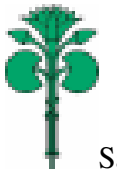
ENVIRONMENTAL CONSTRAINT ANALYSIS LOT 66 DP 551005, PACIFIC HIGHWAY MOONEE BEACH

SEPTEMBER 2006



Sainty and Associates

Geoff Sainty was accompanied in the field by botanist John Westaway. John has extensive experience with the flora and ecological communities of the north coast of NSW. Mark Robinson reviewed the fauna report.

TABLE OF CONTENTS

LIST OF MAPS

1.0 INTRODUCTION

1.1 Purpose of the Report

The subject site, Lot 66 DP 551005, is approximately 102ha and located on the eastern side of the Pacific Highway at Moonee Beach. It is subject to three zonings under the Coffs Harbour City Local Environmental Plan 2000 (LEP 2000). The current zonings are Residential 2E Tourist, 7(a) Environmental Protection, 7A Habitat and Catchment and Open Space 6A Public Recreation.

Draft amendments to LEP 2000 would rezone most of the land to Environmental Protection 7A Habitat and Catchment with the remaining area being Open Space 6A. Coffs Harbour City Council's (CHCC) Moonee DCP came into force on 22 September 2004. The DCP classifies the entire lot as Protected Land, due to the presence of protected vegetation.

A major project concept plan application is currently with the Department of Planning under part 3A of the Environmental Planning and Assessment Act (the Act) for a residential subdivision of Lot 66 DP 551005 into 378 lots.

Draft amendments to LEP 2000 along with the application under Part 3A of the Act have prompted the Department of Planning (DoP) to commission Geoff Sainty of Sainty and Associates to identify the high conservation lands on the site. The results will be used to determine land suitable for environmental protection and the areas of the least constraints suitable for future residential development.

Not all environmental and planning aspects of the site are reviewed in this report. To keep the information concise the report focuses on literature and information relevant to aspects of the high conservation lands on the parts of the site zoned Residential 2E under the LEP 2000, as high conservation lands located on other parts of the site will be largely protected by the existing Environmental Protection and Open Space zonings of those areas. The report is also based on site investigations undertaken by Sainty and Associates.

1.2 Scope of works

The scope of works for this project*, as specified by the Department of Panning, includes:

(1) Review of available documentation on ecological value of land (principally coastal wetlands, ICOLL and other areas of high conservation value) within Hearnes Lake/Sandy Beach and Moonee Beach, Coffs Harbour specifically relating to 3 major development proposals at 45 Hearnes Lake Rd (Council application for 51 lots), Sandy Beach (Major project for 295 lots) and Moonee Beach (Major Project for 378 lots).

(2) Undertake consultation with Department of Environment and Conservation and Department of Natural Resources staff.

(3) Undertake consultation with Coffs Harbour City Council staff.

(4) Identify and provide individual maps of high conservation value lands by on site survey using a differential GPS. High conservation lands for the purpose of this brief include (but are not necessarily limited to):
- Existing SEPP 14 – Coastal wetlands and any additional lands identified as satisfying SEPP 14 – Coastal Wetlands criteria.
- Endangered Ecological Communities (as listed under the NSW Threatened Species Conservation Act 1995).

- Buffer zones around existing SEPP 14 – Coastal Wetlands, Hearnes Lake ICOLL and any Endangered Ecological Communities.

(5) Identify and map lands suitable for environmental protection based on site survey and consideration of existing studies including Council's: Hearnes Lake/Sandy Beach Draft DCP; Draft Vegetation Conservation Strategy; Draft Local Environmental Plans around Hearnes Lake/Sandy Beach and Moonee Beach.

(6) Identify and map land designated for future potential development areas in relation to the 3 development proposals.

- This report relates to lot 66 DP 51005 Moonee Beach only.

2.0 Background and Site Description

The proponents, Hillview Heights Estate Pty Ltd have submitted a major project concept plan application to the Department of Planning under Part 3A of the Environmental Planning Act for the subdivision of Lot 66 DP 551005 into 378 residential lots. The site lies immediately south of the coastal settlement of Moonee, approximately 13km north of the regional centre of Coffs Harbour. The site is bounded to the west by the Pacific Highway.

A narrow easement (electricity transmission) runs just inside the western boundary and constitutes the only currently cleared area of the property. Drainage from the more elevated parts of the property flows into healthy SEPP 14 wetlands that form a key component of the estuarine environment of Moonee and Sugar Mill Creeks (the tidal limit extends up Sugar Mill Creek). The coastal dune system provides an eastern boundary to the property and protects it from infrequent, but potentially severe, cyclonic storm influences.

The property is a large integral unit that has been in the same ownership for more than three decades. It would appear to have been significantly cleared prior to being acquired by the present owners and large standing stumps attest to an earlier period of timber harvest. Under the current ownership, regrowth has been allowed to take place with little evidence of significant agricultural or forestry activities taking place. Maintenance of the external property boundary and the aforementioned easement has taken place, otherwise the reestablishment of native vegetation has proceeded at nature's pace.

The principal vehicle access is not maintained and is suitable only for off-road vehicles. It provides a connection along the southern boundary of the property from the Pacific Highway to the coastal dune system, which may be crossed to the beachfront at a point some 500m south of Green Bluff. Minor access tracks feed off the principal access and appear to have been used in most recent times for the dumping of domestic waste and larger items such as car bodies and truck tyres.

The reestablishment of vegetation broadly reflects the underlying patterns of elevation, soil types (refer *Coffs Harbour Soil Landscapes Map 1:100 000 scale*) and drainage. A closed forest assemblage, dominated by blackbutts, covers the higher portions of the property. The lower portion is characterised by a tall Swamp Oak and Paperbark assemblage, with a more open wet forest area (Swamp Mahogany, Swamp Paperbark and Swamp Oak) area developed about the drainage line of the small creek feeding into Sugar Mill Creek from the coastal (hind) dune system. Weed species are evident at many points, and include lantana and domestic garden weeds.

The overall fire risk appears to be significant with high fuel loads at all elevations, however there is no evidence of recent major high temperature burns visible from the property boundary. In the event of an uncontrolled fire, the lack of access to the property in its present configuration would make ground control difficult, if not impossible.

2.1 Concept Plan for subdivision of the site

The concept plan for the subdivision of the site identifies areas for urban development that are generally confined to the upper parts of the site closest to the highway, with an area closer to the beach behind the dunes proposed to be dealt with as a deferred matter (Annand and Alcock 2005).

The concept plan involves development of the portions of land that the proponent's consultants indicate are of lower biodiversity value (involving only 44% of the land which is zoned for development purposes) and the retention and protection of approximately 70% of the land for biodiversity conservation purposes. The lots will be in the northwest corner of the site, replacing a Dry Blackbutt and Turpentine Tall Open Forest and a second grouping of houses on the central south corner of the block will replace another section of the Dry Blackbutt Tall Open Forest community.

2.2 Flora and Fauna Report, Gunninah Environmental Consultants, (Fanning and Leonard) 2006

Gunninah Environmental Consultants were engaged by the proponents to carry out a flora and fauna assessment of the site and proposed subdivision. They have identified five Endangered Ecological Communities (EEC) now listed under the Threatened Species Conservation Act. They found areas of Swamp Oak Floodplain Forest, areas of Swamp Sclerophyll Forest on Coastal Floodplains of the NSW Coast, a parcel of wetland that may conform to the listing as a Freshwater Wetland on the on Coastal Floodplains on the NSW North Coast, sections of Littoral Rainforest in the NSW North Coast and areas of Coastal Saltmarsh in the NSW North Coast. Although the listing of these communities post-dated the development of the Master Plan, Fanning and Leonard state that those communities were recognized early on as having high conservation value and had substantially been excluded from the proposed development area.

Two threatened plant species were recorded on and immediately adjacent to the subject site. The Rusty Plum, *Amorphospermum whitei* and the Moonee Quassia were found as scattered individuals in the northern part of the subject site, and in areas of moist Coastal Blackbutt Forest in the vicinity of the northern boundary (within the conservation reserve) (Gunninah 2006).

Their fauna survey found a total of 15 species on the site listed as Vulnerable under the Threatened Species Conservation Act. One of which – the grey headed flying fox, is also listed as Vulnerable on the Commonwealth Environment Protection Biodiversity Conservation Act 1999 (EPBC Act) (Gunninah 2006).

The author believes that most of the threatened fauna recorded on the site (excluding the Koala, Yellow-bellied glider and Green-thighed frog) are highly mobile and wide ranging. Consequently, they state that the site represents only a small portion of the available habitat for these species within their home ranges and in this location generally. For most of the species , the areas of the site which are to be affected constitute only a small part of the habitat for even individuals of the species (Gunninah 2006).

In conclusion, the report states that development of the subject site as proposed will require the removal of dry forest and woodland vegetation from the development portions of the site and the implementation of environmental management measures to limit the potential for adverse impacts from eventual development of the land. They recognize that the development activities will involve the imposition of impacts upon the natural environment in general terms, and there will be some limited impacts on "*threatened species*" and "*endangered ecological communities*" listed on the TSC Act (Gunninah 2006).

However, the result of their studies supports the development proposal as set out in the Master Plan. Fanning and Leopold (2006) believe that "the impacts which will be imposed by development of the site "are not regarded as either unacceptable or unreasonable in terms of s.79C of the EP&A Act with regard to plant communities, because of:

- The extent of those plant communities and ecosystems which are to be affected throughout the locality and region;
- The relatively small areas of land to be affected compared to the total size of the subject site and extent of vegetation in the locality;
- The concentration of development activities within the most common plant communities and those of the lowest conservation significance (by reference to the TSC Act); and
- The protection of most of the subject land (approximately 70%) including the most significant and sensitive environments, in a substantial conservation zone on the site."

3.0 DISCUSSION

3.1 Endangered Ecological Communities

There are three Endangered Ecological Communities (EECs) on the site, which can be collectively described as Coastal Floodplain EECs and comprise:

- Swamp Sclerophyll Forest of the NSW North Coast, Sydney Basin and South East Corner Bioregions;
- Swamp Oak Floodplain Forest of the NSW North Coast, Sydney Basin and South East Corner Bioregions; and
- Coastal Saltmarsh in the NSW North Coast, Sydney Basin and South East Corner Bioregions.

Source: Gunninah 2006.

EEC's have been listed due to their ecological significance, and development should be excluded from these areas. Since the gazettal of LEP 2000, cumulative loss of habitats on the North Coast has led to new listings of endangered ecological communities, including Swamp Sclerophyll Forest. Key threatening processes have continued to degrade and destroy these significant ecological habitats, particularly in areas suitable for human settlement. Care needs to be taken to protect these communities from the marginal attrition and deleterious impacts (e.g. ingress of weeds, contaminant input, altered fire regimes) often associated with the development of a site. As loss of those habitats has continued, the need to preserve any remnants of certain communities has become apparent. For certain endangered communities, even an area in very poor condition has a high priority for conservation. The majority of conserved habitats continue to be found primarily on steep and rugged terrain, unsuitable for urban expansion or agricultural use.

This report focuses on the EEC's that are currently located within the parts of the site zoned Residential 2E under LEP 2000, and determining the boundary between the EEC and other vegetation on this part of the site. Internal boundaries of EECs (Swamp Sclerophyll Forest and Salt Marsh) within the eastern part of the site were not delineated as these communities are included in the Environmental Protection zone under LEP 2000 and are not proposed for development within the concept plan.

The boundary was mapped between the EEC, Swamp Sclerophyll Forest and other areas of dry blackbutt and turpentine tall open forest, outside the EEC, refer to the *Environmental Constraints and Development Potential Map* attached to this report. This was investigated by traversing the ecotone between the Swamp Sclerophyll Forest and the adjacent coastal blackbutt (*Eucalyptus pilularis*) and other sclerophyll open forest communities where the contours of the western elevated hills join the low lying floodplain. Delineation involved determining the line-of-best-fit along this ecotone with regard to changes in topography, substrate and floristics. This boundary was subsequently captured by surveyors employing orthodox surveying techniques (distance measures and bearings).

An area of tall flooded gum (*Eucalyptus grandis*) riparian open forest with a mesic understorey was also identified immediately to the south of the western area of blackbutt forest, or adjacent to southern boundary nearest to Pacific Hwy. This vegetation shares elements of Swamp Sclerophyll Forest, but, not withstanding this, was not included in this EEC and could be included in areas that may potentially be developed, subject to the provision of environmental buffers discussed below. It is considered that the environmental buffers will provide appropriate protection for the vegetation on this area of the site.

3.2 The Need for Environmental Buffers to Endangered Ecological Communities

The prime purpose of a buffer zone is to "insulate areas where biodiversity conservation is the primary objective, from potentially damaging external influences, and particularly from those caused by inappropriate forms of land use" (Bennett and Mulongoy 2006).

A buffer zone will provide (Martino 2001):
1) a physical barrier from human encroachment;
2) protection from storm damage;
3) an increase in natural habitat and a reduction in edge effects; and
4) an enhancement to the environmental services provided by the nature reserve.

Due to lack of research, the size of a buffer for wetlands and other sensitive ecosystems in Australia should be determined on a case–by-case basis after site specific investigations (Winning 1997).

In urbanizing landscapes where there is fragmentation of valuable habitat, buffering the affect of urban development on High Conservation Value lands assists to reduce the edge effect. The 'edge' is the zone on the outer edge of a community where it is noticeably affected by 'outer' influences. Research on edge effects has identified widely variable ingress distances. Tropical Rainforest edges have been shown to penetrate up to 500m (Laurence, 1991), whilst in temperate Rainforest edge effects were recorded up to 12.7m (Fox *et al* 1997). Land form, ecological attributes, climate, threats, and abutting land use will all influence the size of buffer required to protect the integrity of an EEC.

It is recommended that a 50m environmental buffer zone surround the EEC where these areas abut land identified for potential subdivision and urban development. The environmental buffer will reduce edge effects, allow for regeneration and protect key features such as; nature corridor, remnant vegetation, and significant habitat.

The fire sensitivity of EEC and need for hazard reduction should also be considered. Bushfire protection and asset protection zones for development should be designated outside of the EEC and outside the environmental buffer areas.

Wetland buffer zones vary in size and nature depending upon the specific purpose for which it is created. Buffers are important to ensure that wetland ecosystems are maintained and protected. Buffers are generally a minimum of 50m extending to 100m and more under some circumstances. The rigid application of a buffer width to a wetland is not always practical and 'offsets' may be appropriate. This may mean that a 50m buffer can be reduced to 20m in some parts of a development to be made up with a greater width elsewhere on the site depending on but not limited to the adjacent land use, elevation and slope.

3.3 Regional Context and Significance of Vegetation on the Site

3.3.1 Significant Area of Forested Land

The property effectively represents the single largest unit of forested land in the strip between Coffs Harbour and Woolgoolga. The site provides habitat for fauna and due to its significance at a regional level, it offers a refuge for local wildlife during times of fire, drought or loss of habitat elsewhere.

The size also mitigates edge effects that, for smaller parcels of protected wooded areas can alter light penetration, increase wind damage, decrease humidity, contaminate watershed, and promote the encroachment of invasive species. And these effects can extend well into the forest from its perimeter. Small forest parcels are very susceptible to edge effects. This large core of forest would also function as a source area of plants propagules and dispersing fauna for the surrounding locality.

3.3.1 Importance of Vegetation on the Site and Impacts of Clearing

The decline in biodiversity (species, genes & ecosystems) as the result of vegetation clearing is well recognized (Hobbs, 1992; Kirkpatrick, 1994; Saunders *et al*, 1996) and affects a variety of habitats including rainforest (Floyd, 1990; Adam, 1994a), eucalypt forests and woodlands (Norton & May, 1994; Hobbs & Yates, 2000), grasslands (McDougall & Kirkpatrick, 1994) and wetlands (Adam, 1994b; Harty, 1997).

Vegetation clearing affects many taxa including birds (Recher, 1999; Reid, 1999), marsupials (Lindenmayer, 1994), frogs (Woinarski, *et al*, 2006), reptiles (Reed & Shine, 2002) and invertebrates (New, 1995) and is recognized as a Key Threatening Process by the NSW Scientific Committee (NSW Scientific Committee, 2001).

In addition to the obvious impacts of habitat loss, physical damage or mortality of biota the impacts of vegetation clearing can include:

- Fragmentation,
- Increase in invasive species in remnants,
- Increase nutrient loads in remnants,
- Physical changes at the edge including wind exposure, temperature, light and humidity (Lindenmayer & Burgman, 2005).

The concept of fragmentation usually encompasses a suite of processes associated with landscape change and includes:

- Habitat degradation - habitat suitability is reduced and may become unusable to some species,
- Habitat subdivision - clearing vegetation results in smaller remnants that may result in non-viable populations,
- Patch Isolation - clearing vegetation results in increased distances between remnant patches thus reducing inter-remnant movement,
- Edge Effects - in fragmented landscapes the ratio of remnants perimeter to remnant interior is higher and the above mentioned impacts (invasive species, nutrients loads & physical changes) can result (Lindenmayer & Burgman, 2005).

Using Fisher *et al* (1996) regional review, Fanning and Leonard (2005; their table 1) attempt to identify the conservation status of the sites' vegetation communities. The residential development site is largely centred on the Dry Blackbutt Open Forest that is mapped by Fisher *et al* (1996) and interpreted by Fanning and Leonard (2005) as map unit N44a. Fanning and Leonard (2005; their table 1) cite Fisher et al (1996) that this vegetation community is 'adequately conserved'. This is contrary to the writer's interpretation of Fisher *et al* (1996) local work where N44a is a subset of map unit N2a that is classed as "*inadequately conserved over all its range*" where only 5-10% is conserved regionally (table 1 below).

Table 1: Conservation of overstorey community N2a (includes N34a, N44a & N2b) (source: Fisher *et al*, 1996; their table 6)

Map Unit	Forest Type or Floyd RF Suballiance (F)	H & B Association	H & B Conservation status in central zone	H & B Conservation status - regional	H & B Conservation code central zone
N2a Include N34a, N44a & N2b	37	EF145b	LT10	LT5-LT10	2

Key

Reservation codes as per Hager & Benson (1994) are as follows: 1 = not or poorly conserved; 2 = inadequately conserved over all its range; 3 = inadequately conserved in major part of its range; 4 = adequately conserved.

LT1, LT5, LT10, LT25 = less than 1, 5, 10, 25 per cent reserved respectively; GT25=>25 per cent conserved. A and I is Floyd (1990) Conservation Code where A = Adequate and I = Inadequate

The implication for fauna is that the major portion of their Dry Blackbutt Open Forest (as at 1994) habitat tenure may not be secure within the region.

3.3.2 Role of Site as a Nature Corridor

Though the role of wildlife corridors to ameliorate the impacts of habitat degradation, habitat subdivision and patch isolation is still debated (Beier & Noss, 1998; Downes *et al*, 1997), there is a plethora of literature arguing the need for corridors for their role in providing linkages in the landscapes for biota (Bennet, 1990, 1991, 1999; Saunders & Hobbs, 1991; Lindenmayer, 1998; Wilson & Lindenmayer, 1995). It is also acknowledged that what are perceived as corridors are also used as fauna habitat (Downes *et al*, 1997). Though there is a degree of uncertainty, corridors have also been identified as useful structures across landscape environmental gradients in the face of the global climate change (Hughes & Westoby, 1994; Bennett, 1999; Soule *et al*, 2004).

In north-eastern NSW, wildlife and habitat corridors have been identified independent of planning legislation and structures and in a transparent methodology articulated in readily available literature (Scotts, 2003) and peer-reviewed scientific literature (Scotts & Drielsma, 2003). Moonee Waters has both **Regional** and **Subregional** corridors linking the coastline Regional Corridors and key habitats to the State Forests to the west of the Pacific Highway (Map 2).

The site includes the coastline Regional Corridor and a small section of Key Habitat; is adjacent to a major area of Key Habitat (Moonee Beach Nature Reserve) and includes a Subregional Corridor link to the Orara East State Forest west of the Pacific Highway (Map 3). Exiting the site to the west, the Subregional Corridor has to cross the Pacific Highway and approximately 1.4km of freehold land prior to connection to the State Forest (Map 3).

It is acknowledged that the Pacific Highway provides a formidable north-south barrier to some species and can result in wildlife fatalities (Donaldson & Bennett, 2004; Ramp *et al*, 2006). While these effects may be compounded with the RTA planned upgrade of the Pacific, they can be addressed by measures such as roadside barrier fences with culverts, fauna underpasses and rope crossings (see Taylor & Goldingay, 2003).

The overall continuity of the vegetation corridor is excellent (if not ideal) in terms of the needs of more nimble species including birds, bats and insects for feeding, breeding, resting and refuge habitats, and for the interchange of seed and pollen materials. Habitats on private lands to the west of the Pacific Highway can be protected to prevent the integrity of the corridor being compromised. Maintaining the integrity of these corridor networks and values is consistent with Council's draft Vegetation Strategy and proposed vegetation clearing controls which would apply to the site and private lands to the west of the Highway.

3.4 Potential Loss of Nature Corridor and Habitat

The current development proposal will severely impact on the Subregional corridor network by further fragmenting the link between the coastal Regional corridor/Key Habitats and the habitats west of the Pacific Highway (Scotts, 2003; Scotts, & Drielsma, 2003; see Map 3). Development of the deferred area closer to the beach behind the dunes (AAUD, 2005) will directly impact the

coastline Regional corridor and further narrow this corridor; a small patch of Key Habitats will also be directly impacted (Map 3).

The proposed development will contribute to habitat loss across the site and the region, the most important cause of decline and loss of species in Australia and worldwide (Lindenmayer & Burgman, 2005) and further fragment the remaining habitats.

4.0 CONCLUSION

The property has many ecological attributes. The maturation of the regrowth of the site has closely mimicked the natural vegetation profile of this part of the coast and consequently it represents the first large coastal forest remnant north of the expanding Coffs Harbour residential area. It also effectively represents the single largest unit of forested land in the strip between Coffs Harbour and Woolgoolga. It also constitutes one of the best natural vegetation sequences (including the coastal Nature Reserves) of the region from Sawtell to Corindi in terms of density, canopy cover and diversity.

The site is part of a nature corridor, linking the coast to significant vegetation west of the Pacific Highway. This can best be seen on the local 1:25 000 scale photomosaic (Moonee) and on the individual air photos. It currently maintains a degree of coherence in an otherwise fragmented landscape, where there is little connection between ecological communities to either side of the Pacific Highway. Linking isolated patches of valuable habitat allow animals' access to a larger area of habitat, can facilitate seasonal migration, permit genetic exchange, and offer opportunities for individuals to move from a habitat that is degrading or under threat.

It is acknowledged that the Pacific Highway provides a formidable north-south barrier to larger and slow moving ground fauna. However, the overall continuity of the vegetation corridor is excellent (if not ideal) in terms of the needs of more nimble species including birds, bats and insects for feeding, breeding, resting and refuge habitats, and for the interchange of seed and pollen materials.

The vegetation communities (Coastal Floodplain and Dry Blackbutt and Turpentine Tall Open Forest – Map 1) on site also maintain a high edge to area ratio, thereby having resilience to the edge effect that can affect urban vegetation. This large core of forest would also function as a source area of plants propagules and dispersing fauna for the surrounding locality. The area also provides habitat for fauna and due to its significance at a regional level, it offers a refuge for local wildlife during times of fire, drought or loss of habitat elsewhere.

The proposed development will destroy the habitats of both threatened species and those more widespread and considered of least concern. The proposed development will also destroy both Regional and Subregional Corridors and Key Habitats (*sensu* Scotts & Drielsma, 2003) and will likely contribute to further fragmentation of the fauna species along the coastline. In effect, the development will be positively biased toward conservation of significant habitats but also negatively biased in the destruction of habitats that the fauna consultants have identified as threatened species habitat. The habitats to be destroyed by the proposed development do provide some different fauna habitat resources than those habitats to be retained. Additionally, as determined from available literature, the habitat to be cleared is inadequately conserved in reserves.

In conclusion, the proposed development will contribute to the decline in fauna habitat values of the Moonee Beach area. It will further threaten significant species and result in clearing and destruction of habitat which is a Key Threatening Process in NSW.

Therefore, due to the importance of the Dry Blackbutt and Turpentine Tall Open forest as a nature corridor and the need for the EEC's to be retained and provided with adequate development buffers, the recommended available land for development is reduced to a small section in the south west corner of the site, as identified on the *Environmental Constraints and Development Potential Map* attached to this report.

5.0 RECOMMENDATIONS

The areas of High Conservation Significance on the site which require protection, and provision of environmental buffers and the areas of future development potential, are indicated on the *Environmental Constraints and Development Potential Map* attached to this report. This will require that:

a. All EEC's on site including;

- Swamp Sclerophyll Forest of the NSW North Coast, Sydney Basin and South East Corner Bioregions,
- Swamp Oak Floodplain Forest of the NSW North Coast, Sydney Basin and South East Corner Bioregions; and
- Coastal Saltmarsh in the NSW North Coast, Sydney Basin and South East Corner Bioregions,

should be preserved, zoned for Environmental Protection under the Coffs Harbour Local Environmental Plan and surrounded by a 50m environmental buffer where they will abut urban development,

b. The Dry Blackbutt and Turpentine Tall Open Forest area in the northwest corner of the site should be preserved and zoned for environmental protection to maintain its ecological function as a nature corridor,

c. Land available for potential subdivision and urban development should be confined to the elevated southwest corner of the site, and confined to the west of the 50m environmental buffer to the adjacent EEC.

d. Variation to reduce the recommended 50m width to any parts of the environmental buffers should only be considered where this would provide more practical development outcomes and where these variations can be justified by means of further assessment and where any reductions may be offset by increasing the size and/or width of the environmental buffer elsewhere on this site.

6.0 REFERENCES

Adam, P. (1994a) *Australian Rainforests.* Oxford University Press, Oxford, U.K.

Adam, P (1994b) Chapter 14: Saltmarsh and mangrove, in *Australian Vegetation: Second Edition* Groves, R.H. (ed) pg 157-196 Cambridge University Press, Great Britain.

Adam, P. (1995) Urbanization and Transport in *Conserving Biodiversity: Threats and Solutions* (eds) Bradstock, R.A, Auld, T.D., Keith, D.A., Kingsford, R.T., Lunney, D. & Sivertsen, D.P. pg. 55-75 Surrey Beatty & Sons, Chipping Norton, Australia.

AAUD (2005) *Moonee Waters Coastal Village Preliminary Assessment Lot 66 DP 551005 Pacific Highway Moonee Beach* Prepared by Annand Alcock Urban Design for Hillview Heights Pty Ltd.

Beier, P. & Noss, R.F. (1998) Review: Do habitat corridors provide corridor? *Conservation Biology 12 pp 1241-1252.*

Bennett, A.F. (1999) *Linkages in the Landscape: The Role of Corridors and Connectivity in Wildlife Conservation* IUCN The World Conservation Union.

Bennett, A.F. (1991) Roads, roadsides and wildlife conservation: a review, in Saunders, D.A., & Hobbs, R. J. (Eds.)(1991) *Nature Conservation 2: The Role of Corridors.* Surrey Beatty & Sons Pty. Ltd., Chipping Norton, Australia.

Bennett, A.F. (1990) *Habitat Corridors: Their role in Wildlife Management and Conservation.* Department of Conservation and Environment, Melbourne, Australia.

Benson, D. & McDougall, L. (1998) Ecology of Sydney Plant Species: Part 6; dicotyledon family Myrtaceae. *Cunninghamia. Vol. 5(4): 808-9874.*

Donaldson A. & Bennett A. (2004) *Ecological effects of roads: Implications for the internal fragmentation of Australian parks and reserves.* Parks Victoria Technical Series No. 12. Parks Victoria, Melbourne.

Downes, S.J., Handasyde, K.A. & Elgar, M.A (1997) The use of corridors by mammals in fragmented Australian eucalypt forests *Conservation Biology 11 pp 718-726.*

Fanning, F.D. & Leonard, G. (2005) *Lot 66 DP 551005, Moonee Beach Proposed Residential & Tourist Development Flora and Fauna Assessment Report* Gunninah Environmental Consultants Crows Nest (Unpublished report) February.

Fisher, M., Body, M. & Gill, J. (1996) *The Vegetation of the Coffs Harbour City Council LGA* Unpublished report prepared for Coffs City Council.

Fox, B.J., Taylor, J.E., Fox, M.D., and Williams, C. (1997) Vegetation Changes Across Edges of Rainforest Remnant Biological Conservation: 82, 1-13.

Gunninah Environmental Consultants 2006. Lot 66 in DP 551005, Moonee Beach, Moonee Waters Residential Development and Conservation Reserve. Flora and Fauna Assessment.

Harty, C. (1997) *Mangroves in New South Wales and Victoria* Vista Publications, Melbourne.

Hobbs, R. (1992) Function of biodiversity in Mediterranean ecosystems in Australia: definitions and background. in Hobbs, R. (Ed) *Biodiversity in Mediterranean Ecosystems in Australia*. Surrey Beatty & Sons Pty. Ltd., Chipping Norton.

Hobbs, R.J. & Yates, C.J. (2000)(eds) *Temperate Eucalypt Woodlands in Australia: biology, conservation, management & restoration* Surrey Beatty & Sons, Chipping Norton.

Hughes, L. & Westoby, M. (1994) Climate change and conservation policies in Australia: coping with change that is far away and not yet certain *Pacific Conservation Biology 1 pp308-318* Surrey Beatty & Sons, Chipping Norton.

Kirkpatrick, J. (1994) *A Continent transformed: Human Impact on the Natural Vegetation of Australia* Oxford University Press, Melbourne, Australia.

Lambeck, R.J. & Saunders, D.A. (1993) The role of patchiness in reconstructed wheatbelt, in *Nature Conservation 3: Reconstruction of Fragmented Ecosystems* Saunders, D., Hobbs, R.& Ehrlich, P.(Eds.) Surrey Beatty & Sons Pty. Ltd., Chipping Norton, Australia.

Lawrence, W.F. 1991 Edge effects in tropical forest fragments: application of a model for the design of nature reserves. Biological Conservation: 57, 205-219

Lindenmayer, D.B. (1994) Chapter Three, Timber harvesting in the Montane Ash Forest of the Central Highlands of Victoria: Impacts at different spatial scales of arboreal Marsupials and the implications for ecologically sustainable forest use, in *Ecology and Sustainability of Southern Temperate Ecosystems* Norton, T.W. & Dovers, S.R. (Eds) CSIRO Publishing Australia.

Lindenmayer, D.B. (1998) *Forest Issues 4: The design of wildlife corridors in wood production forests* NSW NPWS Hurstville.

Lindenmayer, D. & Burgman, M. (2005) *Practical Conservation Biology* CSIRO Publishing.

Martino, D. (2001) Buffer Zones Around Protected Areas: A Brief Literature Review. Electronic Green Journal, Issue 15. ISSN: 1076-7075.

McDougall, K. & Kirkpatrick, J.B. (1994)(eds) *Conservation of lowland native grasslands in south-eastern Australia* World Wild Life Fund for Nature Australia.

Norton, T.W & May, S.A. (1994) Towards sustainable forestry in Australian temperate eucalypt forests: Ecological Impacts and priorities for conservation, research and management in *Ecology and Sustainability of Southern Temperate Ecosystems* Norton, T.W. & Dovers, S.R. (Eds) CSIRO Publishing Australia.

NSW Scientific Committee (2001) *Clearing of native vegetation - key threatening process declaration- final determination* http://www3.environment.nsw.gov.au/npws.nsf/content/clearing+of+native+vegetation+key+threatening+process+declaration.

Ramp, D., Wilson, V.K. & Croft, D.B. (2006) Assessing the impacts in peri-urban reserves: Road-based fatalities and road usage by wildlife in the Royal National Park.

Recher, H.F. (1999) The state of Australia's avifauna: a personal opinion and prediction for the new millennium *Australian Zoologist 31 pp11-29.*

Reid, J.R.W. (2000) *Threatened and declining birds in New South Wales Sheep-Wheat Belt: II. Landscape relationships – Modelling birds atlas data against vegetation cover* Prepared by CSIRO Sustainable Ecosystems for NSW NPWS.

Sandpiper (2003) *Lot 66 DP 551005 Moonee Fauna Assessment* Unpublished report Prepared by Sandpiper Ecological Surveys Pty Ltd for IRC Properties Pty Ltd; Provided as Appendix 3 in Fanning & Leonard (2005).

Saunders, D. & Hobbs, R. (1991)(eds.) *Nature Conservation 2: The Role of Corridors* Surrey Beatty & Sons, Chipping Norton, Australia.

Saunders, D., Beattie, A., Eliot, S., Fox, M., Hill, B., Pressey, B., Veal, D., Venning, D., Maliel, M & Zammit, C. (1996) Chapter 4: Biodiversity in *Australia: State of the Environment*, *1996,* Alexander, N. (ed) CSIRO, Collinwood, Australia.

Scotts, D. (2003) *Key habitats and corridors for forest fauna: A landscape framework for conservation in north-east New South Wales* Occasional Paper 32, NSW National Parks and Wildlife Service Hurstville.

Scotts, D. & Drielsma, M. (2003) Developing landscape frameworks for regional conservation planning; an approach integrating fauna spatial distributions and ecological principles *Pacific Conservation Biology 8 pp 235-254* Surrey Beatty & Sons, Chipping Norton.

Soule, M.E., Mackey, B.G., Recher, H.F., Williams, J.E., Woinarski, J.C.Z., Driscoll, D., Dennison, W.C. & Jones, M.E. (2004) The role of connectivity in Australian conservation *Pacific Conservation Biology 10 pp266-79* Surrey Beatty & Sons, Sydney.

Taylor, B.D. & Goldingay, R.L. (2003) Cutting the carnage: wildlife usage of road culverts in north-eastern New South Wales, in *Wildlife Research 30 pp529-538.*

Wilson, A. & Lindenmeyer, D.B. (1995) *Wildlife Corridors and the Conservation of Biodiversity: A Review* Greening Australia Ltd, Canberra Australia.

Woinarski, J.C.Z.. McCosker, J.C., Gordon, G., Lawrie, B., James, C., Augusteyn, J., Slater, L. & Danvers, T. (2006) Monitoring changes in the vertebrate fauna of central Queensland, Australia, over a [period of broad-scale vegetation clearance, 1973-2002 *Wildlife Research, 33 pp263-274.*

Winning, G. 1997. The functions and widths of wetland buffers, Hunter Wetlands Research Technical Memorandum No. 1. Unpublished.