioned following rain or in the early morning when seeds are damp and less likely to dislodge from the inflorescence during the process. If digging out of all underground tubers is attempted, caution is required if infestation is within an area prone to erosion such as a riparian edge or steep embankment. Methodical manual removal of small regrowth seedlings is required before deeper tuber formation has developed. Seed requires removal from site and if possible tubers.

8.2 Weeds of national significance (refer to Appendix 3)

Weeds of national significance (WONS) that are not listed as noxious and are present at the Narara Ecovillage are *Lantana camara* Lantana, *Asparagus aethiopicus* Asparagus, *Senecio madagascariensis* Fireweed and perhaps *Anredera cordifolia* Madiera Vine. Methods to eradicate these species are detailed hereunder.

Lantana: Lantana infestations are prominent in zones MCF1 and MCF2. Lantana thrives along watercourses and in moist soils. Mechanical control by cutting stems and following that up with cut and paint is likely to achieve the desired results. In this way the root system remains in the ground and any stream banks do not become destabilized. Herbicides can be used at these locations, but with respect to watercourses only those products registered to be used near water should be used. Furthermore, if chemical control methods are to be used, compliance with the law and environmental safety is important. Strict use of the herbicide label should be complied with.

If herbicide is to be used, it should not be applied to stressed plants caused by cold and drought. It is advisable to apply herbicide under conditions of readily available soil moisture,

but not during rain or prediction of any rain. Windy conditions should also be avoided and so should temperatures above 35°C.

Asparagus Fern: At the Narara Ecovillage the Asparagus Weed is *Asparagus aethiopicus*, but it is uncommonly distributed throughout the property. The weed is a perennial climber often seen in low-lying saline wetlands. It has the ability to clothe trees, understorey shrubs and undershrubs. The roots are fibrous forming dense mats, which causes competition with native plant species. The species is spread by native birds feeding on ripened fruit and through transported soil which has been contaminated with the rhizomes and fruit.

As the infestation by this species is not significant it is recommended mechanical removal be the preferred method used. This is achieved with a sharp knife cutting out the crowns which are extracted and disposed of. This is a time consuming method however, but the low rate of infestation warrants this safe method.

A herbicide treatment is available, but given the extensive nature of the wetlands and streams, together with the low rate of infestation, it is recommended this method not be used.

Fireweed: Fireweed has been added to the WONS list because of its invasiveness and threats to the grazing industry, the environment and the fact that it contributes to socio-economic costs (Australian Weeds Committee, 2012a). However, the species is not listed separately as a noxious weed for the local government area of Gosford. This weed has been recorded to have spread throughout all of coastal New South Wales and now into Gippsland in Victoria, the Atherton Tablelands in Queensland and the northern and southern tablelands of New South Wales. It grows on most soil types where it seeds prolifically and grows to a mature state quickly. Seeds are small and they can germinate immediately after dispersal. Due to its rapid growth it is very difficult to control. The management plan to control the species is complicated and recommends firstly, preventative measures against the plant re-establishing, together with strategic management of existing populations and an increased capacity and willingness of stock managers to control the species.

The management plan suggests actions to prevent its further spread, but as yet there is no definitive approach to completely eradicate the species. Nevertheless it is recommended hand weeding is appropriate with small infestations but gloves should be used as a preventative measure against exposure to plant alkaloids. Due to this, plants dug out should be bagged and destroyed immediately.

Madiera Vine: Madiera Vine is likely to occur at the Narara Ecovillage and should be easily controlled. The draft strategic plan (Australian Weeds Committee, 2012b) states that prevention and early detection are the key elements of controlling this species.

Madiera Vine is an aggressive canopy climber reproducing by asexual tubers formed on the roots and stems or by vegetative spread of a section of severed vine. Prolific numbers of aerial tubers can be produced throughout the year which can then drop to the ground and reproduce. The species then has the ability to outcompete native climbers and has now become naturalized in all States of Australia.

Control of the species must involve exhaustion of the tubers with a long term plan of follow up treatment. Treatment can include release of the leaf feeding beatle, *Plectonychna*

cornentina which will reduce the photosynthetic capacity of the vines and thus deplete tuber reserves.

The strategic plan only recommends physical control for small infestations. If physical removal is attempted all tubers and vegetative material must be disposed of properly by mulching at areas away from the vegetation or the material can be double bagged and disposed of at a landfill site.

It is recommended, the vines not be cut or pulled from the canopy because it results in other viable tubers dropping to the ground. If this method is used it is recommended tarpaulens be set up to trap falling tubers.

Herbicides can also be effective if the spray and scrape and paint methods are used. The best results are achieved in spring and summer and sometimes in late winter. Floroxypyr and Picloram Gel are the registered herbicides for Madiera Vine in Australia, but Glyphosate, Metsulphuron-Methyl and Tricolpyr and Picloram are used for minor infestations.

Glyphosate is highly recommended using the scrape and paint or cut stump method. Glyphosate is applied at a ratio of 1:1.5 mixed with water and 1.5g/l of metsulphuron-methyl can be added to the mixture to increase the effects on aerial tubers.

8.3 Other problematic weeds

There are differing treatment requirements across different species and at different stages of a plant's life cycle with position in the landscape also a deciding factor for selecting options. Management pathways also need to be sequenced accordingly to high seed volumes being produced from mature stands, anticipation of and action high seedling germination on opening up of areas through weed removal, eradication of high density small plants (some in a state of suppressed growth) and retention of creek bank stability. All this needs to be undertaken in consideration of the plants role as a food source for native fauna. Many, if not all of these, apply to all weed species.

The Department of Primary Industries Noxious & Environmental Weed Control Handbook 5th Edition (2011) (free download) provides detailed information on herbicides this includes: selection, dilutions, mixing, storage, safety, surfactants, method of treatment including restrictions on use and Legislative requirements. Restoring Natural Areas in Australia by Robin Buchanan 2009 provides a comprehensive overview of bushland values, plants, specific vegetation community needs, weeds, regeneration techniques and other all relevant to effective bushland management.

Small-leaved Privet: The Small-leaved Privet *Ligustrum sinense* is a serious weed of watercourses in certain areas of the Central Coast of New South Wales. In ideal situations, such as alluvial flats, it can form dense stands that become inpenetrable and such is the case along Narara Creek on the floodplain.

Small-leaf Privet is a densely branched woody shrub 2- 5 meters high belonging to the Olive family. Favouring creeks, gullies, drainage lines and disturbed soils a mature plant growing in optimal conditions is capable of producing on average 1,300 fruits per square meter of canopy. Each fruit contains two seeds and if growing in a shaded position fruit production can be up to half of that in a sunny position. Fruit matures over June, July and August and either drops to the ground or is eaten by both native and introduced bird species which spread the seed widely as regurgitated droppings. The latter often gives rise to consolidated

satellite colonies away from major infestations. If the infestation is large and long standing native bird species both permanent and seasonal feeders will have become heavily reliant of the Privet as a food source. The seed will also disperse along waterways or into riparian edges at times of flooding.

Germinated seedlings under low light conditions have the ability to remain in a state of suppressed growth often outnumbering native species by a ratio of several hundred to one and can rapidly accelerate their growth if light is made available through actions such as weed clearing. The ideal temperature for mature seed germination is 15° C with very poor germination under 10° C and over 20° C with seed requiring a shallow cover of soil for this to occur. Fortunately, the Small-leaf Privet seed has a relatively short term period of viability (6 months) with a very poor germination capability after 1 year. These factors are critical in steering successful management approaches as infestations are large and long standing in many sections of the Narara site which includes the riparian zone, lower portions of the gullies and degraded east facing slopes abutting the development edge. Additionally the riparian zone in sections is in part reliant on Privet for creek bank stabilisation.

Many small young seedlings or juveniles (stem up to 2cm) may be easily pulled from the ground with this best undertaken following rain when the soils are soft with the least soil resistance. Personal injuries may occur if an attempt is made to pull out a defiant plant. All roots must be removed as they have the potential to sucker.

For drainage re-entrants or steep verges, an assessment is required to ascertain whether this technique is appropriate given possible erosion potential. Additionally, these areas may contain over 100 seedlings per square meter and if in a suppressed growth state, the roots maybe deeply entrenched making manual removal difficult.

Many more seedlings are likely to germinate if the area is one which has dense infestation of viable seed in the ground and has been dropped within the previous six month period.

Larger juveniles will require cutting and painting at the base with a suitable herbicide such as Glyphosate 360g/L undiluted (Round-up Biactive). Foliar (leaf) spraying of high density small growth plants with diluted herbicide may be undertaken however plants must be in an active growth state and this is may not be suited if native vegetation is present or the area is adjacent to a waterway or within a wetland environment. Dilution rates per herbicide brand need to be referenced and adhered to. Surfactants may be included in the diluted spray solution to provide the herbicide with a closer contact with the leaf surface, thereby increasing uptake into the plant. Surfactants may be either wetting or sticking agents or emulsifiers.

Stem injection is used if the Privet tree is large and is to be left in situ in an upright position but this method requires direct application of herbicide into sapwood. In this case the softer outer layer of the trunk will transport the herbicide around the plant. Angled cuts are chiselled or drilled into the base of the trunk and immediately filled with herbicide. The number of cuts required is dependent on the size of the trunk. For example a trunk diameter of 10cm requires two evenly spaced cuts or a 20cm trunk diameter requires 5 cuts and so on with the cuts made below the first branching. Privets also have the ability to be multi-stemmed and if this is present all trunks need to be treated.

Treatment needs to be in the active growing stage when the uptake of herbicide is maximised and plants not stressed through drought, cold or frost, factors which will reduce the uptake of herbicide. Treating the mature plant prior to any early fruit formation is also a

consideration as the situation may eventuate with having to deal with additional seedlings underneath the parent plant. Glyphosate 360g/L (Roundup Biactive) undiluted may be used for the stem injection method.

If the Privet requires felling and or removal from the site the trunk needs to be cut low at the base and undiluted herbicide immediately applied. This may apply to situations such as the plant or stands being adjacent to a road or pathway, within close proximity to a dwelling or the density is such that culling is required to open up the area and enhance opportunities for natural regeneration of taller native plants to occur.

Camphor Laurel: *Cinnamomum camphora* Camphor Laurel is present as large trees and furthmore will require a similar treatment to Privet. However the cut and paint method with smaller Camphor Laurels will result in the plant re-shooting as they have a different response. Stem scrape and herbicide paint along the length of the stem is required to kill Camphor Laurel.

Mickey Mouse Plant and Moth Vine: The scrape and paint method also applies to *Ochna serrulata* Mickey Mouse Plant and weedy vine species such as *Araujia sericifera* Moth Vine both identified within the conservation and development area.

The tools required for stem injection includes a large sharp chisel and a rubber mallet. Use of a metal hammer is not recommended because it creates significant jarring. Cut and paint requires sharp secateurs or a hand saw with scrape and paint requiring a sharp knife.

9.0 DISCUSSION

The mapping (Figure 2) and section 2.0 shows that only two out of the six vegetation communities are likely to come under the classification as being endangered. These two vegetation types are therefore protected under state legislation according to the Lowland Rainforest and Freshwater Wetland EEC's. Together with the fact that seven threatened fauna species have now been recorded on the property now places it in the high conservation value class and in particular supports a very good quality forest of Sydney Blue Gum.

One of the most important features of the vegetation on this property is the remnant riparian grassland and the remnant flooplain freshwater wetland. Although they are presently in a remnant state their presence adds a further dimension of habitat diversity to the property. Riparian and floodplain grasslands are relatively unknown on the Central Coast. Some effort, therefore, together with the potential nursery facilities, should focus on the embellishment of these grasslands communities. The project would require the collection of seed, raising seedlings, establishing grasses and most importantly of all, overcoming competition from Kikuyu and Narrow-leaved Carpet Grass.

There have been no mention of these grassland vegetation communities, comprising grasslands, in the previous LGA and regional surveys (see Payne & Duncan, 1999; Bell, 2011; Keith & Scott, 2005) although a one grassland community of *Paspalum distichum* with *Elaeocharis sphacelata* is identified in the regional survey for the lower Hunter & Central Coast (Somerville, 2009). Information on coastal floodplain grasslands is poorly known and poorly documented because they have now mostly disappeared. The Narara Ecovillage and the Pioneer Dairy have a unique opportunity to promote the conservation and further expansion of these native grasslands, which have been obviously been lost to

previous grazing activities based on studies elsewhere (see Clarke, 2003; Lewis, et. al., 2009; Eldridge & Lunt, 2010).

The property also supports at least six threatened flora and fauna species. There is now a responsibility of the Narara Ecovillage to maintain the habitat of these species, especially the land covered under DCP 175, in good order and condition so that these species can perpetuate. In order to accomplish this task the relevant ultimate managers will be required to manage the condition of the forests that make up the wildlife corridor on the western slope. This is seen as a large scale management issue. To undertake this task, fencing, plant propagation and weed removal will need to be implemented and further funding will be required for these purposes. These management tasks will need to compliment the proposed urban development.

For the next stage of management (Figure 5), the focus should be on weeding the DCP 175 area and some effort should be employed to restore the floodplain wetlands and riparian grasslands (see Figure 2). Management should also be directed towards removing the introduced Narrow-leaved Carpet Grass to allow riparian grasses to expand within the 10m riparian buffer required by the NSW Department of Water (see Table 2). Ideally removal of the extensive tracts of Lantana, growing on the slopes has the potential to be successful because the Lantana is easily accessible, easily seen and easily treated, although progress is expected to be slow.

The conservation of *Syzygium paniculatum* is also seen as very important because the single tree of this species onsite represents a suite of tiny sub-populations that make up the regional population. Given the restricted range distribution of this species and paucity of large populations and it is important that the tree and buffer area be given a high priority with respect to management.

Weeds listed on the *Noxious Weeds Act, 1993*, and those listed as "Weeds of National Significance" have been identified and included outlining the recommended eradication and management procedures. This suite of weeds does not occur as major infestations on the property and some are listed as being likely to occur. Weed species that are not shown on these lists, such as *Ligustrum sinense* Small-leaved Privet, are more troublesome and pose the greatest threat to riparian and wetland habitats as what can be seen along Narara Creek. Privet has established itself along almost the entire length of Narara Creek as a dense thicket behind the levee bank and shows signs of becoming problematic to control.

This management plan identified the main cause of concern is weed eradication and as this is implemented, there is potential to re-introduce the lost native tree and grass species.

According to the requirements of DCP 175 certain environmental protection parameters need to be implemented accordingly. All of those requirements have now been addressed except that only one Magenta Lilly Pilly could be found of the two mentioned in previous reports. Despite a thorough search along the drainage line beside the transmission line no tree of *Syzygium paniculatum* could be located at that location. The Yellow-bellied Glider sap site tree is within the land transferred to Strickland State Forest.

10.0 CONCLUSIONS AND RECOMMENDATIONS

This updated survey for the Narara Ecovillage has involved mapping of the vegetation remnants and the survey of a number of increased quadrats to initially improve the base flora and fauna data for the property. At this stage six vegetation communities have been identified along with seven threatened species.

The focus of the Ecological Restoration Plan mainly addresses both embellishment of the DCP 175 area and the eradication of weeds, particularly any noxious weeds or weeds of national significance. Lantana, Small-leaved Privet, Blackberry, Whiskey Grass, Turkey Rhubarb, Black-eyed Susan and Fireweed are seen as the main weeds of concern and are in need of more urgent eradication. In particular, the management of Fireweed also is seen as very important because there are alkaloids contained within this plant and it doesn't take long before the plant increases into large populations.

The management plan addresses the restoration of the DCP area as well as the floodplain environment which ultimately will lie outside the Narara Ecovillage jurisdiction. This abides by the recommendation of DCP 175 and includes a prescriptive framework for the management of known threatened species habitat; weed management, potential impacts associated with the sub-division and ongoing management. Management matters include replacement tree planting for Camphor Laurel, threatened plant species management, feral animal control, removal of weeds, and ecological restoration of floodplain wetlands and riparian grasslands. Whatever re-planting and weeding controls are implemented for this project the control of Narrow-leaved Carpet Grass and Fireweed will be ever present. The following main recommendations are suggested (refer to Appendix 5). Those management actions that apply to the stage 1 development application have been shown separately.

Stage 1 Development Application Requirements (see Appendix 5 for summary)

Management of threatened species;

- Provide for a 20m buffer zone around the known location of *Syzygium paniculatum*.
- Install only low level lighting against the forest edge and the dam because of the presence of threatened fauna species but should be consistent with human safety (see sections 5.0 and 6.3).

Management of impacts associated with the sub-division;

- Regenerate the native riparian grassland alongside drainage lines within the 10m riparian buffer zone, where required by the *NSW Department of Water* (see section 6.1).
- Take steps, through discussions with Government Authorities, to eradicate the European Fox, the European Rabbit and Feral Cat (see section 7.7).
- If in the event an Aboriginal relic is found during work procedures the location and detail is to be reported to NSW OEH (see section 6.2).

Weed management;

- Eradicate the Small-leaved Privet from all relevant drainage lines and paddock areas (see section 8.3)

- Set up a nursery facility to propogate plants for onsite restoration.
- Remove all noxious weeds that apply to the stage 1 area as listed in Section 8.1.
- Remove all weeds of national significance that apply to the stage 1 area as listed in Section 8.2.

Ongoing Management Requirements

Management of endangered ecological communities;

- Remove the paddock grasses and weeds in the floodplain freshwater wetland (see sections 7.1-7.7) and maintain the present mowing regime (section 5.0).
- Restrict the Cumbungi to the drain in the floodplain freshwater wetland (see section 7.7).

Weed management;

- Control the Fireweed and Whiskey Grass within the existing paddock areas (see sections 7.6, 7.7 and 8.2).
- Eradicate all the Camphor Laurels from the property but not at the same time. Replace these trees with *Elaeocarpus reticulatus* Blueberry Ash and *Cryptocarya obovatus* Hard Quandong (see section 7.7).
- Remove all problematic weeds set out in Section 8.3.
- Drainage lines in the slopes and the freshwater wetland on the alluvial flats are probably examples of endangered ecological communities and all personnel working in these habitats will need to be licensed by NSWOEH.
- Set up a Landcare Group through Gosford City Council to manage weeds on the site.

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APPENDIX 1 – PLANT SPECIES LIST

Family	Latin Name
Escalloniaceae	*Abrophyllum ornans*
Fabaceae (Mimosoideae)	*Acacia buxifolia subsp. buxifolia*
Fabaceae (Mimosoideae)	*Acacia decurrens*
Fabaceae (Mimosoideae)	*Acacia floribunda*
Fabaceae (Mimosoideae)	*Acacia irrorata subsp. irrorata*
Fabaceae (Mimosoideae)	*Acacia linifolia*
Fabaceae (Mimosoideae)	*Acacia longifolia subsp. longifolia*
Fabaceae (Mimosoideae)	*Acacia maidenii*
Fabaceae (Mimosoideae)	*Acacia prominens*
Fabaceae (Mimosoideae)	*Acacia ulicifolia*
Polygonaceae	*Acetosa sagittata*
Myrtaceae	*Acmena smithii*
Epacridaceae	*Acrotriche divaricata*
Adiantaceae	*Adiantum hispidulum*
Asteraceae	*Ageratina adenophora*
Sapindaceae	*Alectryon subcinereus*
Casuarinaceae	*Allocasuarina littoralis*
Casuarinaceae	*Allocasuarina torulosa*
Rhamnaceae	*Alphitonia excelsa*
Myrtaceae	*Angophora costata*
Myrtaceae	*Angophora floribunda*
Fabaceae (Faboideae)	*Aotus ericoides*
Cunoniaceae	*Aphanopetalum resinosum*
Araucariaceae	*Araucaria heterophylla*
Asclepiadaceae	*Araujia sericifera*
Arecaceae	*Archontophoenix cunninghamiana*
Asparagaceae	*Asparagus aethiopicus*
Aspleniaceae	*Asplenium attenuatum*
Aspleniaceae	*Asplenium australasicum forma australasicum*
Aspleniaceae	*Asplenium flabellifolium*
Poaceae	*Axonopus fissifolius*
Proteaceae	*Banksia cunninghamii*
Proteaceae	*Banksia serrata*
Asteraceae	*Bidens pilosa*
Pittosporaceae	*Billardiera scandens*
Blechnaceae	*Blechnum cartilagineum*
Blechnaceae	*Blechnum wattsii*
Euphorbiaceae	*Breynia oblongifolia*
Poaceae	*Briza minor*
Pittosporaceae	*Bursaria longisepala*
Cunoniaceae	*Caldcluvia paniculosa*

Family	Latin Name
Cunoniaceae	*Callicoma serratifolia*
Myrtaceae	*Callistemon shiressii*
Dicksoniaceae	*Calochlaena dubia*
Rubiaceae	*Canthium coprosmoides*
Cyperaceae	*Carex appressa*
Cyperaceae	*Carex maculata*
Cyperaceae	*Carex spp.*
Vitaceae	*Cayratia clematidea*
Araliaceae	*Cephalaralia cephalobotrys*
Cunoniaceae	*Ceratopetalum apetalum*
Orchidaceae	*Chiloglottis spp.*
Poaceae	*Chloris gayana*
Thelypteridaceae	*Christella dentata*
Lauraceae	*Cinnamomum camphora*
Vitaceae	*Cissus antarctica*
Vitaceae	*Cissus hypoglauca*
Euphorbiaceae	*Claoxylon australe*
Ranunculaceae	*Clematis aristata*
Ranunculaceae	*Clematis spp.*
Verbenaceae	*Clerodendrum tomentosum*
Commelinaceae	*Commelina cyanea*
Sterculiaceae	*Commersonia fraseri*
Proteaceae	*Conospermum longifolium*
Asteraceae	*Conyza bonariensis*
Asteraceae	*Coreopsis lanceolata*
Rutaceae	*Correa reflexa*
Myrtaceae	*Corymbia gummifera*
Lauraceae	*Cryptocarya glaucescens*
Lauraceae	*Cryptocarya microneura*
Cyatheaceae	*Cyathea australis*
Cyatheaceae	*Cyathea leichhardtiana*
Poaceae	*Cynodon dactylon*
Cyperaceae	*Cyperus imbecillis*
Cyperaceae	*Cyperus spp.*
Dennstaedtiaceae	*Dennstaedtia davallioides*
Fabaceae (Faboideae)	*Desmodium varians*
Phormiaceae	*Dianella caerulea*
Phormiaceae	*Dianella caerulea var. producta*
Poaceae	*Digitaria parviflora*
Dioscoreaceae	*Dioscorea transversa*
Ebenaceae	*Diospyros australis*
Sapindaceae	*Diploglottis cunninghamii*
Blechnaceae	*Doodia aspera*

Family	Latin Name
Monimiaceae	*Doryphora sassafras*
Poaceae	*Echinopogon spp.*
Poaceae	*Ehrharta erecta*
Elaeocarpaceae	*Elaeocarpus reticulatus*
Celastraceae	*Elaeodendron australe*
Myrsinaceae	*Embelia australiana*
Lauraceae	*Endiandra discolor*
Poaceae	*Entolasia marginata*
Poaceae	*Entolasia stricta*
Myrtaceae	*Eucalyptus acmenoides*
Myrtaceae	*Eucalyptus agglomerata*
Myrtaceae	*Eucalyptus costata*
Myrtaceae	*Eucalyptus grandis*
Myrtaceae	*Eucalyptus paniculata*
Myrtaceae	*Eucalyptus piperita*
Myrtaceae	*Eucalyptus saligna*
Myrtaceae	*Eucalyptus scias*
Myrtaceae	*Eucalyptus siderophloia*
Myrtaceae	*Eucalyptus umbra*
Eupomatiaceae	*Eupomatia laurina*
Luzuriagaceae	*Eustrephus latifolius*
Santalaceae	*Exocarpos cupressiformis*
Moraceae	*Ficus coronata*
Moraceae	*Ficus rubiginosa*
Cyperaceae	*Gahnia aspera*
Cyperaceae	*Gahnia melanocarpa*
Luzuriagaceae	*Geitonoplesium cymosum*
Geraniaceae	*Geranium homeanum*
Euphorbiaceae	*Glochidion ferdinandi*
Fabaceae (Faboideae)	*Glycine spp.*
Fabaceae (Faboideae)	*Glycine tabacina*
Verbenaceae	*Gmelina leichhardtii*
Fabaceae (Faboideae)	*Gompholobium huegelii*
Grammitaceae	*Grammitis billardierei*
Proteaceae	*Grevillea buxifolia*
Sapindaceae	*Guioa semiglauca*
Araceae	*Gymnostachys anceps*
Zingiberaceae	*Hedychium gardnerianum*
Dilleniaceae	*Hibbertia dentata*
Dilleniaceae	*Hibbertia obtusifolia*
Dilleniaceae	*Hibbertia scandens*
Euphorbiaceae	*Homalanthus populifolius*
Violaceae	*Hybanthus monopetalus*

Family	Latin Name
Apiaceae	*Hydrocotyle peduncularis*
Hymenophyllaceae	*Hymenophyllum cupressiforme*
Pittosporaceae	*Hymenosporum flavum*
Dennstaedtiaceae	*Hypolepis muelleri*
Poaceae	*Imperata cylindrica var. major*
Cyperaceae	*Isolepis prolifera*
Proteaceae	*Isopogon anemonifolius*
Juncaceae	*Juncus articulatus*
Juncaceae	*Juncus spp.*
Verbenaceae	*Lantana camara*
Sterculiaceae	*Lasiopetalum ferrugineum*
Dryopteridaceae	*Lastreopsis decomposita*
Dryopteridaceae	*Lastreopsis microsora subsp. microsora*
Menispermaceae	*Legnephora moorei*
Cyperaceae	*Lepidosperma elatius*
Cyperaceae	*Lepidosperma laterale*
Myrtaceae	*Leptospermum polygalifolium*
Oleaceae	*Ligustrum sinense*
Arecaceae	*Livistona australis*
Lomandraceae	*Lomandra confertifolia subsp. confertifolia*
Lomandraceae	*Lomandra confertifolia subsp. pallida*
Lomandraceae	*Lomandra longifolia*
Lomandraceae	*Lomandra obliqua*
Caprifoliaceae	*Lonicera japonica*
Asclepiadaceae	*Marsdenia rostrata*
Celastraceae	*Maytenus silvestris*
Myrtaceae	*Melaleuca linariifolia*
Apocynaceae	*Melodinus australis*
Poaceae	*Microlaena stipoides var. stipoides*
Rubiaceae	*Morinda jasminoides*
Myrsinaceae	*Myrsine variabilis*
Lauraceae	*Neolitsea dealbata*
Davalliaceae	*Nephrolepis cordifolia*
Oleaceae	*Notelaea longifolia forma longifolia*
Oleaceae	*Notelaea venosa*
Ochnaceae	*Ochna serrulata*
Poaceae	*Oplismenus imbecillis*
Poaceae	*Ottochloa gracillima*
Asteraceae	*Ozothamnus diosmifolius*
Monimiaceae	*Palmeria scandens*
Bignoniaceae	*Pandorea pandorana*
Apocynaceae	*Parsonsia straminea*
Apocynaceae	*Parsonsia velutina*

Family	Latin Name
Poaceae	*Paspalum dilatatum*
Poaceae	*Paspalum distichum*
Poaceae	*Paspalum urvillei*
Passifloraceae	*Passiflora edulis*
Adiantaceae	*Pellaea falcata*
Adiantaceae	*Pellaea nana*
Poaceae	*Pennisetum clandestinum*
Peperomiaceae	*Peperomia tetraphylla*
Polygonaceae	*Persicaria decipiens*
Proteaceae	*Persoonia levis*
Proteaceae	*Persoonia linearis*
Proteaceae	*Persoonia spp.*
Euphorbiaceae	*Phyllanthus hirtellus*
Solanaceae	*Physalis peruviana*
Pinaceae	*Pinus radiata*
Pittosporaceae	*Pittosporum multiflorum*
Pittosporaceae	*Pittosporum revolutum*
Pittosporaceae	*Pittosporum undulatum*
Polypodiaceae	*Platycerium bifurcatum*
Apiaceae	*Platysace lanceolata*
Apiaceae	*Platysace linearifolia*
Poaceae	*Poa annua*
Fabaceae (Faboideae)	*Podolobium ilicifolium*
Escalloniaceae	*Polyosma cunninghamii*
Araliaceae	*Polyscias sambucifolia subsp. A*
Dryopteridaceae	*Polystichum australiense*
Rhamnaceae	*Pomaderris ferruginea*
Rhamnaceae	*Pomaderris spp.*
Rubiaceae	*Pomax umbellata*
Lobeliaceae	*Pratia purpurascens*
Acanthaceae	*Pseuderanthemum variabile*
Rubiaceae	*Psychotria loniceroides*
Dennstaedtiaceae	*Pteridium esculentum*
Pteridaceae	*Pteris tremula*
Fabaceae (Faboideae)	*Pultenaea daphnoides*
Fabaceae (Faboideae)	*Pultenaea flexilis*
Polypodiaceae	*Pyrrosia rupestris*
Myrtaceae	*Rhodamnia rubescens*
Ripogonaceae	*Ripogonum fawcettianum*
Rosaceae	*Rubus fruticosus sp. agg.*
Rosaceae	*Rubus moluccanus var. moluccanus*
Rosaceae	*Rubus moluccanus var. trilobus*
Rosaceae	*Rubus nebulosus*

Family	Latin Name
Rosaceae	*Rubus parvifolius*
Orchidaceae	*Sarcochilus falcatus*
Menispermaceae	*Sarcopetalum harveyanum*
Araliaceae	*Schefflera arboricola*
Cunoniaceae	*Schizomeria ovata*
Cyperaceae	*Schoenus ericetorum*
Flacourtiaceae	*Scolopia braunii*
Fabaceae (Caesalpinioideae)	*Senna pendula var. glabrata*
Poaceae	*Setaria italica*
Asteraceae	*Sigesbeckia orientalis subsp. orientalis*
Elaeocarpaceae	*Sloanea australis*
Smilacaceae	*Smilax australis*
Smilacacaceae	*Smilax glyciphylla*
Solanaceae	*Solanum mauritianum*
Solanaceae	*Solanum nigrum*
Proteaceae	*Stenocarpus salignus*
Menispermaceae	*Stephania japonica var. discolor*
Myrtaceae	*Syncarpia glomulifera*
Meliaceae	*Synoum glandulosum subsp. glandulosum*
Myrtaceae	*Syzygium oleosum*
Myrtaceae	*Syzygium paniculatum*
Asteraceae	*Tagetes minuta*
Acanthaceae	*Thunbergia alata*
Commelinaceae	*Tradescantia fluminensis*
Ulmaceae	*Trema tomentosa var. viridis*
Myrtaceae	*Tristaniopsis laurina*
Epacridaceae	*Trochocarpa laurina*
Typhaceae	*Typha orientalis*
Verbenaceae	*Verbena rigida*
Violaceae	*Viola hederacea*
Monimiaceae	*Wilkiea huegeliana*
Xanthorrhoeaceae	*Xanthorrhoea resinifera*

APPENDIX 2 – FAUNA SPECIES LIST

COMMON NAME	LATIN NAME	REMARKS	A	S	T
AMPHIBIANS					
Common Eastern Froglet	*Crinia signifera*				
Giant Burrowing Frog	*Heleioporus australiacus*	TSC Act			
	Mixophyes balbus	TSC Act			
Red-crowned Toadlet	*Pseudophryne australis*	TSC Act			
Green Tree Frog	*Litoria caerulea*				
Bleating Tree Frog	*Litoria dentata*				
Eastern Dwarf Tree Frog	*Litoria fallax*				
Peron's Tree Frog	*Litoria peroni*				
	Litoria tyleri				
	Litoria verreauxii				
Long-necked Tortoise	*Chelodina longicollis*				
REPTILES					
	Lampropholis delicata				
	Lampropholis guichenoti				
Eastern Water Skink	*Eulamprus quoyii*				
Eastern Water Dragon	*Physignathus lesuerii*				
Lace Monitor	*Varanus varius*				
Diamond Python	*Morelia spilota*				
Common Death Adder	*Acanthophis antarcticus*				
Dwarf Crowned Snake	*Cacophis krefftii*				
Yellow-faced Whipsnake	*Demansia psammophis*				
Black-bellied Swamp Snake	*Hemiaspis signata*				
Red-bellied Black Snake	*Pseudechis porphyriacus*				
Eastern Brown Snake	*Pseudonaja textilis*				
BIRDS					
Australian Brush Turkey	*Alectura lathami*				
Australian Wood Duck	*Chenonetta jubata*				
Freckled Duck	*Stictonetta naevosa*	(TSC Act)			
Pacific Black Duck	*Anas superciliosa*				
Straw-necked Ibis	*Threskiornis spinicollis*				
• Masked Lapwing	*Vanellus miles*				
• White-necked Heron	*Ardea pacifica*				
• White-faced Heron	*Egretta novaehollandiae*				
• Black Bittern	*Ixobrychus flavicollis*	(TSC Act)			
• Black-shouldered Kite	*Elanus axillaris*				
• Purple Swamphen	*Porphyrio porphyrio*				
• Eurasian Coot	*Fulica atra*				
Spotted Turtle-dove	*Streptopelia chinensis*				
Brown Cuckoo-dove	*Macrpygia amboinensis*				
Wonga Pigeon	*Leucosarcia melanoleuca*				
White-headed Pigeon	*Columba leucomela*				
Glossy Black-Cockatoo	*Calyptorhynchus lathami*	(TSC Act)			
Yellow-tailed Black-cockatoo	*Calyptorhnchus funereus*				
Galah	*Cacatua roseicapilla*				

Long-billed Corella	*Cacatua tenuiorostris*				
Sulphur-crested Cockatoo	*Cacatua galerita*				
Rainbow Lorikeet	*Trichoglossus haematodus*				
Australian King Parrot	*Alisterus scapularis*				
Crimson Rosella	*Platycercus elegans*				
Eastern Rosella	*Platycercus eximius*				
Channel-billed Cuckoo	*Scythrops novaehollandiae*				
Barn Owl	*Tyto alba*				
Powerful Owl	*Ninox strenua*	(TSC Act)			
Southern Boobook	*Ninox novaeseelandiae*				
Sooty Owl	*Tyto tenebricosa*	(TSC Act)			
Barn Owl	*Tyto alba*				
Tawny Frogmouth	*Podargus strigoides*				
White-throated Nightjar	*Eurostophodus mysticalis*				
Azure Kingfisher	*Alcedo azurea*				
Laughing Kookaburra	*Dacelo novaeguineae*				
Superb Lyrebird	*Menura novaehollandiae*				
Superb Fairy-wren	*Malurus cyaneus*				
White-browed Scrubwren	*Sericornis frontalis*				
Yellow-throated Scrubwren	*Sericornis citrohularis*				
Large-billed Scrubwren	*Sericornis magnirostris*				
Brown Gerygone	*Gerygone mouki*				
Brown Thornbill	*Acanthiza pusilla*				
Little Wattlebird	*Anthochaera chrysoptera*				
Red Wattlebird	*Anthochaera carunculata*				
Bell Miner	*Manorina melanophrys*				
Noisy Miner	*Manorina melanocephala*				
Lewins Honeyeater	*Meliphaga lewinii*				
Eastern Yellow Robin	*Eopsaltria australis*				
Eastern Whipbird	*Psophodes olivaceus*				
Red-whiskered Bulbul	*Pycnonotus jocosus*				
Rufous Whistler	*Pachycephala rufiventris*				
Golden Whistler	*Pachycephala pectoralis*				
Grey Shrike-thrush	*Colluricincla harmonica*				
Willie Wagtail	*Rhipidura leucophyrs*				
Grey Fantail	*Rhipidura fuliginosa*				
Rufous Fantail	*Rhipidura rufifrons*				
Grey Butcherbird	*Cracticus torquatus*				
Magpie-lark	*Grallina cyanoleuca*				
Australian Magpie	*Gymnorhina tibicen*				
Pied Currawong	*Strepera graculina*				
Australian Raven	*Corvus coronoides*				
Green Catbird	*Ailuroedus cressirostris*				
Regent Bowerbird	*Sericulus chrysocephalus*				
Satin Bowerbird	*Ptilonorhynchus violaceus*				
Red-browed Finch	*Neochmia temporalis*				
Welcome Swallow	*Hirundo neoxena*				
Silvereye	*Zosterops lateralis*				
Bassian Thrush	*Zoothera lunulata*				
MAMMALS					

Brown Antechinus	*Antechinus stuartii*			■	
Long-nosed Bandicoot	*Parameles nasuta*		■	■	
Eastern Pigmy Possum	*Cercatus nanus*	(TSC Act)			■
#Yellow-bellied Glider	*Petaurus australis*	(TSC Act)		■	
Sugar Glider	*Petaurus breviceps*			■	■
#Long-nosed Potoroo	*Potorous tridactylus*	(TSC Act)		■	
#Eastern Grey-Kangaroo	*Macropus giganteus*			■	
Swamp Wallaby	*Macropus bicolor*			■	■
Grey-headed Flying Fox	*Pteropus poliocephalus*	(TSC EPBC Acts)		■	
A Freetail Bat	*Mormopterus sp. 2*		■	■	
White-striped Freetail Bat	*Tadarida australis*		■		
Eastern Freetail-bat	Mormopterus norfolkensis	(TSC Act)	■		
Eastern Bentwing Bat	*Miniopterus schreibersii oceanensis*	(TSC Act)	■	■	
Little Bent-wing Bat	*Miniopterus australis*	(TSC Act)	■		
Gould's Wattled Bat	*Chalinolobus gouldii*		■	■	
Chocolate Wattled Bat	*Chalinolobus morio*			■	
Southern Myotis	*Myotis macropus*	(TSC Act)	■		
Eastern Broad-nosed Bat	*Scotorepens orion*		■		
Large Forest Bat	*Vespadalus darlingtoni*			■	
Little Forest Bat	*Vespadalus vulturnis*		■	■	
Bush Rat	*Rattus fuscipes*				
Fox	*Vulpes vulpes*			■	
Cat	*Felis catus*			■	
Rabbit	*Oryctolagus cuniculus*			■	

Stratification Units
S=Narrabeen slopes
T=Narrabeen summit
#=**Anecdotal evidence**

APPENDIX 3 – WEEDS THAT MAYBE APPLICABLE TO THE NARARA ECOVILLAGE UNDER THE WEEDS OF NATIONAL SIGNIFICANCE (WONS) PROGRAM

COMMON NAME	LATIN NAME	FAMILY	REMARKS
Sagittaria	*Sagittaria platyphylla*	Alismataceae	Likely in drainage lines
Asparagus	*Asparagus aethiopicus*	Asparagaceae	Isolated infestation
Bridal Creeper	*Asparagus asparagoides*	Asparagaceae	Not seen
Boneseed	*Chrysanthemoides subsp. monilifera*	Asteraceae	Not seen
Bitou Bush	*Chrysanthemoides subsp. rotundata*	Asteraceae	Not seen
Fireweed	*Senecio madagascariensis*	Asteraceae	Common in paddocks
Madiera Vine	*Anredera cordifolia*	Basellaceae	Not seen but isolated infestations mey be present
Water Hyacinth	*Eichhnornia crassipes*	Pondetericeae	Not seen
Blackberry	*Rubus fruticosus agg.*	Rosaceae	Common on edges of paddocks
Salvinia	*Salvinia molesta*	Salviniaceae	Not seen

APPENDIX 4 – EXOTIC PLANT SPECIES RECORDED DURING THE MAPPING QUADRAT SURVEYS AND ONGOING- NARARA ECOVILLAGE

Family	Latin Name	Common Name	Remarks
Polygonaceae	*Acetosa sagittata*	Turkey Rhubarb	Manual removal with tubers
Asteraceae	*Ageratina adenophora*	Crofton Weed	Refer to section 8.1
Araucariaceae	*Araucaria heterophylla*	Norfolk Island Pine	Manual removal
Araucariaceae	*Araucaria bidwillii*	Hoop Pine	Manual removal
Asclepiadaceae	*Araujia sericifera*	Moth Vine	Manual removal/scrape & paint
Asparagaceae	*Asparagus aethiopicus*	An Asparagus Fern	Refer to section 8.2
Poaceae	*Axonopus fissifolius*	Narrow-leaved Carpet Grass	Manual removal but only where necessary
Asteraceae	*Bidens pilosa*	Cobblers Pegs	Manual removal
Poaceae	*Briza minor*	Shivery Grass	Manual removal & bag
Poaceae	*Chloris gayana*	Rhodes Grass	Manual removal including stolons & rhizomes
Lauraceae	*Cinnamomum camphora*	Camphor Laurel	Fell/cut & paint
Asteraceae	*Conyza spp.*	A Fleabane	Manual removal
Asteraceae	*Coreopsis lanceolata*		Manual removal
Poaceae	*Ehrharta erecta*	Panic Veldt Grass	Manual removal & bag. Follow up in 6 weeks.
Zingiberaceae	*Hedychium gardnerianum*	Exotic Ginger	Manual removal including rhizomes. Remove from site
Cyperaceae	*Isolepis prolifera*		Allow to remain
Juncaceae	*Juncus articulatus*		Manual removal
Verbenaceae	*Lantana camara*	Lantana	Refer to section 8.2
Oleaceae	*Ligustrum sinense*	Large-leaved Privet	Refer to section 7.7
Caprifoliaceae	*Lonicera japonica*	Japanese Honeysuckle	Trace stems to base; cut & paint for 20 secs.
Ochnaceae	*Ochna serrulata*	Ochna	Scrape & paint
Poaceae	*Paspalum dilatatum*	Paspalum	Manual removal
Poaceae	*Paspalum urvillei*	Vasey Grass	Manual removal
Passifloraceae	*Passiflora edulis*	Passionfruit	Manual removal; cut & paint
Poaceae	*Pennisetum clandestinum*	Kikuyu	Spray with suitable herbicide
Solanaceae	*Physalis peruviana*	Cape Gooseberry	Manual removal

Family	Latin Name	Common Name	Remarks
Pinaceae	*Pinus radiata*	Radiata Pine	Fell/manual removal
Poaceae	*Poa annua*	Winter Grass	Manual removal
Rosaceae	*Rubus fruticosus sp. agg.*	Blackberry	Refer to section 8.1
Araliaceae	*Schefflera arboricola*	Umbrella Tree	Manual removal
Fabaceae	*Senna pendula var. glabrata*		Manual removal
Poaceae	*Setaria italica*	Foxtail Millet	Manual removal
Solanaceae	*Solanum mauritianum*	Wild Tobacco Plant	Allow to remain
Solanaceae	*Solanum nigrum*	Black-berry Nightshade	Manual removal
Asteraceae	*Tagetes minuta*	Stinking Roger	Manual removal
Commelinaceae	*Tradescantia fluminensis*	Wandering Jew	Manual removal/spray in winter
Vebenaceae	*Verbena rigida*	Veined Verbena	Manual removal

APPENDIX 5 – SUMMARY OF RECOMMENDATIONS
(Refer to Figure 2 for vegetation map; highlighted recommendations are for the Stage 1 DA application)

Main recommendations				
No.	**Management Issue**	**Vegetation community**	**Management Action**	**Priority**
1	Remove weeds and exotic grasses in the freshwater floodplain wetland	Remnant Freshwater grassland with rushland/sedgeland	Remove all weeds and the Narrow-leaved Carpet Grass.	2
2	Restrict the Cumbungi to the drain in the floodplain freshwater wetland	Remnant Freshwater grassland with rushland/sedgeland	Restrict the Cumbungi to the drainage channel as this is habitat for the Black Bittern	2
3	Restore native riparian grassland within the 10m riparian buffer zones required by the NSW Department of Water	Remnant riparian grassland on slopes: *Ottochloa gracillimus*	Fence off 10m buffers, weed and begin to grow *Ottochloa gracillimus* using the nursery facilities. Transplant when ready. Also carry out direct seeding.	2
4	Control of fireweed and Whiskey Grass within the existing paddock areas	Paddocks	Cut and bag seed heads and dispose of at the appropriate waste disposal depot before the weeds spread to other cleared areas.	1
5	Eradicate all the Camphor Laurels from the property but not at the same time.	Closed Forest with emergents on alluvial flats: Moist Closed Forest with emergents on Narrabeens; Palm gully open to closed forest and sometimes Gallery Rainforest	Replace the trees with *Elaeocarpus reticulatus* Blueberry Ash and *Elaeocarpus obovatus* Hard Quandong as a food resource for the fruit pigeons, Satin & Regent Bowerbirds and Pied Currawong. Trees will have to be specifically grown in nursery facility.	1
6	Establish nursery facility on site.	N/A	Function will be to grow native grasses, plants & trees for restoration purposes.	2
7	European Fox and the European Rabbit	Paddocks	Conduct baiting and shooting programs in conjunction with Gosford City Council	2
8	Remove all noxious weeds, weeds of national significance and other problematic weeds in stage 1 area initially	Closed Forest with emergents on alluvial flats: Moist Closed Forest with emergents on Narrabeens; Palm gully open to closed forest and sometimes Gallery Rainforest	Carry out weed removal as per sections 8.1, 8.2 & 8.3. Select an area for Lantana & Privet storage & breakdown on the western lower slope.	1

9	Aboriginal relics	All habitats	If during any works program Aboriginal relics are found NSW OEH is to be notified.	3
10	Low lighting	Moist Closed Forest with emergents on Narrabeens; Palm gully open to close forest and sometimes Gallery Rainforest	Install only low lighting on public access roads against vegetated slopes and near the dam consistent with human safety	2
11	*Syzygium paniculatum*	Palm gully open to close forest and sometimes Gallery Rainforest	Install a fence to mark the edge of the buffer. Undertake weeding within the buffer zone.	1
Secondary recommendations				
12	Heritage trees	Refer to separate report	Refer to separate report (Musecape, 2007)	1
13	Poor representation of freshwater floodplain wetland	Remnant Freshwater grassland with rushland/sedgeland	Propagate recommended species and plant within wetland	As required
14	Protection of additional threatened species	Palm gully open to close forest and sometimes Gallery Rainforest	One tree of *Syzygium paniculatum* found only. If the second tree is found in the future establish 20m buffer zone and undertake weeding as per No. 11.	As required
15	Blackberry - WONS	Isolated infestations along drainage lines	Spray or scrape & paint between flowering and fruitset. Follow-up	1
16	Lantana - WONS	Closed Forest with emergents on alluvial flats: Moist Closed Forest with emergents on Narrabeens; Palm gully open to closed forest and sometimes Gallery Rainforest	Cut & paint	1
17	Asparagus fern - WONS	Isolated infestations	Remove crowns & fruit manually & bag	2
18	Madeira Vine - WONS	Not seen	Scrape & paint Spring-Summer	2
19	*Xanthium* spp. NOXIOUS (Noogoora burr et al.)	Not seen	Remove manually & bag	2
20	Turkey Rhubarb	Isolated infestations	Remove manually/hebicide	1
21	Crofton Weed	Isolated in drainage lines	Remove flower & seed heads manually & bag	1
22	Rhodes Grass	Clearing near dam	Remove manually	1
	Exotic ginger	Palm gully open to closed forest and sometimes Gallery	Remove manually	1

		Rainforest		
23	Regenetation of native canopy trees	Closed Forest with emergents on alluvial flats: Moist Closed Forest with emergents on Narrabeens; Palm gully open to closed forest and sometimes Gallery Rainforest	Propagate using nursery facilities as required	2