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Ecological Assessment
Whelan Insites - August 2010

Sandy Beach North

Lot 22 in DP 1070182 Pacific Highway Sandy Beach

Ecological Constraints & Development Opportunities

9th August 2010

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Lot 22 in DP 1070182 Pacific Highway Sandy Beach

Ecological Constraints & Development Opportunities

9th August 2010

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SANDY BEACH

ECOLOGICAL CONSTRAINTS & DEVELOPMENT OPPORTUNITIES

9th August 2010

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PART A	**INTRODUCTION & INFORMATION BASE**

1 INTRODUCTION

1.1 The Subject Site

The subject site (Lot 22 in DP 1070182 Pacific Highway, Sandy Beach) occupies approximately 49.5 hectares of land, surrounding the southern half of Hearnes Lake, 3km south of Woolgoolga, on the mid-north coast of NSW (Figure 1).

The subject site is located immediately north of the existing village of Sandy Beach, and is bound by:

- the Pacific Highway to the immediate west;
- Double Crossing Creek to the immediate north, with Crown Land to the immediate north of the eastern part of the site;
- the frontal dune system and Crown Land to the immediate east; and
- the existing village of Sandy Beach to the immediate south.

In addition to those features, Hearnes Lake (an ICOLL[1]) occupies a tongue of 'land' which projects into the subject site from the north. This results in a site with three main physical elements *viz*:

- a narrow eastern portion which includes *inter alia* part of the frontal dune along Sandy Beach and the eastern foreshores of Hearnes Lake;
- a southern portion which fronts the existing residential development of Sandy Beach village and which encompasses the southern extremity of Hearnes Lake; and
- a broad western tract of land located between the Pacific Highway and Hearnes Lake (Figure 2).

The subject site has long been used for agricultural purposes, particularly the grazing of cattle and the slashing of the groundcover vegetation (and occasional burns) to promote the growth of grasses and herbs suitable for grazing.

As a consequence of those activities over a long period, there are portions of the subject site which are devoid of tree canopy and native vegetation, and the majority of the site has a 'park-like' appearance with canopy trees and a maintained (slashed) and grazed grassy understorey.

[1] ICOLL – Intermittently Closed and Open Lake or Lagoon.

1.2 Part 3A Major Project Application

The subject site was zoned in 2000 by Coffs Harbour City Council (CHCC), with the approval of the Department of Planning (DoP), in part for residential purposes and in part for environmental protection (see Figure 1 in the *Response Report* of Willana 2010).

The existing (1988) zoning of the land was re-confirmed by CHCC in 2000, as indicated in the DoP-approved *Local Environmental Plan* (LEP), identifies:

- most of the site for residential purposes:
    - *2(a) - Residential Low Density* in the southern two-thirds of the site as well as in the northeastern corner; and
    - *2(e) - Tourism* in the northwestern position of the site, between the Pacific Highway and Hearnes Lake;
- defined bands on the site for environmental protection purposes, being:
    - *7A - Environmental Protection – Habitat and Catchment* in a band around the shores of Hearnes Lake; and
    - *7B - Environmental Protection – Scenic Buffer* in a narrow band along the western boundary, immediately adjacent to the Pacific Highway.

The site is currently the subject of a *Part 3A Application* by Sandy Shores Developments pursuant to the *Environmental Planning & Assessment Act 1979* (EP&A Act) for residential development of part of the land (approximately half of the site) and designation of a substantial portion of the land for biodiversity conservation purposes (Figure 3). All of the land zoned for *Environmental Protection* purposes is to be retained and managed, with the exception of a single access road crossing to the Pacific Highway. In addition, a substantial portion of that part of the land which is currently zoned for *Residential* purposes (as acknowledged in the *Mid-North Coast Regional Strategy*) is to be retained and managed *inter alia* for biodiversity conservation purposes.

It is also of importance to note that the land (both developed and retained) is to be managed in perpetuity by a *Community Title* scheme that will ensure the ongoing engagement of the residents in the appropriate management of the whole site. This approach will facilitate achievement of the goals of the LEP (indeed, will exceed those expectations) and the objectives of the *Mid-North Coast Regional Strategy* at no cost to Council or the State Government.

Residential and tourism development of part of the subject site is proposed in three separate precincts, occupying 280 lots (Figure 3):

- the Western Precinct, which occupies the land to the immediate east of the Pacific Highway between a buffer to Double Crossing Creek in the north, a buffer to Hearnes Lake in the east, and an area of retained land *inter alia* for the Wallum Froglet to the south;
- the Southern Precinct, which is located along the southern boundary of the subject site immediately adjacent to the existing Sandy Beach village, and constitutes a direct extension of that village; and
- the Eastern Precinct, which is located on the rear part of the beach dune system in the northeastern part of the subject site, to the east of Hearnes Lake.

The proposal also involves the retention of approximately half of the subject site as a *Conservation Area*, to be managed for biodiversity conservation purposes and to protect the ecosystems of Hearnes Lake. The *Conservation Area* is to be managed as *Community Title* land, as noted above.

The *Part 3A Application* was the subject of an *Environmental Assessment Report* (EAR) and associated documentation, including *inter alia* a number of *Reports* with respect to ecological issues on the site and assessment of the potential environmental impacts of the proposal on the site and on Hearnes Lake. In addition to the array of ecological survey and assessment *Reports* prepared by Phil Conacher (see below), there have been two *Reports* prepared by ecologists for the Department of Planning (DoP) with respect to the ecological attributes (or the alleged ecological attributes) of the subject site (see below).

1.3 Endangered Ecological Communities

This *Ecological Constraints & Development Opportunities Report* has been prepared *inter alia* in order to resolve differences of opinion with respect to the presence and distribution of "*endangered ecological communities*" (EECs) on the subject site at Sandy Beach.

The conflicting positions provided in various *Reports* regarding the subject site relate particularly to:

- the presence or otherwise of the Subtropical Coastal Floodplain Forest (SCFF) "*endangered ecological community*" listed in the *Threatened Species Conservation Act 1995* (TSC Act); and
- the distribution on the subject site of the SCFF community and the Swamp Sclerophyll Forest on Coastal Floodplains (SSFCF) "*endangered ecological community*".

In this regard:

- detailed surveys, vegetation mapping and *Reports* by Phil Conacher (Conacher Travers 2005, 2006, 2007a, b; Conacher Environmental Group 2008) have identified three patches of vegetation as (in part at least) examples of the SSFCF community (Figure 4), with one patch immediately south of Hearnes Lake, a second patch along the southern boundary of the subject site, and a third patch[2] in the southwestern part of the site; and
- two *Reports* prepared on behalf of the Department of Planning (DoP) by Sainty & Associates (2006) and by Ecograph (2008), which identify a substantially greater extent of the SSFCF community (and/or the SCFF community), including virtually all of the woodland vegetation on the western side of the subject site along the Pacific Highway (Figure 5).

Further details of the divergent views and positions of the various ecological consultants regarding the presence and the distribution of the EECs on the subject site, and the basis for those views and opinions, are provided in Chapter 2 of this *Report*.

It is relevant to note that the *Reports* and assessments prepared by Phil Conacher are based on a substantial field survey program, including *inter alia* the conduct of 23 vegetation survey quadrats on the subject site. The *Reports* by Sainty & Associates (2006) and Ecograph (2008), by contrast, rely on a

[2] The third patch contains two small areas of SSFCF and a larger area identified by Conacher Travers as "*Eucalypt/Swamp Sclerophyll Transition Forest*", on slightly more elevated ground.

single day (at most) site survey in each case, and provide no new empirical data to support the premises contained therein.

1.4 Scope of This Report

As indicated above, the site at Sandy Beach is the subject of a Part 3A Major Project for residential development of 280 lots and the retention of approximately half of the site for conservation purposes (Figure 3). The site and the proposal have been the subject of a number of ecological investigations and *Reports*, and the project has been the subject of a public exhibition process. The ecological assessments of the site (see below) have raised some issues, which are the subject *inter alia* of this *Report*.

As discussed in some detail below (in Chapter 3 of this *Report*), the principal issues which need to be resolved with respect to ecological matters are:

- the presence or otherwise of one or other of the "*endangered ecological communities*" in the western part of the subject site;
- the validity (or otherwise) of the denial of development opportunities by Sainty in the southwestern part of the site on ecological grounds; and
- the rationale and its validity (or otherwise) for denial by Sainty & Associates of any development opportunities in the northeastern portion of the site, on the rear of the frontal dune and on land adjoining Hearnes Lake foreshore areas.

The scope of this *Report* is:

- to review all of the material prepared by the various consultants regarding the ecosystems present on the subject site (Conacher Travers 2005, 2006, 2007a, b; Conacher Environmental Group 2008; Sainty & Associations 2006; Ecograph 2008);
- to review the *Final Determinations* for the potentially relevant "*endangered ecological communities*" – the Swamp Sclerophyll Forest on Coastal Floodplains (SSFCF) community and the Subtropical Coastal Floodplain Forest (SCFF) community;
- to undertake a supplementary investigation of the subject site in order to clarify the specific nature of the vegetation types present;
- to resolve the differences of opinion expressed by various consultants, and to determine the true nature of vegetation on the subject site; and
- to determine an appropriate, reasonable and balanced development footprint on the subject site which facilitates the achievement of both reasonable and responsible development aspirations and reasonable and appropriate biodiversity conservation goals, in accordance with the 2000 LEP zoning and the *Mid-North Coast Regional Strategy*.

In addition to resolving those matters with respect to the presence or otherwise of "*endangered ecological communities*", this *Report* provides commentary regarding:

- the *Coffs Harbour City Council* (CHCC) *Vegetation Strategy*, and its validity and/or accuracy;
- the basis for and the validity (or otherwise) of Council's *Hearnes Lake DCP*; and
- the relevance of the *Mid-north Coast Regional Strategy*.

1.5 Structure of This Report

In order to achieve the goals and objectives of this *Report*, and to address the relevant issues with respect to the relevant ecological constraints to development on the subject site at Sandy Beach, this *Report* addresses each of the primary issues separately (notwithstanding a level of interrelation between them).

The following chapters of this *Report* document the relevant material and issues:

- Chapter 2 details the information based upon which the opinions and observations contained in this *Report* are based;
- Chapter 3 addresses the presence and distribution of "*endangered ecological communities*" (EECs) on the subject site;
- Chapter 4 considers the issue of buffers and setbacks championed by Sainty;
- Chapter 5 addresses the development constraints and opportunities in the northeastern portion of the subject site (the Eastern Precinct);
- Chapter 6 provides recommendations with respect to the design of the Part 3A project;
- Chapter 7 considers the relevant planning instruments (see above); and
- Chapter 8 provides a summary of the *Report* and a set of *Conclusions*.

2 INFORMATION BASE

The information upon which this *Ecological Constraints & Development Opportunities Assessment Report* is based has been obtained from three primary sources:

- *Reports* and documentation associated with the *Part 3A Application* and the *Environmental Assessment Report* (EAR), including those prepared for the DoP;
- relevant planning instruments, Council *Reports* and studies, and the *Mid-north Coast Regional Strategy* prepared by the Department of Planning (DoP); and
- empirical data obtained during inspections of the subject site by Environmental InSites staff, specifically for this *Report*.

2.1 Previous Investigations

As noted above, the subject site has been surveyed and investigated over a considerable period since the original ecological constraint analysis was undertaken by Phil Conacher in 2004. Investigations and documents addressed in this *Report* include:

- the array of investigations and *Reports* prepared by Phil Conacher with respect to ecological matters on the subject site, resulting from detailed and specific site surveys and investigations conducted between 2004 and 2008 (Conacher Travers, 2005, 2006, 2007a, b; Conacher Environmental Group 2008);
- a *Report* regarding the presence of EECs on the subject site prepared by Sainty & Associates in 2006, arising from a single site inspection conducted in 2006 on a single day (Sainty & Associates 2006);
- a further *Report* commissioned by the DoP regarding the EECs, based on a brief site inspection and utilising data from three of Conacher's quadrats (Ecograph 2008).

It is noted that the assessment and analysis of the subject site and of the appropriate locations for development activities undertaken by Phil Conacher are based on a substantial field survey effort undertaken over a period of 5 years. By contrast, the Sainty 2006 *Report* is based on a single site inspection on a single day, and the Ecograph 2008 *Report* is also based on single brief site inspection.

2.2 Supplementary Site Survey

A initial inspection of the subject site was undertaken by Mr F Dominic Fanning and Ms Fiona Iolini of Environmental InSites on the 1st of June 2010 for the purposes of establishing the nature and layout of the subject site, and to determine the additional data necessary for the preparation of this *Report*.

On the basis of that inspection and review of the associated documentation, it was determined that a supplementary vegetation quadrat survey was warranted, particularly in the western part of the site adjacent to the Pacific Highway (*ie* Vegetation Type B polygon of Conacher Travers 2007a – Figure 4).

The supplementary field survey was undertaken on the 16th of June 2010. The survey consisted of:

- extensive walked traverses over the subject site (Figure 6) recording plant species and identifying vegetation types in an opportunistic manner;

- the analysis of five 30m x 30m quadrats (Figure 6) which were selected;
    - to document the various patches of vegetation on the subject site and facilitate an analysis as to their satisfaction of the criteria for the EECs (or otherwise); and
    - in relatively homogenous patches of vegetation which would collectively address the variability of vegetation types on the subject site but which individually provided a detailed analysis of the canopy characteristics in the different variants; and
- the recording of Braun-Blanquet cover abundance values for each plant species present, particularly with respect to the tree canopy and mid-storey vegetation.

In addition to obtaining floristic data from the subject site, a range of other elements of the environment were recorded or identified in order to address edaphic, locational and topographic elements of the *Final Determinations* for the EECs regarded by some authors as present on the subject site. Relevant information in this regard includes:

- the soil types present at various locations on the site;
- levels of inundation and soil moisture; and
- specific topographic features including the relationship of land to Hearnes Lake and the impact of the adjoining Pacific Highway.

2.3 Other Sources of Information

Other relevant *Reports* and documentation on which this *Report* relies include those in reference to flooding issues, and in particular a recent letter of Cardno Treloar dated 25 June 2010 (Appendix A) which provides a clear summary of the flooding circumstances on the site, both current and those predicated with respect to climate change. I rely on that document to determine the 100 year *Average Recurrence Internal* (ARI) flood levels on the site (see attached Map), and note the comments contained therein with regard to the assumed flood heights assumed by Sainty & Associates (and subsequently adopted by Ecograph 2008).

Other relevant sources of information and data regarding the subject site and its characteristics have been reviewed, including:

- reference material contained on the DECCW website, particularly with respect to "*endangered ecological communities*";
- various judgments of the Land & Environment Court of New South Wales; and
- the *Final Determinations* by the NSW Scientific Committee for the EECs considered by some to be present on the subject site.

Planning instruments and other documents associated with the development potential of the subject site which are of relevance include:

- the *Vegetation Strategy* of Coffs Harbour City Council (CHCC);
- the *Hearnes Lake Development Control Plan* (DCP); and
- the *Mid-north Coast Regional Strategy* prepared by the DoP, and identified as the "***pre-eminent planning document*** *for the mid-north coast*".

Fauna survey locations are approximate and have not been fixed by land survey. *Subject Site boundary subject to final survey

Legend

*Subject Site Boundary

Koala Scat Assessment Quadrat 1 - 14

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Figure 1 -
Koala Scat Assessment Locations
Pacific Highway, Sandy Beach

Ver.F3.1-BB
24/04/07
Ref.No.6107

Source: DLWC 1:25,000 Aerial Photograph,

Flora survey quadrats of Conacher Travers 2007

3 ENDANGERED ECOLOGICAL COMMUNITIES

3.1 The Issues

The three ecological consultants that have provided *Reports* with respect to the subject site (Conacher, Sainty & Associates and Ecograph) agree that:

- the Coastal Saltmarsh (CSM) "*endangered ecological community*" (EEC) is present on the subject site around the edges of Hearnes Lake; and
- some of the vegetation on the subject site conforms to a Swamp Forest EEC.

There is, however, some uncertainty as to which Swamp Forest EEC is present:

- Conacher maintains that the only Swamp Forest EEC present is the Swamp Sclerophyll Forest on Coastal Floodplains (SSFCF) community; whilst
- Sainty & Associates and Ecograph maintain that the SSFCF community and/or the Sub-tropical Coastal Floodplain Forest (SCFF) community and/or ecotonal forest containing characteristics of both Swamp Forest EECs are present.

However, the **key difference** between the position of Conacher and that of Sainty & Associates/Ecograph is the distribution of swamp forest vegetation which is identified as a Swamp Forest EEC on the subject site. In this regard, Conacher maintains that the Swamp Forest EEC is confined to three patches on the subject site (Figure 3), located:

- at the southern end of Hearnes Lake;
- on the southern boundary of the subject site near the southwestern corner; and
- to the southwest of southern part of Hearnes Lake, between two patches of Wallum Heath.

The Conacher Travers mapping of the Swamp Forest EEC is confined to areas which are predominantly lower than 2.5m AHD. It is my observation, however, that the mapping by Conacher Travers is somewhat 'generous', and includes vegetation on more elevated ground that is not representative of the Swamp Forest EECs.

Both Sainty & Associates and Ecograph maintain that the broad band of forest along the western side of the subject site (immediately adjacent to the Pacific Highway) also constitutes the Swamp Forest EEC (Figure 5), whereas Conacher maintains that the vegetation in this part of the site is a 'Eucalypt Dominated Forest', and is not a Swamp Forest EEC (Figure 4). That area of vegetation (Vegetation Type B of Conacher Travers 2007a) occupies land at elevations of approximately 3.2m to approximately 4m AHD.

The **key issues** to be determined therefore are:

- the location and extent of Swamp Forest EEC (be it SSFCF or SCFF or an ecotone of both); and
- what part of community B in the western part of the site constitutes the Swamp Forest EEC.

3.2 Definitions of Endangered Ecological Communities

Determination or otherwise of the presence of an EEC requires consideration of the *Final Determination* for each EEC, prepared by the NSW Scientific Committee. The *Final Determinations* (Appendices C and D) contain (generally) a broad array of descriptors and observations which collectively provide guidance as to the identity of the EEC in question. Of particular importance in this regard are:

- floristic information (generally including a list of "*characteristic assemblage of species*", as well as observations regarding dominant canopy, and sometimes, understorey species);
- locational information (biogeographic regions, LGAs *etc*); and
- edaphic and landform criteria (including soil types, elevations and landform information).

In terms of general locational criteria for the Swamp Forest EECs (Appendices C and D), there is no issue. The subject site is located within a relevant area (the NSW North Coast Biogeographic Region), and is located on the coast. The relevant considerations for this *Report*, therefore, are:

- the **floristic characteristics** of vegetation on the site; and
- the **edaphic criteria** (particularly soils and land form characteristics).

Because ecosystems in general are at least moderately variable (in response to local conditions), the *Final Determinations* for EECs are necessarily somewhat imprecise. For example, the dominance of different species in the tree canopy across even a small patch of an EEC can vary substantially, dependent upon soil, groundwater and topographic variations.

In addition, the plant species which constitute the "*characteristic assemblage of species*" for each EEC are not (with very few rare exceptions) restricted to that EEC or indeed even to a group of closely related EECs (*eg* swamp forest communities on coastal floodplains). In this regard, for example, none of the tree species which are listed in the characteristic assemblages for either the SSFCF or the SCFF communities (Appendices D and E) are restricted (endemic) either to those two EECs or, indeed, to all of the coastal floodplain EECs which have been listed in the TSC Act. Some of the "*characteristic*" tree species (*eg* the Broad-leaved Paperbark *Melaleuca quinquenervia*, Swamp Mahogany *Eucalyptus robusta* and Red Mahogany *Eucalyptus resinifera* ssp. *hemilampra*) are widely distributed, including in vegetation types and habitats which have nothing to do with coastal floodplains.

Thus, the simple presence of a plant species (canopy or understorey) which is in the "*assemblage of species*" for an EEC **cannot**, in isolation of other relevant criteria, be **diagnostic** of or **determinative** for the present of the EEC.

3.3 Floristic Assemblages on the Subject Site

The Conacher Travers *Report* of 2007 provides data from flora quadrats surveyed across the subject site at Sandy Beach. Conacher Travers surveyed twenty three plant survey quadrats across the site (Figure 4), including four (Table 1) in areas of vegetation identified by Conacher Travers as the Swamp Forest EECs, being:

- Swamp Sclerophyll Forest – Vegetation Type C (Quadrats 13, 15 and 17); and
- the Eucalypt – Swamp Sclerophyll Transition Forest – Vegetation Type B/C (Quadrat 1).

Conacher Travers (2007) also provide data from three quadrats (Q3, Q4 and Q5) surveyed in patches of vegetation in the western part of the subject site (Table 1) designated by Conacher Travers as 'Forest (Eucalypt Dominated)' – Vegetation Type B (Figure 4).

Table 1 The presence of canopy trees in 8 of the 23 Conacher survey quadrats on the subject site at Sandy Beach

Common name	**Species name**	**Q1**	**Q3**	**Q4**	**Q5**	**Q8**	**Q13**	**Q15**	**Q17**
Red Mahogany	*Eucalyptus resinifera*	-	-	+	+	-	-	-	-
Broad-leaved Paperbark	*Melaleuca quinquenervia*	+	+	+	+	+	+	+	+
Swamp Turpentine	*Lophostemon suaveolens*	+	+	+	+	-	-	-	-
Black She-oak	*Allocasuarina littoralis*	-	-	-	+	-	-	-	-
Smooth-barked Apple	*Angophora costata*	-	-	-	+	-	-	-	-
Forest Red Gum	*Eucalyptus tereticornis*	+	-	-	-	-	-	+	-
Swamp Mahogany	*Eucalyptus robusta*	+	+	-	-	+	+	+	-

It is Vegetation Type B mapped by Conacher Travers which is the key difference between the opinion of Conacher and the opinions of Sainty & Associates and Ecograph, with the latter classifying the whole of the Vegetation Type B as a Swamp Forest EEC.

It is to be noted that, whilst Conacher Travers undertook detailed plant survey quadrats on the subject site, including within that area of vegetation which is in contention:

- Sainty & Associates neither undertook any detailed quadrat surveys to accurately identify vegetation present on the western side of the subject site nor referred to the data provided by Conacher Travers to analyse the vegetation present; and
- Ecograph similarly conducted no supplementary survey quadrats but did, as least, utilise the data provided by Conacher Travers from those three survey quadrats (Q3, Q4 and Q5) to analyse the vegetation present.

Unlike the Sainty & Associates and Ecograph *Reports*, this *Report* by Environmental InSites BOTH:

- utilises the data provided by Conacher Travers; AND
- relies on detailed supplementary walked surveys and empirical data from plant survey quadrats conducted within the areas of vegetation in contention.

Combination of the data provided by Conacher and that obtained by Environmental InSites from the subject site at Sandy Beach demonstrates that **only limited** parts of the vegetation present in and around the western part of the subject site would **potentially** satisfy the floristic criteria contained in the *Final Determination* for either the SSFCF or the SCFF communities.

Importantly and significantly, only part of the open forest/woodland vegetation present on the western part of the subject site (Vegetation Type B of Conacher Travers 2007) is regarded by the author of this *Report* as satisfying the *Final Determinations* of either the SSFCF or SCFF communities in terms of either the tree canopy or the floristic assembly in general.

Table 2 The numbers of individual canopy trees in the five Environmental InSites survey quadrats on the subject site at Sandy Beach

Common name	**Species name**	**Q1**	**Q2**	**Q3**	**Q4**	**Q5**
Red Mahogany	*Eucalyptus resinifera*	12	-	7	3	2
Broad-leaved Paperbark	*Melaleuca quinquenervia*	5	5	4	9	13
Swamp Turpentine	*Lophostemon suaveolens*	3	4	9	1	3
Black She-oak	*Allocasuarina littoralis*	-	-	1	-	-
Smooth-barked Apple	*Angophora costata*	-	-	-	8	-
Forest Red Gum	*Eucalyptus tereticornis*	-	-	-	-	10
Swamp Mahogany	*Eucalyptus robusta*	-	9	-	-	1

On the basis of our empirical quadrat data (Table 2; Appendix A) and the data provided by Conacher Travers 2007 (Table 1), and on the basis of our extensive walked surveys of the western part of the subject site (Figure 6), vegetation within the area of contention is mapped by us as a mosaic of open forest and woodland with a variable canopy dominated in different patches by the Smooth-barked Apple, Swamp Mahogany, Red Mahogany, Swamp Turpentine and/or Forest Red Gum. The Broad-leaved Paperbark is present throughout the stand of woodland, as a sub-dominant middle stratum tree.

With respect to the floristic assemblages, it is important *inter alia* to note that the Smooth-barked Apple *Angophora costata*:

- is **not** listed in the "*characteristic assemblage of species*" for **either** the SSFCF **or** the SCFF communities; and
- is **not tolerant** of swampy conditions.

Further, the Broad-leaved Paperbark *Melaleuca quinquenervia* is a species which is characteristic of a **wide** array of coastal forest, woodland and tall shrubland communities, including *inter alia* swales and sand plains behind the coastal dune system. Indeed, on the subject site, bands or tracts of vegetation in the eastern part of the subject site, behind the frontal coastal dune system, provide an example of Broad-leaved Paperbark woodland on sand. These patches of vegetation are **not** claimed to be Swamp Forest EEC by Sainty (2006), and do **not** constitute any listed EEC.

Thus, the presence of the Broad-leaved Paperbark in the western part of the subject site is not diagnostic of the presence of either the SSFCF or the SCFF communities.

Given the mosaic of canopy species present, and the non-specificity of the *Final Determinations* for the relevant EECs, some of the woodland in the western part of the subject site (*ie* Vegetation Type B of Conacher Travers 2007) appears, at various locations, to satisfy the floristic criteria for the SSFCF and/or the SCFF communities.

It is to be noted, however, that the understorey vegetation is certainly not "*characteristic*" of "*waterlogged or periodically inundated*" sites. Additionally, some of the tree species present (the Smooth-barked Apple and the Forest Red Gum) are typically located in more elevated and drier habitats, and do not occur preferentially (or at all) in water-logged locations.

3.4 Topographic and Geomorphic Characteristics

Both the Swamp Sclerophyll Forest **on Coastal Floodplains** (SSFCF) community and the Sub-tropical **Coastal Floodplain** Forest (SCFF) community are defined as being located on "*coastal floodplains*" or as being located on features (soils, landforms) that are "*associated with coastal floodplains*" (Appendices D and E).

These two features of the *Final Determinations* for the SSFCF and SCFF communities are addressed in detail below.

3.4.1 Is a Coastal Floodplain Present?

The **key question** with respect to the nature of the relevant patches of vegetation on the subject site, therefore, is the presence or otherwise of a "*coastal floodplain*"[3] on the subject site or adjacent to it, on which (or "*associated with*" which) the vegetation is located.

Proper and careful analysis of the definition of "*floodplain*" contained in the *Final Determinations* by the NSW Scientific Committee for the two Swamp Forest EECs demonstrates that vegetation within the western part of the subject site (*ie* the area in contention) is **NOT** located on a "*coastal floodplain*", as discussed in detail below.

Floodplains, by their very nature, are maintained by and are dependent on 'periodic inundation' from adjoining streams or waterbodies, which provide the alluvium of which they are composed. As noted in the *Final Determinations* (Appendices D and E), "*floodplains are level land form patterns on which there may be active erosion and aggradation* ***by channelled and overbank stream flow with an average recurrence interval of 100 years or less***" (emphasis added). Thus, the extent of a "*floodplain*" can reasonably be regarded as approximating the area which would currently (*ie* in 2010) be inundated in a 100 year *Average Recurrence Interval* (ARI) event[4].

[3] Whilst the term "*floodplain*" is a defined geomorphological feature, there is no formal geomorphological definition of a "*coastal floodplain*". Presumably, it is a floodplain on, or perhaps "*associated with*" (whatever that means), the coast.

[4] Otherwise known as a '1:100 year flood event'.

With respect to the subject site at Sandy Beach, the 100 year ARI flood extent has been mapped (Figure 7) as extending to the 2.4m AHD contour (Cardno Treloar 2010). That area of inundation, which constitutes the "*floodplain*" on the subject site (although see discussion below), substantially contains the areas of vegetation which have been identified by Conacher Travers as the SSFCF community (Figure 4).

Interestingly, and relevantly, the vegetation identified by Conacher Travers 2007 as Vegetation Type B/C (Eucalypt/Swamp Sclerophyll Transition Forest – Figure 4) is located outside of the 100 year ARI flood extent (Figure 7; Chapter 4.1). This vegetation is slightly more elevated than the pure stands of SSFCF identified by Conacher Travers (2007) to the immediate northeast and southwest of that stand (*ie* within the 100 year ARI flood level).

Of particular significance is that **NONE** of Vegetation Type B as mapped by Conacher Travers (2007) is located **below** the 3m AHD contour. N**one** of that land would be "*inundated*" in even a more significant rainfall event than a 100 year ARI storm event. It is of note that several significant storm events in early 2009 did **not** result the inundation of **any** land within the areas proposed for development activities in the western part of the subject site.

The clear and unequivocal conclusion arising from the data and analysis of the hydrologists[5] (Cardno Treloar and Patterson Britton & Partners) is that the western part of the subject site does not constitute a "*floodplain*" at all.

That area of land does **not** become inundated as a result of a 100 year ARI event (*ie* "*overbank stream flow with an average recurrence interval of 100 years or less*"), and would not be subjected to flooding as a result of even a much more intense rainfall event.

The relevant portion of the subject site (*ie* the northwestern elevated land adjacent to the Pacific Highway) is **NOT** located on a "*coastal floodplain*".

Furthermore, that area of land:

- is **NOT** "*waterlogged*"; and
- is **NOT** "*periodically inundated*", other than by incipient rainfall.

There are essentially **no** circumstances in which the western portion of the subject site, on which the Conacher Community Type B is located, would be inundated ("*periodically*" or otherwise) as a result of "*channelled and overbank stream flow*", currently or in the recent past. The lack of any such inundation (noting that the land and the vegetation in question is located above the 3.2m AHD contour and is therefore at least 0.8m **above** the 100 year ARI flood level), demonstrates that the western part of the subject site is **NOT** located on a "*floodplain*".

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[5] I note that neither Sainty & Associates nor Ecograph are hydrologists (nor indeed am I). I rely on the expert opinion of Cardno Treloar (Appendix A) in establishing that the current 100 year ARI level, on the basis of an **EXTREMAL ANALYSIS**, is 2.4m AHD.

I also note that the levels assumed by Sainty regarding the potential berm height for Hearnes Lake, and the likely current and/or future flood levels, have **no basis in fact** (see comments in Appendix A).

There are a number of relevant observations pertaining to this matter:

- the assessment of Patterson Britton & Partners (2004) of data from 1943 onwards is that "*there is **no** evidence that there has been any alteration in the general coastal process at the entrance* [to Hearnes Lake] *over the last 60 years*";
- the sand berm at the entrance to Hearnes Lake is historically always breached (naturally) before the Lake surface reaches a level anywhere near 3m AHD;
- based on the **EXTREMAL ANALYSIS** by Cardno Treloar (Appendix A), the current 100 year ARI flood level on the subject site is 2.4m AHD, and the maximum hydraulic berm height in 1964 (Appendix A) was 1.85m AHD; and
- the water gauge readings collected by Manly Hydraulics (commissioned by the DECCW) form 2005 to 2008 reveal a **maximum** water level in the Lake of 2.15m AHD (Appendix E). Of importance is that of the 13 'major' breakouts of Hearnes Lake over that period, 11 were at Lake levels of between 1.5 and 1.8m AHD, and **NONE** were at levels above 2.15m AHD.

3.4.2 Association with Coastal Floodplains

A further consideration in the identification of the SSFCF and the SCFF communities is the use of the term "*associated with coastal floodplains*" in Paragraph 1 of both *Final Determinations*, in both instances.

The two *Final Determinations* differ slightly in Paragraph 1, but the relevant parts are similar:

- the Swamp Sclerophyll Forest **on Coastal Floodplains** (SSFCF) community is -

  "*the ecological community **associated with** humic clay loams and sandy loams, on waterlogged or periodically inundated alluvial flats and drainage lines **associated with** coastal floodplains*"; and

- the Sub-tropical **Coastal Floodplain** Forest (SCFF) community is -

  "*the ecological community **associated with** clay–loams and sandy loams, on periodically inundated alluvial flats, drainage lines and river terraces **associated with** coastal floodplains*"[6].

As noted above, the **key issue** in both instances is the presence of a "*coastal floodplain*", on which (or "*associated with*" which the vegetation is located. If there is no "*coastal floodplain*" present, neither of these EECs can be present.

General Considerations and Interpretation

For the SSFCF community, the term "*associated with coastal floodplains*" in Paragraph 1 of the *Final Determination* relates to two elements:

- the "*humic clay loams and sandy loams*" with which the community is specifically "*associated*"; and

[6] In both *Final Determinations*, "*floodplains*" are defined as "*level landform patterns on which there may be active erosion and aggradation by channelled and overbank stream flow with an average recurrence interval of 100 years or less (adapted from Speight 1990)*".

- "*waterlogged or periodically inundated alluvial flats and drainage lines*", being the items which are "*associated with coastal floodplains*" (as discussed above).

For the SCFF community, the term "*associated with coastal floodplains*" in Paragraph 1 of the *Final Determination* also relates to two elements:

- the "*clay-loams and sandy loams*" with which the community is **specifically** "*associated*", and
- "*periodically inundated alluvial flats, drainage lines and river terraces*".

Association with Soil Types

With respect to the term "*associated with coastal floodplains*", which occurs in both of the *Final Determinations*, it is **critical** to note that:

- both *Final Determinations* state that the ecogical communities are "*associated with*" certain specific soil types ("*humic clay loams and sandy loams*" in the case of SSFCF and "*clay–loams and sandy loams*" in the case of the SCFF); and
- the use of the term "*associated with*" in these instances (*ie* with respect to the relevant soils) cannot sensibly or reasonably mean some tenuous or peripheral link with those soil types. Rather, it means the communities occur **ON** those soil types, and **not** on other soil types.

Thus, it is **NOT** sufficient that the ecological communities be 'in proximity to' or have some other tenuous 'connection' with those soil types.

The identified soil types **must** be present, else the EEC is **not present**.

Other Criteria

Further, and significantly, many other elements of the *Final Determinations* make it absolutely clear that the relevant EECs are located **ON** "*coastal floodplains*", and are **not** just "*associated with*" them in some undefined, tenuous or peripheral manner (as discussed below for each community).

With respect to the SSFCF community, the *Final Determination* states *inter alia*:

- Paragraph 3 – "*Major examples* [of the SSFCF community] *once occurred **ON the floodplains** of the Tweed, Richmond, Clarence, Macleay, Hastings and Manning Rivers, although smaller **floodplains** would also have supported considerable areas of this community*:;
- Paragraph 6 – "*Swamp Sclerophyll Forest **ON Coastal Floodplains** of the NSW North Coast, Sydney Basin and South East Corner bioregions forms part of a complex of forested and treeless wetland communities found **THROUGHOUT the COASTAL FLOODPLAINS** of NSW*";

- Paragraph 6 – "*The combination of features that distinguish Swamp Sclerophyll Forest **ON Coastal Floodplains** from other endangered ecological communities **ON the COASTAL FLOODPLAINS** include …*"; and
- Paragraph 7 – SSFCF "*may adjoin or intergrade with several other endangered ecological communities, which collectively cover all remaining native vegetation **ON the COASTAL FLOODPLAINS** of New South Wales*".

With respect to the SCFF community, the *Final Determination* states:

- Paragraph 3 – "*Major examples* [of the SCFF community] *once occurred **ON the floodplains** of the Tweed, Richmond, Clarence, Macleay, Hastings and Manning Rivers, although smaller **floodplains** would also have supported considerable areas of this community*:;
- Paragraph 6 – "*Subtropical **Coastal Floodplain** Forest of the NSW North Coast bioregion forms part of a complex of forested and treeless wetland communities found **THROUGHOUT the COASTAL FLOODPLAINS** of NSW*";
- Paragraph 6 – "*The combination of features that distinguish Subtropical **Coastal Floodplain** Forest from other endangered ecological communities **ON the COASTAL FLOODPLAINS** include…*"; and
- Paragraph 7 – SCFF "*may adjoin or intergrade with several other endangered ecological communities, which collectively cover all remaining native vegetation **ON the COASTAL FLOODPLAINS** of New South Wales*".

None of these elements of the *Final Determinations* are equivocal.

Clearly, these communities have a **direct** and **specific** relationship **with** "*coastal floodplains*". They are **NOT merely** "*associated with*" the coastal floodplains in some **peripheral** or **nebulous** fashion.

The Meaning in the Name

Finally, the simple fact that the term "***coastal floodplain***" or "***coastal floodplains***" occurs in the title of both EECs clearly indicates that these communities are located **on** or are **directly** "*associated with*" "*coastal floodplains*". If that not be the case, the names of both EECs (and many others) is at best meaningless and at worst misleading.

In this regard:

- the SSFCF community is the 'Swamp Sclerophyll Forest **ON COASTAL FLOODPLAINS**' community;
- it is **NOT** the 'Swamp Sclerophyll Forest **associated with** Coastal Floodplains' community;
- similarly, the SCFF community is the Sub-tropical **COASTAL FLOODPLAIN** Forest' community;
- it is **NOT** the 'Sub-tropical Forest **associated with** Coastal Floodplain' community.

It should be noted that similar considerations and observations apply to **ALL** other EECS identified as being **ON the coastal floodplains** of New South Wales.

Site Specific Considerations

With respect to the presence and location of the SSFCF community on the subject site, the vegetation in consideration (*ie* that in the western part of the subject site at Sandy Beach):

- is **NOT located** on "*waterlogged .. alluvial flats*";
- is **NOT located** on "*periodically inundated alluvial flats*"; and
- is **NOT located** along "*drainage lines*".

With respect to the presence and location of the SCFF community on the subject site, the relevant stand of vegetation (Vegetation Type B) on the subject site:

- is **NOT located** on "*periodically inundated alluvial flats*";
- is **NOT located** along "*drainage lines*"; and
- is **NOT located** on "*river terraces*".

The relevant area of the subject site (*ie* the western part of the site on which Community B is located) is **neither** "*waterlogged*" **nor** is "*periodically inundated*" other than by incipient rainfall – a circumstance which would apply to virtually the whole landscape, including the surrounding hills during torrential downpours in northern NSW.

On the basis of those observations, **NONE** of the vegetation present in the location of Community B on the subject site constitutes an example of **either** the SSFCF community **or** the SCFF community.

NONE of that vegetation:

- is **ON** a coastal floodplain; or
- is "***associated with***" a coastal floodplain in any direct or relevant manner.

3.5 Conclusions - Swamp Forest EECs

On the basis of the hydrological evidence, and the physical characteristics of the Hearnes Lake catchment and estuary, as detailed above:

- the "*floodplains*" on the subject site at Sandy Beach are restricted in size, and are confined to land below the 2.4m AHD contour (at a maximum); and
- land on the western side of the subject site adjacent to the Pacific Highway (at 3.2m to 4m+ AHD) is located well above the 100 year ARI flood levels.

Importantly, the hydrological evidence of Cardno Treloar (Appendix A) makes it abundantly clear that the characteristics of the Hearnes Lake system are such that the sand berm between the Lake and the ocean is breached under current circumstances well before the lake reaches 2.4m AHD in a 100 year ARI event, based on an **extremal analysis** (Cardno Treloar – Appendix A). The maximum recorded hydraulic berm height is 1.85m AHD, and the 100 year ARI flood level **cannot** be significantly above that level. Thus, there is no possibility of those areas of land on the western side of the subject site which are proposed for development activities (and which are all located above 3.2m AHD) being subjected to inundation as a result of flooding in even a 100 year ARI event.

Given all of those circumstances, it is clear that the vegetation in the western part of the subject site (*ie* that designated by Conacher Travers 2007 as Vegetation Type B):

- is **not located** on a "*coastal floodplain*"; and
- is **not located** on any of the identified features "*associated with coastal floodplains*" (*ie* river terraces, alluvial flats or drainage channels).

With respect to floristic assemblages, the vegetation mapped by Conacher Travers (2007) as Vegetation Type B, in the western part of the subject site, exhibits a mosaic of open forest or woodland characteristics, with different parts of that vegetation dominated in the upper canopy by the Swamp Mahogany, Broad-leaved Paperbark, Red Mahogany and/or Smooth-barked Apple.

Whilst parts of that patch of vegetation do support a floristic assemblage which might be characteristic of the SSFCF or SCFF communities, other parts of the vegetation are dominated by the Smooth-barked Apple which is neither present in the "*characteristic assemblage of species*" for either EEC nor is a species which is tolerant of high soil moisture conditions. Given those circumstances, it cannot be stated that all of Vegetation Type B satisfies the floristic criteria of either the SSFCF or the SCFF "*endangered ecological community*".

On the basis of those considerations, the vegetation mapped by Conacher Travers (2007) as Vegetation Type B (Figure 3) **DOES NOT constitute** an example of either of the Swamp Forest EECs (SSFCF or SCFF) identified on the subject site by Sainty & Associates (2006) or by Ecograph (2008), because:

- some parts at least of that area of vegetation does **NOT** satisfy the floristic criteria for either EEC; and
- **NONE** of the vegetation is located "*on a coastal floodplain*" or is relevantly "*associated with coastal floodplains*".

Consequent on all of the above, the Swamp Forest EECs on the subject site at Sandy Beach are essentially in the locations identified by Conacher Travers (2007).

4 BUFFERS and SETBACKS

4.1 Introduction (the Mantra)

Sainty & Associates (2006) maintain *inter alia* that:

- 100 metre wide buffers to or setbacks from Hearnes Lake are "*required*";
- 50 metre wide buffers to or setbacks from the Swamp Forest EECs, as defined (incorrectly) by Sainty & Associates (2006), are "*required*"; and
- additional setbacks from the 1:100 year flood line are "*required*" to account for climate change and rising sea levels.

The assertions and "*requirements*" of Sainty with respect to "*buffers*" and setbacks are:

- generally excessive and onerous;
- inappropriate and unnecessary given the nature of the site and the impact amelioration measures incorporated into the project;
- unsubstantiated by any objective analysis of the site and of the proposal; and/or
- inconsistent or illogical.

The mere **assertion** by Sainty that setbacks or "*buffers*" of any particular size are "*required*" is simply the personal opinion of Sainty. These so-called 'requirements' for "*buffers*" of various sizes are not mandated by any statute or relevant planning instrument, and are based predominantly on assumptions and personal preferences rather than an objective substantiated analysis of the proposal.

The asserted 'requirements' for various "*buffers*" on the subject site at Sandy Beach provided in the Sainty & Associates 2006 *Report* are addressed individually below. At the outset, however, it is critical to note the comments contained in Chapter 4.5 of this *Report* regarding the critical role of proper and intelligent development design.

Doubtless, in the absence of an intelligent development design and in the absence of appropriate management measures and regimes, the provision of "*buffers*" to sensitive environments or ecosystems may be required in order to minimise or avoid significant adverse impacts. However, in most instances, the need for "*environmental buffers*" can be obviated or reduced by a combination of appropriate and environmentally sensitive urban design and by the appropriate management of potential impacts arising from stormwater discharges and of other direct and indirect impacts which may arise from development activities.

4.2 Buffers to Endangered Ecological Communities

There are two **significant problems** with the Sainty 'requirements' for "*environmental buffers*" to the "*endangered ecological communities*" (EECs) on the subject site at Sandy Beach;

- in the first instance, the EECs on the subject site are not located where Sainty asserts they are (see Chapter 3 of this *Report*); and
- second, Sainty makes a series of unsubstantiated and unjustified assertions regarding the width of buffers allegedly required for EECs.

4.2.1 The Location and Extent of the EECs

With respect to the locations of the EECs, Sainty states that "*the EEC swamp sclerophyll forest and salt marsh are distributed across the site*" (emphasis added).

In this regard, Sainty is **incorrect**.

Not only are those communities **NOT** "*distributed across the site*", but rather they are confined to specific locations (see Chapter 3 of this *Report*). The Swamp Sclerophyll Forest Community (ie the Swamp Sclerophyll Forest on Coastal Floodplains community) is confined to the floodplain areas of the subject site below the 100 year *Average Recurrence Interval* (ARI) contour (of 2.4m AHD).

The large band of vegetation along the western side of the subject site:

- is located on land above approximately 3.2m AHD;
- is **NOT** located on a "*coastal floodplain*"; and
- only partially supports woodland with the floristic characteristics of the SSFCF and/or the SCFF community, and the vegetation is (in any case) **not** located on a "*coastal floodplain*".

4.2.2 The Extent of Buffers

The further assertions by Sainty that the EECs on the site (wherever they are located) "*require*" a certain minimum size buffer is merely an unsubstantiated assertion that pays no heed either to the alleged role of "*buffers*" for such communities or to the circumstances of this particular proposal. The Sandy Beach North project development design has specifically incorporated measures to avoid the discharge of contaminants into wetlands and relevant EECs, and to minimise or avoid the potential for other adverse impacts upon such communities.

In this regard, the claim by Sainty that "*salt marsh, being a low growing community, usually requires a buffer of 30m*" is no more than an unsubstantiated assertion. In fact, provided that the discharge of increased quantities of fresh water and/or increased nutrient loads is avoided by appropriate and intelligent development design, there is little need for any "*buffer*" to a saltmarsh community at all. Saltmarsh communities are highly exposed in the natural environment, and appear highly resilient with respect to 'edge effects' or other impacts.

It is also to be noted that the landward edge of the saltmarsh and sedgeland community around Hearnes Lake is marked generally by an abrupt (albeit small) change in elevation, with a fringe of either Swamp Oak or wallum heath vegetation. These taller plant types provide some protection for the saltmarsh community (to the extent that such protection is required), and would also facilitate ongoing management of the boundary between the communities.

On that basis, and noting that the proposed development maintains an approximately 50m buffer to Hearnes Lake in any case, no additional "*buffer*" to the saltmarsh or sedgeland communities on the subject site is considered necessary.

Sainty further asserts that "*swamp sclerophyll forest requires a buffer to reduce the edge effect on the community and allow for regeneration. Being comprised of taller tree species, the SSF, requires a buffer of 50m*".

Again, this assertion by Sainty is neither justified nor substantiated.

There are many instances of stands of the SSFCF community which have little or no "*buffer*" but which display very limited "*edge effects*". For example, the western edge of vegetation asserted (incorrectly) by Sainty to constitute the SSFCF community on the western side of the subject site abuts the existing Pacific Highway. Despite the **total absence** of **any** measures to minimise or avoid the discharge of contaminated stormwater and/or to limit other "*edge effects*" (*eg* high winds from passing trucks *etc*), the extent of "*edge effects*" from the Pacific Highway into that vegetation is minimal.

The discrete patch of SSFCF vegetation on the southern boundary of the subject site has no "*buffer*" at all from the surrounding pasture, but appears little affected.

Further, Sainty appears to totally disregard the impact amelioration and environmental management measures provided in the substantial *Draft Environmental Site Management Strategy* prepared by Conacher Environmental Group, and lodged with the EAR.

On the basis of the approach and measures described in Chapter 5.5 of this *Report*, and the substantial *Draft Environmental Site Management Strategy* prepared by Conacher Environmental Group, it is patently clear that there is no justification for "*environmental buffers*" of 50m from the EECs identified on the subject site. As also noted below (Chapter 5.4), Sainty himself further accepts that "*effective buffers*" can be substantially less than 50m in width (indeed, as little as 20 metres according to Sainty).

It is to be noted that 'edges' and "*edge effects*" are a **normal part of the natural regime**, and are in fact essential parts of the natural environment. Whilst some "*edge effects*" can be degrading or of negative biodiversity effect (particularly "*edge effects*" which involve pollutants, contaminants, rubbish, trampling or excess access, and effects which are not properly ameliorated or managed), it is **not** the fact that all "*edge effects*" are inimical to the survival of biota or biological diversity generally, or of threatened biota in particular.

Indeed, it can be argued that modifications to the edges of patches of vegetation (be they natural or artificial) provide habitat niches and opportunities for species which might not otherwise be able to survive in that location. There is an array of both flora and fauna species that not only benefit from the presence of 'edges' but depend on them.

It is clear that the **uncritical demonisation** of all "*edge effects*" in **all** circumstances is **not** an **appropriate, objective or scientifically valid** approach in considering *Development Applications*.

4.3 Buffers for Migratory Shorebirds

Sainty claims that "*Hearnes Lake is* [only] ***occasionally*** *frequented by migratory Shore birds*".

Sainty further notes that:

- "*Most species of migratory shorebirds* ***need a large area of open mudflats*** *on which to feed*"; and
- "*a buffer zone that is* ***clear*** *of tall trees or structures that restrict a clear line of sight*" is required for such species (emphases added).

Neither of these circumstances currently exist in most parts of the subject site adjoining Hearnes Lake:

- the peripheral Saltmarsh and/or sedgelands around the Lake are predominantly densely vegetated, and do not provide significant foraging habitat (*ie* "*open mudflats*" or sandflats) for most of the potential migratory shorebirds; and
- there is a fringing band of paperbarks, Swamp Oak and/or wallum shrubland around much of the Saltmarsh and/or sedgelands around the Lake that would in fact "*restrict a clear line of sight*" for such species.

There is **NO basis**, **NO justifcation** and **NO requirement** for a 100m setback from the Coastal Saltmarsh vegetation lining Hearnes Lake for the benefit of "*migratory shorebirds*". Further, to impose such an onerous restrictive constraint for 'occasional' migratory shorebirds is unreasonable and unjustifiable.

It is to be noted that the Department of the Environment, Water, Heritage & the Arts (DEWHA) has determined that the proposal is **NOT** a "*controlled action*" pursuant to the EPBC Act. That assessment includes consideration of the potential impacts of the **current** proposal on *inter alia* migratory shorebirds.

4.4 Effective Buffers

Sainty notes that "***Effective buffers*** *vary from around* ***20m*** *to 100m and more*" (emphases added).

In other words, a 20m wide buffer can be '**effective**' if properly designed and managed, and if the adjoining development is properly designed.

In fact, depending on circumstances and the vegetation type, a **much smaller** "*buffer*" can be effective. Edges are a natural phenomenon (see above) and do not always need 'buffering'. Further, intelligent design and proper management can readily achieve the role of a "*buffer*" over distances of a few metres.

In any case, the "*buffers*" to the EECs provided in the Sandy Beach North development design satisfy the 'requirement' of "***20m*** *to 100m*" cited by Sainty. In addition, as discusssed below, implementation of the substantial *Draft Environmental Site Management Strategy* prepared by Conacher Environmental Group, as a *Commitment* of the proponent, obviates the need for greater "*buffers*" than are proposed.

Sainty further states that:

- "*In a development adjacent to an Endangered Ecological Community, there is usually potential to vary the width of the buffer to allow for site specific practicalities, provided* ***any loss of buffer width*** *can be made* [sic] *by 'offsets' elsewhere on the site*" (emphasis added).

This appears nonsensical.

Either a "*buffer*" **is** needed (at whatever the minimum width designated or alleged is necessary) in order to **actually** provide **real** protection for an EEC, **or it is not**. If a smaller buffer (*eg* of 20m) is acceptable, "*to allow for site specific practicalities*", then there is **no justification** for any larger buffer requirement.

4.5 Development Design

The **key** to the **need for** (if indeed there be a need), and to determining the **appropriate size** of, any 'buffers' required is **PROPER** and **INTELLIGENT development design.**

As noted by Sainty, 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 & Mulongoy 2006).

Therefore, the generation of an environmentally sensitive and responsible development design, which minimises "*potentially damaging external influences*" and/or which avoids "*inappropriate forms of land use*", theoretically (at least) **could obviate** the need for **any** buffers, at least in some circumstances.

The proposed development at Sandy Beach North has adopted a set of environmental management and design criteria intended specifically *inter alia* to minimise adverse impacts on the substantial areas of conserved vegetation and habitats on the site. The proposal has been particularly sensitive to the presence and values of the ecosystems associated with Hearnes Lake and to the EECs present on the site.

On that basis, the Sandy Beach North project is **NOT** an "***inappropriate*** *form of land use*". It is, to the contrary, an appropriately and sensitively designed project that has sought to minimise or limit adverse impacts on the natural environment.

Specific features of the Sandy Beach North development proposal that obviate the need for the excessive buffers proposed by Sainty include:

- the setbacks from Hearnes Lake which are provided in the existing development design (at least 45m and in most areas >50m – Figure 3);
- the application of current 'best practice' *Water Sensitive Urban Design* (WSUD) principles throughout the project, including the capture and re-use of stormwater on individual lots, the use of bio-retention swales to treat and manage stormwater, the use of detention basins to manage stormwater quality and flows, and the avoidance of piped discharge into Hearnes Lake;
- the management of the buffer and setback areas for passive recreation and other forms of non-invasive activities, thus facilitating their ongoing monitoring and heightening awareness of their management;
- the implementation of a *Community Title Scheme* for the project so that all residents take 'ownership' of the retained vegetation and open space areas, and be encouraged to participate in conservation activities and in management and maintenance *inter alia* of the "*buffers*";
- the application of a comprehensive *Vegetation Management Plan* (VMP) for the "*buffers*" and open space areas on the site to ensure the protection of habitat (including for wading birds) and water quality within Hearnes Lake; and
- implementation of the substantial *Draft Environmental Site Management Strategy* prepared by Conacher Environmental Group, which was lodged with the EAR and which forms part of the *Statement of Commitments* for the project.

4.6 Conclusions – Buffers and Setbacks

The need for "*environmental buffers*" between the proposed Sandy Shores development and retained vegetation and Hearnes Lake has been either obviated *in toto* or, at least, has been reduced in extent, on the basis of:

- the appropriate and environmentally sensitive design of the proposed development on the subject site at Sandy Beach;
- the incorporation of stringent water quality control measures and measures to control human and domestic pet access; and
- the substantial *Draft Environmental Site Management Strategy* prepared by Conacher Environmental Group.

The proposed development has been designed in full cognisance of the sensitivity of various features on the subject site, particularly the "*endangered ecological communities*" (EECs) present and the ecosystems of and around Hearnes Lake. The development concept has been derived with the need to protect such sensitive environments and ecosystems in mind, and has incorporated a range of measures to facilitate that protection, including the provision of appropriate "*environmental buffers*".

In this regard, the proposed Sandy Beach North Project has incorporated:

- **appropriate and satisfactory** setbacks from and "*buffers*" to the correctly identified Swamp Forest EECs present on the subject site;
- **appropriate and effective** "*environmental buffers*" around Hearnes Lake (greater than the 20m "*effective buffers*" of Sainty);
- stormwater management measures (including water quality control and water volume discharge controls) to **ensure** that high water quality is maintained in and around the Hearnes Lake ecosystems;
- measures to **control and manage** human access to sensitive ecosystems and wetlands, including Hearnes Lake; and
- measures to ensure that there will be **no decline** in the water quality within Hearnes Lake, and **no likelihood** of eutrophication as a consequence of the proposed development on the subject site.

By contrast, the **arbitrary** "*buffers*" 'required' by Sainty & Associates (2006) are **incorrectly located**, are **excessive**, are **unnecessary** and **unsubstantiated**. These 'constraints' on development of the site have been imposed by Sainty **without regard** to the details of the proposal or to the impact amelioration measures proposed.

The arbitrary "*buffers*" of Sainty on the site at Sandy Beach are inappropriate and unjustified.

5 THE EASTERN PRECINCT

5.1 The Issues

With respect to the Eastern Precinct (located in the northeastern corner of the subject site), the Sainty & Associates 2006 *Report* maintains that:

- a "*30m environmental buffer will be **required** as a **minimum setback** from the eastern boundary to protect the dunes fronting the beach and the areas within Coffs Coast Regional Park*" (emphasis added).

The approach of Sainty & Associates to the Eastern Precinct is both **superficial** and **perfunctory**.

Sainty provides **NO justification** for the required "*30m environmental buffer*" (see Chapter 5.3), and there is **NO** objective basis for any such 'requirement'.

5.2 The Circumstances

The subject site at this location, including the rear (landward) part of the top of the coastal dune system, supports a maintained grassland, which is both slashed and grazed, with scattered trees (Appendix B). There is **no** erosion or bare sand present, and the density of weed species is **much lower** in the dune system on the subject site than is the case within the adjoining Coastal Park.

Indeed, the **principal concern** at this location is that a lack of proper maintenance and management in the Coastal Park will adversely affect the values of the subject site, rather than the other way around. It is more likely that, absent the current management of the subject site, weeds would rapidly invade the site from the Coastal Park.

Further, there is no evidence that the current management regime in the northeastern part of the subject site is imposing any adverse impacts upon the adjoining Coastal Park, at all. Vegetation within the Coastal Park (much of which is dominated by introduced weeds such as the Bitou Bush and/or the 'environmental weed' – Coastal Wattle) is growing densely up to the boundary fence at present (Appendix B), with no apparent harm from the ongoing management of the subject site. Long-term use of the subject site for cattle grazing appears to have had no adverse impact upon the vegetation within the Coastal Park.

Further, coastal dune vegetation, absent intensive direct impacts such as trampling or clearing, is highly resilient. This type of vegetation is located on naturally highly exposed areas, and is highly unlikely to be susceptible to "*edge effects*".

The proposed residential development of the Eastern Precinct on the subject site would **NOT** be likely to impose adverse impacts upon either the coastal dune vegetation or Hearnes Lake and its immediate surrounds. Further, because the development areas are based on a sand substrate, it is anticipated that all stormwater runoff would be discharged into the dune and sand plain soils by infiltration processes. This approach would *inter alia* protect vegetation in the eastern part of the coastal dune and in and around Hearnes Lake. The use of appropriately designed bio-retention swales and detention basins is proposed, along with the implementation of other WSUD processes and systems.

Given the implementation of the recommendations identified below (and in the substantial *Draft Environmental Site Management Strategy* prepared by Conacher Environmental Group) in respect of management of development on the Eastern Precinct, it is the opinion of the author of this *Report* that there is absolutely no justification for a "*30m environmental buffer*" from the Regional Park.

5.3 The Justification (or Not)

The Sainty & Associates *Report* (2006) '**requires'** the provision of a "*30m environmental buffer*" on the eastern boundary adjoining the Coffs Coast Regional Park. As noted above, Sainty provides **no justification** for this "*buffer*", and deals with the Eastern Precinct and his 'required' "*buffer*" in just over four lines of text in his *Report* in an entirely **perfunctory** manner.

There is **NO justification** either provided by Sainty or which can objectively be provided for the "*30m environmental buffer*" (see Chapter 5.2).

The only 'justification' provided by Sainty with respect to the buffer at this location is contained not in the 2006 *Report* (dated September 2006) but in an email (dated the 21st of September 2006) to Mr Ray Lawlor of the Department of Planning (DoP). In that email, Sainty states that:

> "*It* [presumably the Coastal Park] ***needs*** *a 30m buffer from the boundary – the* ***same*** *as we gave the littoral rainforest at Hearnes Lake rd. I* ***do not want*** *development right up to the fence*" (emphases added).

This missive from Sainty is of **considerable concern** because:

- Sainty **merely** restates his subjective **assertion** regarding the '**need'** for a "*30m buffer*", without providing **any** science, rationale or substantiation of that alleged requirement;
- the reference to "*littoral rainforest*" is **irrelevant** as there is **no** "*littoral rainforest*" (in either its general sense or in its formal sense pursuant to SEPP 26 and/or the TSC Act) present on the subject site; and
- the mere fact that Mr Sainty '**wants'** or **does** "***not want***" something (in this case "*development right up to the fence*") is **utterly and entirely irrelevant**. Mr Sainty's **personal desires do not qualify** as justification for the provision of a buffer at this location.

A further concern with respect to this correspondence is a subsequent email from Mr Ray Lawlor of the DoP to other DoP officers, within about 2 hours of receiving the email from Sainty, and the directions of Mr Lawlor contained therein. In that regard, Mr Lawlor states *inter alia* that:

- the constraints map for "*Sandy Beach North needs to show a 30m buffer to the dunal foreshore area along the eastern boundary*"; and
- "*this will mean totally removing the isolated area labeled 'potential development area' within the northeast section of the site. This area will instead be hatched as environmantal* [sic] *buffer*".

The **significant concerns** with this set of correspondence are:

1 the **absence of any objectivity or justification** by Sainty for his 'personal desires' with respect to opposing development on that part of the site;

2 the **immediacy** with which Mr Lawlor, as a representative of the DoP, responded to the **desires** of Sainty; and

3 the **uncritical and unquestioning imposition** of **substantial constraints** on the development potential of privately owned land by the DoP on the basis of a **highly personal and subjective** 'requirement' from Sainty, and the **total lack of any objective or reasoned assessment** of the circumstances.

5.4 Recommendations

It is the recommendation of the author of this *Report* that:

- a **10 metre** wide *Management Buffer* be provided along the eastern boundary of the site (adjoining the Coffs Coast Regional Park) to provide a **managed interface** between development in the Eastern Precinct and the Regional Park;
- the *Management Buffer* be **actively maintained** using native and/or non-invasive introduced grasses and scattered native shrubs **to prevent invasion** from the Coastal Park of the subject site by Bitou Bush, Coastal Wattle or other weed species;
- the *Management Buffer* also be actively maintained to provide a **fire protection zone** and an **access** for fire-fighting trucks; and
- additional detailed design of the stormwater treatment and infiltration systems be undertaken at the DA stage to ensure that **no** piped stormwater discharges into Hearnes Lake occur. Rather, stormwater should be treated to remove any sediment or contaminants and/or discharged by infiltration into the underlying sand substrate and/or by overland flow from bio-retention swales and/or detention basins in more intense rainfall events.

6 PLANNING INSTRUMENTS

With respect to the subject site at Sandy Beach, the *Mid-North Coast Regional Strategy* identifies the majority of the subject site (indeed a greater area than is currently proposed for development activities) as one of the "***Growth Areas***" for the Mid-North Coast (Figure 8).

Whilst the *Strategy* does not obviate the need to undertake site-specific assessment of potential development constraints and opportunities, the currency of the *Strategy* (dated March 2009) **MUST** be regarded as providing guidance as to the **appropriate** locations for urban growth (if that not be the case, the *Strategy* is worthless).

It is **significant** to note in this regard that the *Mid-North Coast Regional Strategy* states *inter alia* that the *Strategy*:

- sets the "***regional*** *parameters for future* ***strategic planning***";
- ensures "*that* ***adequate*** *land is available and appropriately located to accommodate the projected housing and employment needs of the region's population over the next 25 years*";
- "*sets the policy to govern* ***where and how*** *growth can occur*" and "*places* ***limits*** *on growth in some areas where the value of* ***environmental****/cultural assets and* ***natural resources*** *is high*";
- "*is the* ***pre-eminent*** *planning document for the Mid-north Coast*".

In respect of those matters, it is also of **significance** and **relevance** to note that the *Regional Strategy* identifies the subject site as one of the "*growth areas*" for the Mid-north Coast (Figure 8), but does **not** identify either the subject site or any land in this locality as being one of the "*Growth Areas requiring significant issues to be resolved*" (Appendix 2 of the *Strategy*).

Thus, the *Mid-North Coast Regional Strategy* **both**:

- identifies the subject site as part of the "*Growth Areas*" for the region; **and**
- fails to identify the subject site as an area "*requiring significant issues to be resolved*".

With respect to the environmental planning instruments of Coffs Harbour City Council (CHCC):

- the mapping of vegetation pursuant to the *Koala Plan of Management* (KPoM) is incorrect insofar as there is **no** evidence of any Koalas presently or previously on the subject site;
- the identification of vegetation on the subject site as of "*High*" or "*Very High Conservation Value*" pursuant to the *Vegetation Strategy* of CHCC is incorrect and inaccurate. There is no evidence that the mapping of vegetation on the subject site has involved the conduct of any appropriate investigations or proper analysis; and
- the *Hearnes Lake/Sandy Beach Development Control Plan* (DCP), which was adopted by Council in 2005 and amended in 2008, is likewise not based on any objective analysis of the subject site or the vegetation contained thereon.

The **inappropriateness** of these environmental planning instruments is clearly reflected in the *Mid-North Coast Regional Strategy* which has identified the subject site as part of the "*Growth Areas*" for the region. Further, the *Mid-North Coast Regional Strategy* does not identify the site as being one of the "*Growth Areas requiring significant issues to be resolved*".

7 RECOMMENDED AMENDMENTS to DEVELOPMENT LAYOUT

7.1 Western Precinct

- In the event that the Highway access to the Western Precinct is required, review the location of the northern access to the Pacific Highway to ensure no interference with the proposed fauna crossing between the DoP-approved Pacific Highway upgrade at Double Crossing Creek.
- Review the details of the stormwater treatment and management features at the DA stage to ensure that there is no piped discharge of stormwater, that all stormwater is treated (and/or re-used) and that stormwater is discharged either by infiltration or by broad overland flow in high rainfall events.

7.2 Southern Precinct

- Curve the east-west access between the Southern and the Western Precinct southwards to the approximate alignment of the existing road north of Sandy Beach, to reduce the clearing of SSFCF at this location.
- Review the details of the stormwater treatment and management features at the DA stage to ensure that there is no piped discharge of stormwater, that all stormwater is treated (and/or re-used) and that stormwater is discharged either by infiltration or by broad overland flow in high rainfall events.

7.3 Eastern Precinct

- Provide a 10 metre wide *Management Buffer* along the eastern boundary (adjoining the Coffs Coast Regional Park) to provide a managed interface between development in the Eastern Precinct and the Regional Park.
- Actively maintain the *Management Buffer* using native and/or non-invasive introduced grasses and scattered native shrubs to prevent invasion of the subject site by Bitou Bush, Coastal Wattle or other weed species.
- Actively maintain the *Management Buffer* to provide a fire protection zone and access track for fire-fighting trucks.
- Review the details of the stormwater treatment and infiltration systems at the DA stage so that no piped stormwater discharges into Hearnes Lake occur. Rather, stormwater should be treated to remove any sediment or contaminants and/or discharged by infiltration into the underlying sand substrate and/or by overland flow from bio-retention swales and/or detention basins in more intense rainfall events.

8 SUMMARY & CONCLUSIONS

This *Report* has been prepared as a 'peer review' and of and to review previous ecological *Reports* regarding the subject site and the proposed *Part 3A Major Project Development* thereon.

8.1 Information Base

The ecological features of the subject site and the potential constraints to development activities which **might** be imposed by various biota and ecosystems are based on a number of investigations of the subject site, and associated *Reports*, including:

- several intensive and detailed investigations of flora and fauna by Mr Phil Conacher over the years 2004-2008;
- a one-day (or less) site inspection by Mr Geoff Sainty in 2006, which did not include the collection of any additional reported data;
- a one-day inspection of the site by Mr Kingston of Ecograph in 2007, which also provides no additional empirical data; and
- two inspection and surveys of the subject site undertaken by Environmental InSites in 2010, which included the collection of specific data from five additional plant quadrats and a substantial array of additional observations and records over the site.

8.2 The Issues

Conacher provides mapping of vegetation on the subject site, and identified the presence of two "*endangered ecological communities*" (EECs):

- Coastal Saltmarsh, which is confined to a fringing band around Hearnes Lake itself; and
- Swamp Sclerophyll Forest on Coastal Floodplains (SSFCF), which Conacher identified in two patches in the southern part of the subject site, as well as associated with a patch of mixed ecotone forest in the south of the site.

The subsequent inspection by Sainty & Associates (2006) claimed that a large band of vegetation on the western side of the subject site adjacent to the Pacific Highway also constituted an example of the SSFCF community and/or in part at least an example of the Sub-tropical Coastal Floodplain Forest (SCFF) community, which is also an EEC. Sainty made that assertion on the basis of a brief analysis of the floristics of that band of vegetation, but provides no empirical data or detailed objective analysis to support his conclusions.

Mr Kingston (Ecograph 2008) has reviewed the *Reports* of Conacher & Sainty, and provides an analysis of vegetation in the western band (Community B of Conacher) using data obtained in plant survey quadrats by Conacher and analysing various elements of the *Final Determination* for the SSFCF and SCFF communities. Kingstown concurs *inter alia* with the identification by Sainty of Community B as a Swamp Forest EEC and/or a mixture of the two Swamp Forest EECs.

A further issue raised with respect to the proposed Part 3A development on the subject site is that of the "*need*" (or otherwise) for "*environmental buffers*" to EECs, Hearnes Lake and/or other features. On the basis of his (**incorrect**) mapping of the Swamp Forest EECs, and on the basis of his (**incorrect**)

assumptions about current and future flood levels on the subject site, Sainty has provided "*environmental buffers*" which constrain the whole of the subject site. The outcome of the Sainty analysis and 'requirements' for "*buffers*" essentially renders the whole of the site undevelopable.

8.3 Swamp Forest EECs

It is the conclusion of this *Report* that the Swamp Forest EECs on the subject site at Sandy Beach are essentially as identified by Conacher (2007a). That conclusion is based on:

- the empirical data provided by Conacher (Conacher Travers 2007a);
- the additional plant survey quadrat data and detailed surveys undertaken by Environmental InSites in 2010;
- a comprehensive analysis of the *Final Determination* for the two Swamp Forest EECs; and
- analysis of the landscape and physical characteristics of the site.

Whilst some parts of Community B **could** potentially or theoretically, **on a floristic basis alone**, constitute examples of the Swamp Forest EECs, **NONE** of that vegetation is located "*on a coastal floodplain*". **Nor** is that vegetation or landform "*associated with a coastal floodplain*" in any meaningful or relevant manner.

Thus, **NONE** of the vegetation present in Community B constitutes an example of either of the Swamp Forest EECs.

The Swamp Forest EECs, on the basis of a proper and objective analysis of the criteria contained in the *Final Determinations* for those EECs, are **confined essentially** to the land which is affected by the 100 year Average Recurrence Interval (ARI) flood level. That land is located approximately **below** the **2.4m** AHD contour on the subject site (Figure 7).

Significantly, the mapping of the SSFCF community by Conacher conforms substantially to vegetation located on land below or about that contour.

8.4 The Need (or Not) for Buffers

Sainty provides a range of assertions and claims regarding the requirement or "*need*" for "*environmental buffers*" of various sizes over the subject site.

However, the Sainty *Report* contains internal inconsistencies with respect to "*environmental buffers*", admitting *inter alia* that "*effective buffers*" can be provided over a distance of 20m in some circumstances. Further, Sainty entirely ignores the circumstances of the subject site and the impact amelioration and environmental management measures contained within the proposal.

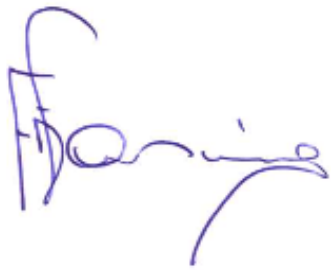
Finally, Sainty makes a totally unsubstantiated and unjustified demand for a 30m setback from the Coastal Park to the immediate east of the subject site. Sainty provides no justification for that 'requirement', and indeed there is no objective or rational justification available.

8.5 Development Design & Environmental Management

The proposed Part 3A North Sandy Beach development, which is documented in the *Environmental Assessment* (EA) and associated *Reports*, is an appropriate and reasoned proposal for the subject site, which has been generated in full cognizance of the ecological and environmental constraints present.

Important features of the proposal include:

- the setback of all development activities from Hearnes Lake and the relevant EECs;
- the provision of a comprehensively designed stormwater management system and regime which is intended *inter alia* to maintain high water quality and to minimise the discharge of any contaminants, pollutants or other materials into the natural environment;
- a commitment to the rehabilitation and ongoing management of vegetation in retained areas within the subject site according to the comprehensive detailed *Draft Environmental Site Management Strategy* prepared by Conacher Environmental Group; and
- incorporation of the retained vegetation and habitats into a Community Lot to be managed by the local residents pursuant to a *Community Title Scheme*, thus directly involving local residents in the ongoing management of the land for biodiversity conservation purposes.



F Dominic Fanning
Director – Environmental InSites

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Sandy Beach North

Lot 22 in DP 1070182 Pacific Highway
Sandy Beach

Ecological Constraints & Development Opportunities

Appendix A
Correspondence from Cardno Treloar regarding flooding issues in Hearnes Lake

3rd August 2010

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Shaping the Future

25 June 2010

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Attention: Mr Bill Yassine - Director

Dear Sir,

SANDY BEACH NORTH RESIDENTIAL DEVELOPMENT
REVIEW OF ENTRANCE BERM LEVEL/FLOOD EFFECTS AND FLOOD RISK

Preamble

Cardno Lawson Treloar (CLT) have been engaged by Sandy Shores Development Pty Ltd (SSD) to review a range of reports that have been prepared for them and the Department of Planning/Coffs Harbour City Council. These reports cover a range of issues that relate to or affect planned residential development on a site north of Sandy Beach on the north coast of NSW. They are listed in the References section of this letter.

The site is located adjacent to the Pacific Highway, about 20km north of Coffs Harbour. It is referred to as Lot 22 in DP1070182 and adjoins the northern boundary of the existing Sandy Beach township. The site also adjoins the northern and western shorelines of Hearns Lake and extends to the rear of the back beach dunes along Hearns Lake Beach.

Sydney NSW Property Consultants are acting as Project Managers for SSD and have requested that CLT address the following issues:-

- What is the appropriate entrance berm level to adopt for flood modelling of Double Crossing Creek and Hearns Lake; now and in the future?
- What is the degree of flood hazard related to this site?
- Is there an entrance opening policy for Hearns Lake?
- Any other relevant issues

This report does not repeat many of the detailed reporting aspects that have been prepared for this site, but refers to them as needed.

Entrance Berm Level

Hearns Lake is described as an ICOLL - an Intermittently Closed and Open Lake or Lagoon. The entrance berm level for an ICOLL is affected by the local wave climate and sediment volume and characteristics, as well as the catchment flows (frequency, peak flow, volume) and tidal prism of the estuary. BMT WBM (2009) describe the Hearns Lake Entrance berm as being dynamic. The entrance is usually closed, but opens naturally following sufficient catchment rainfall.

A flood modelling investigation was undertaken for SSD by Patterson Britton and Partners (2005), who have also undertaken a 'Scientific Assessment of Entrance Berm Elevation' (2007) as additional advice to SDD. WMA Water (2009) have reviewed a range of reports for the Department of Planning and their summary of entrance berm elevation is presented on their Page 15. It is higher than that assessed by Patterson Britton and Partners – 2.6m to 3.0m AHD compared with 1.6m AHD by Patterson Britton. However, WMA Water use the term 'maximum berm height' loosely and do not appear to make an assessment of the hydraulic berm level, merely reporting assessments by others and do not acknowledge that berm levels are spatially variable and that that characteristic affects berm overtopping and initiation of the entrance breakout.

There are contrary opinions on what should be adopted as the berm level for flooding.

The Draft Flood Risk Management Guide: Incorporating sea level rise benchmarks in flood risk assessments, including the Appendix - Ocean boundary conditions for hydraulic flood modelling, as published by the Department of Environment, Climate Change and Water (NSW) have been considered in this assessment.

Berm Level Assessment

Patterson Britton and Partners (2007) present plan views and berm levels based on photogrammetric analyses of berm profiles prepared by the Department of Natural Resources. There are seven of these figures relating to analysed dates of 1943, 1964, 1973, 1986, 1996, 2000 and 2004.

Patterson Britton and Partners also mark the minimum level flow path (continuous) across the dune crest. This is the path that rising flood waters will find, and then gradually scour deeper, as the lake level rises and discharge to the sea commences. It is what may be called the functional or hydraulic level. The 'highest' berm levels are not important in this context and it is a mistake to interpret them that way. This level is different in every one of the analysed cases of photogrammetric data.

The maximum hydraulic berm level is limited by the site specific wave climate and the frequency of entrance opening events - as well as the available volume of sand – when opening naturally. The entrance generally opens naturally towards the north, a consequence of site specific wave conditions and greater eastward protection of the shoreline on the southern side of the entrance. Entrance opening characteristics will have been modified by human activity such as land use.

An analysis of the seven available photogrammetric berm level data sets leads to the following limiting hydraulics levels:-

1943 - 1.008
1964 - 1.848
1973 - 1.194
1986 - 1.546
1996 - 1.142
2000 - 1.125
2004 - 1.459

Note that Patterson Britton and Partners (2007) estimated the 1964 berm level to be 2.6m AHD, but there is a lower hydraulic berm level in that photogrammetric data set. Philip Haines of WBM, in his email to Martin Rose and Marcelle Mills dated 19 January 2006, advises that berm levels at the southern end of the entrance berm are higher than those at the northern end 'due to the regularity of entrance breakouts and scouring of the berm'. This point is agreed.and emphasizes the fact that the much lower berm levels at the northern end of the entrance berm are the appropriate levels to be used in flooding analyses. There is no evidential basis for suggesting that the higher southern area berm levels develop at the northern end of the berm. The DECCW guide cited above advises in Section A4.2 to use 'a range of known historical (berm) configurations'.

An extremal analysis of this data leads to an hydraulic berm level at the 20-years average recurrence interval (ARI) of 1.44m AHD. Although there is little data, there is more confidence in this result than an assessed value. Moreover, it has relevance in that it is consistent with the NSW Government's flood modelling policy that advises that the 100-years ARI flood should be modelled with the 20-years ARI ocean level hydrograph - a joint occurrence condition. Where the entrance is closed initially, the hydraulic berm level is commonly the initial controlling downstream boundary condition. The equivalent, joint occurrence relationship is then the 20-years ARI hydraulic berm level. This is the most likely 100-years ARI flood scenario, as considered by the NSW Government's flood modelling policy. ICOLL flood model simulations are best undertaken applying a numerical model that includes sediment transport and the related entrance scour morphological changes, as well as combined flood flows, wave processes and storm tide. These processes then provide a slightly lower peak flood level than is achieved with a fixed bed model. Patterson Britton and Partners (2005) did not include entrance scour in their flood modelling and hence on that basis their flood level results will be marginally conservative having also adopted a berm level of 1.6m AHD. It is acknowledged that the early photogrammetric data is less reliable than the later data. However, removing that data reduces the sample size and that reduces the confidence in the results also.

Patterson Britton (2004) undertook a detailed investigation of the long term stability of the Hearns Lake entrance berm area, extending upstream to the drop-over area. The outcome of that analysis was that 'there is no evidence that there has been any alteration in the general coastal processes at the entrance over the last 60 years.' This outcome is agreed by WBM (2006), Page 3-9.

The DECCW guide is consistent with this analysis and approach described above; this approach is a formalization of the principle of the guide to consider the range of known historic configurations as set out in Section A4.2 to use " a range of known historical configurations"- no mention of an unspecified 'maximum berm level' as mentioned by WMA Water (2009) on their page 6.

The hydraulic berm level for a 'blocked' entrance adopted by Patterson Britton and Partners was 1.6m AHD. This is a less frequent event than the realistic, recommended level of 1.5m (1.46) AHD and is closer to a 60-years ARI entrance berm hydraulic level.

Based on the extremal analysis of the available berm data, the hydraulic level is unlikely to exceed 1.8m AHD (the approximate 100-years ARI berm level, present sea level) in the present climate. A mean sea level rise would gradually build the 20-years ARI berm hydraulic level by an equal amount so that by 2100 it may be 1.44 + 0.86 ≈ 2.3m AHD. This allows for a sea level rise of 0.9m from 1990 levels (DECCW, 2009a), but also accounts for the observed rise in sea levels between 1990 and 2004 (the last photogrammetric date) of 3mm/year (DECCW, 2009b). The berm may also translate landward. This approach to the application of sea level rise is supported by DECCW (pers. comm. Phil Watson DECCW - Doug Treloar). Note that this berm level would only occur at 2100 and until then it would be lower. A future hydraulic berm level at the 100-years ARI would be 1.8m + 0.86m ≈ 2.7m AHD.

There is no basis for the Sainty & Associates (2006) opinion that the berm level '. . . could reasonably increase to a height of 3m (AHD?)...' and then to add 0.5m as an additional sea level rise effect '.... to accommodate predicted maximum sea levels...' His argument that storms and king tides could raise the berm level to 3m overlooks the fact that storms and king tides have been occurring for millennia, and that their effects are included already in observed berm-crest levels.

Worley Parsons Patterson Britton (2008) recommendation for the 2100 Hearns Lake flood level of 2.95m or 3.0m AHD is realistic. Note that they only adopted a 10% rainfall increase for catchment runoff calculation (using RAFTS) and DECCW advise 20% increase. This change is unlikey to cause a significant increase in lagoon flood level, noting that Worley Parsons Patterson Britton (2008) do not include continuing erosion of the entrance berm. That process would lower the peak water level a little. At peak discharge the velocity through the entrance is about 3m/s. When this speed is greater than ¼ of the nearshore wave celerity (about 5.5m/s = √gd_), which is the case here, the onshore propagating waves will be blocked and break further offshore – reducing actual wave set-up.

Mr Hurrell appears to criticize this report because the pilot channel and berm crest levels were not increased in line with SLR in the climate change scenarios. This report (CLT 2010) would advise that the 20-years ARI berm level that would be appropriate with the climate change 100-years ARI catchment flood is 2.3m AHD – see above, which is lower than the peak ocean level. In this situation the entrance would break-out rapidly because the flood level in the lake exceeds the ocean level. It is not appropriate to consider that, or likely for, the 100-years ARI flood to occur together with the 100-years ocean level; they being only weakly correlated processes. Mr Hurrel's view that the lake flood level could be significantly higher than 3m AHD is not supported – principally because the hydraulic level of the berm is not likely to exceed 2.7m AHD following SLR of 0.9m and flood levels are flat in the lake itself.

CLT have assessed that the 2100 hydraulic berm level is unlikely to exceed 2.7m AHD and hence that the berm would be overtopped and scour in such flood events. Water level data recorded in the lake by MHL show that as water level peaked in the lake at about 1.6m AHD, the entrance opened rapidly allowing the lake level to fall by about 0.6m - 28 January 2005, for example. Hence berm level would have been less than 1.6m AHD at that time (in order to allow overtopping and scour) and the rapid entrance opening process demonstrates that together with realistic berm levels the blocked entrance case that concerns Mr Hurrell is not a realistic scenario for this site. Other break-out instances are presented in Patterson Britton (2007) using the MHL data. In all flood cases, six or seven over two years, the water level dropped very rapidly indicating a breakout more effective than assumed by Patterson Britton. Hence their pilot channel approach is conservative.

An additional area of conservatism in the Patterson Britton flood modelling is in the adoption of peak ocean water levels of 2.6m and 2.2m AHD for the 100 and 20-years ARI peak ocean levels, respectively. CLT advise that the Hearns Lake entrance is more protected than many lagoon entrances (hence the lower berm levels) and that therefore the wave set-up component of the ocean water level would actually be less, especially in the pilot channel/scoured entrance where full wave breaking would not occur. Moreover, at peak flood flow, nearshore ocean waves would be blocked in the entrance.

Model Calibration

It is understood that there is no data available for model calibration. However, Worley Parsons Patterson Britton (2009) advise that they adopted friction factors consistent with channel and overbank vegetation and which matched friction factors that were similar to those adopted in previous flood studies where calibration data were available. Apart from model schematisation, which was based on reliable survey data, bed friction is the main calibration factor for hydraulic models.

It is understood that Double Crossing Creek is not gauged and calibration of the hydrologic model was not possible. In those circumstances Worley Parsons Patterson Britton adopted model coefficients developed for other coastal catchments. This a reasonable course to adopt.

Hazard Assessment

Patterson Britton and Partners (2005) demonstrate that the extent of high hazard (in terms of depth x velocity), extends only marginally onto the allotments proposed for this development. .

Cardno Lawson Treloar agree that where needed, some land-filling may be appropriate.

It is understood that the approved 45 Hearns Lake Road project has a maximum fill depth of 1.6m.

For access to the site, in the event that it is partially flooded, Cardno Lawson Treloar would advise that roadways be designed to be passable in a future 500-years ARI flood.

It is understood that road works for the approved 45 Hearns Lake Road project are to be at 3m AHD or higher.

Entrance Opening Policy

CLT understand that there is currently no entrance opening policy, that is, artificially, for Hearns Lake. BMT WBM (2009) advise that the lake entrance should not be opened artificially because this is not natural for the lake. The proposed development would be designed so that flood levels in the future (2100 sea level rise) system for the 100-years ARI flood would not affect properties for the future hydraulic entrance bar/berm level of 1.44 + 0.86m = 2.3m AHD or 2.7m AHD. This requirement would most likely be fulfilled by natural opening because the system opens now in much lower flood flows. However, pre-break-out lake levels would be higher and the lake would be deeper, assuming no other changes.

NSW Department of Planning Document CCA 19, prepared by NSW Department of Natural Resources and Patterson Britton and Partners reports findings on ICOLL flushing, based on investigations of ICOLLS; not including Hearns Lake. Based on this information it is likely that Hearns Lake flushes poorly, but water quality may not be compromised, because that is its natural state, provided that catchment flows are not contaminated. Hence runoff from the proposed SSD would need to be treated to a satisfactory level in order to maintain acceptable water quality conditions. Additionally, Coffs Harbour Council needs to ensure that discharges to the lake from sources outside of the lake itself, for example, Double Crossing Creek, also fulfil satisfactory water quality conditions.

Concluding Remarks

Whilst there are some deficiencies in the Worley Parsons Patterson Britton assessment of flood levels in changed climate conditions, there are also conservative aspects to their work. These conservative aspects relate to the adoption of non-site-specific ocean levels and a non-eroding entrance bar of slightly conservative hydraulic level. Worley Parsons Patterson Britton results show little sensitivity to changes in the configuration of their 'pilot channel'. A blocked entrance flood case is unlikely to be important here and the relatively high sheltering of the entrance from Tasman Sea storms leads to entrance berm hydraulic levels that are lower than those observed at other locations. Wave set-up at this site will be lower also because of this sheltering and also because the full extent of wave set-up only develops on a sandy beach, not in an estuarine channel. At the peak of the flood flow waves will be blocked by the high speed (about 3m/s) of the flood flow.

In summary, without undertaking additional simulations, I believe that a 100-years ARI flood level of 3m AHD at 2100 is realistic.

Yours faithfully,

P.D. Treloar
Manager - Coastal, Ocean & Estuarine Studies
for **Cardno Lawson Treloar**

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Sandy Beach North

Lot 22 in DP 1070182 Pacific Highway
Sandy Beach

Ecological Constraints & Development Opportunities

Appendix B
Photographs of the subject site

6th August 2010

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APPENDIX B Photographs of the Subject Site at Hearnes Lake.

Photo 1 Facing north into the Paperbark Forest with a mesic understorey of sedges, grasses in the northwestern corner of the subject site.

Photo 2 The open grazed and slashed woodland, predominantly of Red Mahogany with scattered paperbarks at *Quadrat 1*, in the western part of the site.

APPENDIX B Photographs of the subject site at Hearnes Lake.

Photo 3 Facing south at *Quadrat 2* showing the open grazed and slashed woodland, dominated by Swamp Mahogany and Broad-leaved Paperbark with scattered Swamp Turpentine and Red Mahogany.

Photo 4 Facing south at *Quadrat 3* showing the 'park-like' nature of woodland in the western part of the site.

APPENDIX B Photographs of the subject site at Hearnes Lake.

Photo 5 The Smooth-barked Apple Open Woodland at *Quadrat 4* in Community B of Conacher.

Photo 6 The Forest Red Gum Open Woodland at *Quadrat 5* to the southwest of Hearnes Lake.

APPENDIX B Photographs of the subject site at Hearnes Lake.

Photo 7 The land sloping east toward the southern finger of Hearnes Lake.

Photo 8 The land sloping east toward the southern finger of Hearns Lake indicating the flood level of the lake.

Photo 9 The western side of Hearnes Lake with the Baumea sedgeland in the middle distance (at an approximate elevation of 1.6m AHD) and the pasture grassland (at an elevation of 2.8m+ in the foreground).

Photo 10 A forest Red Gum with hollows in the centre of the subject site to the immediate south of Hearnes Lake.

Photo 11 The drainage ditch in the southwest of the subject site, draining stormwater from the existing village of Sandy Beach.

Photo 12 The drainage ditch.

APPENDIX B Photographs of the subject site at Hearnes Lake.

Photo 13 The patch of Swamp Sclerophyll Forest in the southwestern part of the subject site, with Broad-leaved Paperbark and Swamp Mahogany.

Photo 14 The Paperbark Forest in the southeast corner of the subject site at Sandy Beach.

APPENDIX B Photographs of the subject site at Hearnes Lake.

Photo 15 The rear of the beach dune in the northeast of the subject site, looking south. The proposal is for a 10m setback from the Coastal Park (to the left) with dwellings to be located on the rear part of the dune (in the centre of the photo) and on the rear slope (to the right).

Photo 16 The top of the beach dune system in the northeast of the subject site, looking south. Note the dense vegetation of the Coastal Park to the left.

Sandy Beach North

Lot 22 in DP 1070182 Pacific Highway
Sandy Beach

Ecological Constraints & Development Opportunities

Appendix C
Final Determination for the
Swamp Sclerophyll Forest on Coastal Floodplain community

3rd August 2010

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Environment, Climate Change & Water

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Swamp sclerophyll forest on coastal floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions - endangered ecological listing

NSW Scientific Committee - final determination

The Scientific Committee, established by the Threatened Species Conservation Act, has made a Final Determination to list Swamp Sclerophyll Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions, as an ENDANGERED ECOLOGICAL COMMUNITY in Part 3 of Schedule 1 of the Act, and as a consequence to omit reference to Sydney Coastal Estuary Swamp Forest in the Sydney Basin bioregion from Part 3 of Schedule 1 of the Act. Listing of endangered ecological communities is provided for by Part 2 of the Act.

The Scientific Committee has found that:

1. Swamp Sclerophyll Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions is the name given to the ecological community associated with humic clay loams and sandy loams, on waterlogged or periodically inundated alluvial flats and drainage lines associated with coastal floodplains. Floodplains are level landform patterns on which there may be active erosion and aggradation by channelled and overbank stream flow with an average recurrence interval of 100 years or less (adapted from Speight 1990). Swamp Sclerophyll Forest on Coastal Floodplains generally occurs below 20 m (though sometimes up to 50 m) elevation, often on small floodplains or where the larger floodplains adjoin lithic substrates or coastal sand plains in the NSW North Coast, Sydney Basin and South East Corner bioregions. The structure of the community is typically open forest, although partial clearing may have reduced the canopy to scattered trees. In some areas the tree stratum is low and dense, so that the community takes on the structure of scrub. The community also includes some areas of fernland and tall reedland or sedgeland, where trees are very sparse or absent. Typically these forests, scrubs, fernlands, reedlands and sedgelands form mosaics with other floodplain forest communities and treeless wetlands, and often they fringe treeless floodplain lagoons or wetlands with semi-permanent standing water (e.g. Pressey 1989a).

The composition of Swamp Sclerophyll Forest on Coastal Floodplains is primarily determined by the frequency and duration of waterlogging and the texture, salinity nutrient and moisture content of the soil. Composition also varies with latitude. The community is characterised by the following assemblage of species:

Acacia irrorata
Acmena smithii
Allocasuarina littoralis
Banksia spinulosa
Baumea juncea
Blechnum indicum
Callistemon salignus
Carex appressa
Centella asiatica
Dodonaea triquetra
Entolasia marginata
Eucalyptus botryoides
Eucalyptus resinifera subsp. *hemilampra*
Ficus coronata
Gahnia sieberiana
Glycine clandestina
Hydrocotyle peduncularis
Imperata cylindrica var. *major*
Leptospermum polygalifolium subsp. *polygalifolium*
Lomandra longifolia
Melaeuca ericifolia
Melaleuca quinquenervia
Melaleuca styphelioides
Omalanthus populifolius
Oplismenus imbecillis
Phragmites australis
Pratia purpurascens
Stephania japonica var. *discolor*
Villarsia exaltata
Viola hederacea
Acacia longifolia
Adiantum aethiopicum
Banksia oblongifolia
Baumea articulata
Blechnum camfieldii
Breynia oblongifolia
Calochlaena dubia
Casuarina glauca
Dianella caerulea
Elaeocarpus reticulatus
Entolasia stricta
Eucalyptus longifolia
Eucalyptus robusta
Gahnia clarkei
Glochidion ferdinandi
Gonocarpus tetragynus
Hypolepis muelleri
Isachne globosa
Livistona australis
Lophostemon suaveolens
Melaleuca linariifolia
Melaleuca sieberi
Morinda jasminoides
Oplismenus aemulus
Parsonsia straminea
Polyscias sambucifolia
Pteridium esculentum
Themeda australis
Viola banksii

2. The total species list of the community is considerably larger than that given above, with many species present at only one or two sites or in low abundance. The species composition of a site will be influenced by the size of the site, recent rainfall or drought conditions and by its disturbance (including fire, grazing, flooding and land clearing) history. The number and relative abundance of species will change with time since fire, flooding or significant rainfall, and may also change in response to changes in grazing regimes. At any one time, above-ground individuals of some species may be absent, but the species may be represented below ground in the soil seed banks or as dormant structures such as bulbs, corms, rhizomes, rootstocks or lignotubers. The list of species given above is of vascular plant species, the community also includes micro-organisms, fungi, cryptogamic plants and a diverse fauna, both vertebrate and invertebrate. These components of the community are poorly documented.

3. Swamp Sclerophyll Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions is known from parts of the Local Government Areas of Tweed, Byron, Lismore, Ballina, Richmond Valley, Clarence Valley, Coffs Harbour, Bellingen, Nambucca, Kempsey, Hastings, Greater Taree, Great Lakes and Port Stephens, Lake Macquarie, Wyong, Gosford, Hornsby, Pittwater, Warringah, Manly, Liverpool, Rockdale, Botany Bay, Randwick, Sutherland, Wollongong, Shellharbour, Kiama and Shoalhaven but may occur elsewhere in these bioregions. Bioregions are defined in Thackway and Creswell (1995). Major examples once occurred on the floodplains of the Tweed, Richmond, Clarence, Macleay, Hastings and Manning Rivers, although smaller floodplains would have also supported considerable areas of this community.

4. Swamp Sclerophyll Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions has an open to dense tree layer of eucalypts and paperbarks, which may exceed 25 m in height, but can be considerably shorter in regrowth stands or under conditions of lower site quality. For example, stands dominated by *Melaleuca ericifolia* typically do not exceed 8 m in height. The most widespread and abundant dominant trees include *Eucalyptus robusta* (swamp mahogany), *Melaleuca quinquenervia* (paperbark) and, south from Sydney, *Eucalyptus botryoides* (bangalay) and *Eucalyptus longifolia* (woollybut). Other trees may be scattered throughout at low abundance or may be locally common at few sites, including *Callistemon salignus* (sweet willow bottlebrush), *Casuarina glauca* (swamp oak) and *Eucalyptus resinifera* subsp. *hemilampra* (red mahogany), *Livistona australis* (cabbage palm) and *Lophostemon suaveolens* (swamp turpentine). A layer of small trees may be present, including *Acacia irrorata* (green wattle), *Acmena smithii* (lilly pilly), *Elaeocarpus reticulatus* (blueberry ash), *Glochidion ferdinandi* (cheese tree), *Melaleuca linariifolia* and *M. styphelioides* (paperbarks). Shrubs include *Acacia longifolia* (Sydney golden wattle), *Dodonaea triquetra* (a hopbush),

Ficus coronata (sandpaper fig), *Leptospermum polygalifolium* subsp. *polygalifolium* (lemon-scented tea tree) and *Melaleuca* spp. (paperbarks). Occasional vines include *Parsonsia straminea* (common silkpod), *Morinda jasminoides* and *Stephania japonica* var. *discolor* (snake vine). The groundcover is composed of abundant sedges, ferns, forbs, and grasses including *Gahnia clarkei, Pteridium esculentum* (bracken), *Hypolepis muelleri* (batswing fern), *Calochlaena dubia* (false bracken), *Dianella caerulea* (blue flax lily), *Viola hederacea, Lomandra longifolia* (spiny-headed mat-rush) and *Entolasia marginata* (bordered panic) and *Imperata cylindrica* var. *major* (blady grass). The endangered swamp orchids *Phaius australis* and *P. tankervillei* are found in this community. On sites downslope of lithic substrates or with soils of clay-loam texture, species such as *Allocasuarina littoralis* (black she-oak), *Banksia oblongifolia, B. spinulosa* (var. *collina* or var. *spinulosa*) (hairpin banksia), *Ptilothrix deusta* and *Themeda australis* (kangaroo grass), may also be present in the understorey. The composition and structure of the understorey is influenced by grazing and fire history, changes to hydrology and soil salinity and other disturbance, and may have a substantial component of exotic grasses, vines and forbs.

5. Swamp Sclerophyll Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions provides habitat for a broad range of animals, including many that are dependent on trees for food, nesting or roosting (Law *et al*. 2000). The blossoms of *Eucalyptus robusta* and *Melaleuca quinquenervia* are also an important food source for the Grey-headed Flying Fox (*Pteropus poliocephalus*) and Common Blossom Bat (*Sycoyncteris australis*) (Law 1994), as well as the Yellow-bellied Glider (*Petaurus australis*), Sugar Glider (*Petaurus breviceps*), Regent Honeyeater (*Xanthomyza phrygia*) and Swift Parrot (*Lathamus discolor*). Other animals found in this community include the Osprey (*Pandion haliaetus*), Australasian Bittern (*Botaurus poiciloptilus*), Large-footed myotis (*Myotis adversus*), *Litoria olongburensis* and Wallum Froglet (*Crinia tinnula*).

6. Swamp Sclerophyll Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions forms part of a complex of forested and treeless wetland communities found throughout the coastal floodplains of NSW. A recent analysis of available quadrat data from these habitats identified a distinct grouping of vegetation samples attributable to this community (Keith and Scott 2005). The combination of features that distinguish Swamp Sclerophyll Forest on Coastal Floodplains from other endangered ecological communities on the coastal floodplains include: its relatively dense tree canopy dominated by *Eucalyptus robusta, Melaleuca quinquenervia* or *E. botryoides*, the relatively infrequent occurrence of other eucalypts, *Casuarina glauca* or *Lophostemon suaveolens*; the occasional presence of rainforest elements as scattered trees or understorey plants; and the prominence of large sedges and ferns in the groundcover. It generally occupies small alluvial flats and peripheral parts of floodplains where they adjoin lithic substrates or coastal sandplains. The soils are usually waterlogged, stained black or dark grey with humus, and show little influence of saline ground water.

7. Swamp Sclerophyll Forest on Coastal Floodplains includes and replaces Sydney Coastal Estuary Swamp Forest in the Sydney Basin bioregion. It may adjoin or intergrade with several other endangered ecological communities, which collectively cover all remaining native vegetation on the coastal floodplains of New South Wales. These include Lowland Rainforest on Floodplain in the NSW North Coast bioregion, River-Flat Eucalypt Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions (including the formerly listed Sydney Coastal River-Flat Forest in the Sydney Basin bioregion), Subtropical Floodplain Forest, Swamp Oak Floodplain Forest of the NSW North Coast, Sydney Basin and South East Corner bioregions and Freshwater Wetlands on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions. For example, as soils become less waterlogged, Swamp Sclerophyll Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions may adjoin or intergrade with River-Flat Eucalypt Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions. As soil salinity increases Swamp Sclerophyll Forest on Coastal Floodplains may intergrade with, and be replaced by, Swamp Oak Floodplain Forest of the NSW North Coast, Sydney Basin and South East Corner bioregions. The boundaries between these communities are dynamic and may shift in response to changes in hydrological regimes, fire regimes or land management practices (e.g. Johnston *et al*. 2003, Stevenson 2003). The Determinations for these communities collectively encompass the full range of intermediate assemblages in transitional habitats.

8. A number of vegetation surveys and mapping studies have been conducted across the range of Swamp Sclerophyll Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions. This community includes the *Eucalyptus robusta* (Swamp Mahogany) community identified on coastal alluvium by Douglas and Anderson (2002) and the Coastal Alluvium Swamp Forest complex defined by Anderson and Asquith (2002). In the Comprehensive Regional Assessment of the north-eastern NSW (NPWS 1999), those areas on floodplains mapped as 'Forest Ecosystem 112, Paperbark', and those areas on floodplains mapped as 'Forest Ecosystem 142, Swamp Mahogany' are included within this community. On the Tweed lowlands, this community includes '*Eucalyptus robusta* mid-high to very tall closed forest' (F7), '*Archontophoenix cunninghamiana-Melaleuca quinquenervia* very tall feather palm swamp forest' (F9), those parts of *Melaleuca quinquenervia* tall to very tall open to closed forest' (F8) on alluvial soils and parts of 'Floodplain Wetland Complex' (FL) dominated by *Eucalyptus robusta* or *Melaleuca quinquenervia* (Pressey and Griffith 1992). In the lower Hunter district, this community includes 'Swamp Mahogany-Paperbark Swamp Forest' (map unit 37), Riparian Melaleuca Swamp Woodland (map unit 42) and Melaleuca Scrub (map unit 42a) of NPWS (2000). In the Sydney-Gosford region, this community includes those parts of 'Freshwater Swamp complex' (map unit 27a) dominated by *Eucalyptus robusta* or *E. botryoides* (Benson 1986, Benson and Howell 1994) and parts of the 'Freshwater wetlands - on the floodplains' of Benson and Howell (1990) and Benson et al. (1996). In the Illawarra, this community includes 'Alluvial swamp mahogany forest' (map unit 35) of NPWS (2002). On the south coast, this community includes 'Northern Coastal Lowlands Swamp Forest' (forest ecosystem 175) of Thomas *et al*. (2000) and 'Coastal Sand Swamp Forest' (map unit 45) of Tindall *et al*. (2004). Swamp Sclerophyll Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions is included within the 'Coastal Floodplain Wetlands' and 'Coastal Swamp Forest' vegetation classes of Keith (2002, 2004). There may be additional or unmapped occurrences of Swamp Sclerophyll Forest on Coastal Floodplains within and beyond these surveyed areas.

9. The extent of the Swamp Sclerophyll Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions prior to European settlement has not been mapped across its entire range. However, one estimate estimate based on a compilation of regional vegetation maps suggests that Coastal Floodplain Wetlands, which include Swamp Sclerophyll Forest on Floodplains, currently cover 800-1400 km2, representing less than 30% of the original extent of this broadly defined vegetation class (Keith 2004). Compared to this combined estimate, the remaining area of Swamp Sclerophyll Forest on Coastal Floodplains is likely to be considerably smaller and is likely to represent much less than 30% of its original range. For example, there were less than 350 ha of native vegetation attributable to this community on the Tweed lowlands in 1985 (Pressey and Griffith 1992), less than 2500 ha on the Clarence floodplain in 1982 (Pressey 1989a), less than 700 ha on the Macleay floodplain in 1983 (Pressey 1989b), up to 7000 ha in the lower Hunter - central coast district during the 1990s (NPWS 2000), and less than 1000 ha in the Sydney - South Coast region in the mid 1990s (Tindall *et al*. 2004), including less than 40 ha on the Illawarra plain in 2001 (NPWS 2002) and about 450 ha on the South Coast in the 1990s (Thomas *et al*. 2000).

10. Swamp Sclerophyll Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions has been extensively cleared and modified. Large areas that formerly supported this community are occupied by exotic pastures grazed by cattle, market gardens, other cropping enterprises (e.g. sorghum, corn, poplars, etc.) and, on the far north coast, canefields. On the Tweed lowlands, Pressey and Griffith (1992) estimated that less than 3% of the original Floodplain Wetlands and Floodplain Forest remained in 1985. Similar estimates are likely to apply to Swamp Sclerophyll Forest on Coastal Floodplains in other parts of the NSW North Coast bioregion (Goodrick 1970, Pressey 1989a, 1989b). In the lower Hunter - central coast district, about 30 % of the original area of Swamp mahogany - paperbark forest was estimated to remain in the 1990s (NPWS 2000).

11. Land clearing continues to threaten Swamp Sclerophyll Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions. A small minority of the remaining area occurs on public land (e.g. Pressey and Griffith 1992, NPWS 2000), with most occurring on productive agricultural land or in close proximity to rural centres. The remaining stands are severely fragmented by past clearing and further threatened by continuing fragmentation and degradation, flood mitigation and drainage works, landfilling and earthworks associated with urban and industrial development, pollution from urban and agricultural runoff, weed invasion, overgrazing, trampling and other soil disturbance by domestic livestock and feral animals including pigs, activation of 'acid sulfate soils', removal of dead wood and rubbish dumping (e.g. Pressey 1989a, b; Pressey and Griffith 1992, Boulton and Brock 1999, Johnston *et al*. 2003). Anthropogenic climate change may also threaten Swamp Sclerophyll Forest on Coastal Floodplains if future flooding regimes are affected (IPCC 2001, Hughes 2003). Localised areas, particularly those within urbanised regions, may also be exposed to frequent burning which reduces the diversity of woody plant species. Clearing of native vegetation; Alteration to the natural flow regimes of rivers, streams, floodplains and wetlands; Invasion of native plant communities by exotic perennial grasses; Predation, habitat destruction, competition and disease transmission by feral pigs; Anthropogenic climate change; High frequency fire and Removal of dead wood and dead trees are listed as Key Threatening Processes under the Threatened Species Act (1995).

12. Large areas of habitat formerly occupied by Swamp Sclerophyll Forest on Coastal Floodplains have been directly drained by construction of artificial channels (e.g. Pressey 1989a, Boulton and Brock 1999). While much of the early drainage works were associated with agricultural

development, more recently they are associated with urban expansion. Additional areas that have not been directly drained may have been altered hydrologically by changed patterns of flooding and drainage following flood mitigation works, particularly the construction of drains, levees and floodgates (Pressey and Griffith 1992). On the north coast of NSW, expansion of *Melaleuca quinquenervia* into open floodplain swamps has been attributed to artificial drainage and shortening of the hydroperiod (Johnston *et al*. 2003, Stevenson 2003). These changes appear to be closely associated with enhanced acidity, altered ionic ratios, increased dissolved organic carbon and sulfide oxidation in the soil profile (Johnston *et al*. 2003).

13. Relatively few examples of Swamp Sclerophyll Forest on Coastal Floodplains remain unaffected by weeds. The causes of weed invasion include physical disturbance to the vegetation structure of the community, dumping of landfill rubbish and garden refuse, polluted runoff from urban and agricultural areas, construction of roads and other utilities, and grazing by domestic livestock. The principal weed species affecting Swamp Sclerophyll Forest on Coastal Floodplains include *Andropogon virginicus* (whiskey grass), *Anredera cordifolia* (Madeira vine), *Ageratina adenophora* (crofton weed), *Baccharis halimifolia* (groundsel bush), *Cinnamomum camphora* (camphor laurel), *Lantana camara* (lantana), *Ligustrum sinense* (small-leaved privet), *Lonicera japonica* (Japanese honeysuckle) and *Ludwigia peruviana* (Keith and Scott 2005).

14. Small areas of Swamp Sclerophyll Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions are contained within existing conservation reserves, including Bungawalbin, Tuckean and Moonee Beach Nature Reserves, and Hat Head, Crowdy Bay, Wallingat, Myall Lakes and Garigal National Parks. These occurrences are unevenly distributed throughout the range and unlikely to represent the full diversity of the community. In addition, wetlands within protected areas are exposed to hydrological changes that were, and continue to be initiated outside their boundaries. Some areas of Swamp Oak Floodplain Forest are protected by State Environmental Planning Policy 14, although this has not always precluded impacts on wetlands from the development of major infrastructure.

15. Given the dynamic hydrological relationship between Swamp Sclerophyll Forest on Coastal Floodplains, Coastal Saltmarsh and other endangered ecological communities on coastal floodplains, future management of water and tidal flows may result in the expansion of some communities at the expense of others. Proposals for the restoration of natural hydrological regimes and for the rehabilitation of acid sulfate soils may also result in changes to the distribution and composition of floodplain communities. Co-ordinated planning and management approaches across whole catchments will be required to address and resolve priorities between different management objectives.

16. In view of the above the Scientific Committee is of the opinion that Swamp Sclerophyll Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions is likely to become extinct in nature in New South Wales unless the circumstances and factors threatening its survival or evolutionary development cease to operate.

Associate Professor Paul Adam

Chairperson

Scientific Committee

Proposed Gazettal date: 17/12/04

Exhibition period: 17/12/04 - 28/01/05

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About the NSW Scientific Committee

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Ecological Constraints & Development Opportunities

Appendix D
Final Determination for the
Sub-tropical Coastal Floodplain Forest community

3rd August 2010

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Environment, Climate Change & Water

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Subtropical coastal floodplain forest of the NSW North Coast bioregion - endangered ecological community listing

NSW Scientific Committee - final determination

The Scientific Committee, established by the Threatened Species Conservation Act, has made a Final Determination to list Subtropical Coastal Floodplain Forest of the NSW North Coast bioregion, as an ENDANGERED ECOLOGICAL COMMUNITY in Part 3 of Schedule 1 of the Act. Listing of endangered ecological communities is provided for by Part 2 of the Act.

The Scientific Committee has found that:

1. Subtropical Coastal Floodplain Forest of the NSW North Coast bioregion is the name given to the ecological community associated with clay-loams and sandy loams, on periodically inundated alluvial flats, drainage lines and river terraces associated with coastal floodplains. Floodplains are level landform patterns on which there may be active erosion and aggradation by channelled and overbank stream flow with an average recurrence interval of 100 years or less (adapted from Speight 1990). Subtropical Coastal Floodplain Forest generally occurs below 50 m, but may occur on localised river flats up to 250 m elevation in the NSW North Coast bioregion. The structure of the community may vary from tall open forests to woodlands, although partial clearing may have reduced the canopy to scattered trees. Typically these forests and woodlands form mosaics with other floodplain forest communities and treeless wetlands, and often they fringe treeless floodplain lagoons or wetlands with semi-permanent standing water (e.g. Pressey 1989a).

The composition of Subtropical Coastal Floodplain Forest is primarily determined by the frequency and duration of waterlogging and the texture, nutrient and moisture content of the soil. Composition also varies with latitude. The community is characterised by the following assemblage of species:

Acacia concurrens
Allocasuarina torulosa
Angophora paludosa
Angophora woodsiana
Brachychiton populneus subsp. *populneus*
Brunoniella australis
Callistemon viminalis
Casuarina cunninghamiana subsp. *cunninghamiana*
Centella asiatica
Cissus hypoglauca
Commersonia bartramia
Cordyline congesta
Cupaniopsis anacardioides
Cymbidium suave
Cyperus enervis
Desmodium varians
Dianella longifolia
Dichondra repens
Drypetes australasica
Elaeocarpus reticulatus
Entolasia stricta
Eucalyptus acmeniodes
Eucalyptus moluccana
Eucalyptus resinifera subsp. *hemilampra*
Eucalyptus seeana
Eucalyptus tereticornis
Ficus macrophylla subsp. *macrophylla*
Ficus superba var. *henneana*
Gahnia clarkei
Glochidion ferdinandii
Hardenbergia violacea
Hibiscus diversifolius
Hovea acutifolia
Kennedia rubicunda
Laxmannia gracilis
Lomandra longifolia
Lophostemon suaveolens
Mallotus philippensis
Melaleuca decora
Melaleuca quinquenervia
Microlaena stipoides var. *stipoides*
Notelaea longifolia
Oplismenus imbecillis
Parsonsia straminea
Phyllanthus virgatus
Pittosporum revolutum
Pteridium esculentum
Smilax australis
Stephania japonica var. *discolor*
Tricoryne elatior
Viola hederacea

Acacia disparrima subsp. *disparrima*
Alphitonia excelsa
Angophora subvelutina
Aristida vagans
Breynia oblongifolia
Callistemon salignus
Callitris columellaris
Casuarina glauca
Cheilanthes sieberi subsp. *sieberi*
Commelina cyanea
Commersonia fraseri
Corymbia intermedia
Cupaniopsis parviflora
Cymbopogon refractus
Desmodium rhytidophyllum
Dianella caerulea
Dichelachne micrantha
Digitaria parviflora
Echinopogon caespitosus var. *caespitosus*
Entolasia marginata
Eragrostis leptostachya
Eucalyptus amplifolia
Eucalyptus propinqua
Eucalyptus robusta
Eucalyptus siderophloia
Eustrephus latifolius
Ficus obliqua
Gahnia aspera
Geitonoplesium cymosum
Glycine clandestina
Hibbertia scandens
Hibiscus tiliaceus
Imperata cylindrica var. *major*
Lagenifera stipitata
Lomandra filiformis
Lomandra multiflora subsp. *multiflora*
Maclura cochinchinensis
Melaleuca alternifolia
Melaleuca nodosa
Melaleuca styphelioides
Morinda jasminoides
Oplismenus aemulus
Panicum simile
Persoonia stradbrokensis
Pimelea linifolia
Pratia purpurascens
Sigesbeckia orientalis
Smilax glyciphylla
Themeda australis
Vernonia cinerea
Wikstroemia indica

2. The total species list of the community is considerably larger than that given above, with many species present at only one or two sites or in low abundance. The species composition of a site will be influenced by the size of the site, recent rainfall or drought conditions and by its disturbance (including fire, grazing, flooding and land clearing) history. The number and relative abundance of species will change with time since fire, flooding or significant rainfall, and may also change in response to changes in grazing regimes. At any one time, above-ground individuals of some species may be absent, but the species may be represented below ground in the soil seed banks or as dormant structures such as bulbs, corms, rhizomes, rootstocks or lignotubers. The list of species given above is of vascular plant species, the community also includes micro-organisms, fungi, cryptogamic plants and a diverse fauna, both vertebrate and invertebrate. Some of these components of the community are poorly documented.

3. Subtropical Coastal Floodplain Forest of the NSW North Coast bioregion is known from parts of the Local Government Areas of Tweed, Byron, Lismore, Ballina, Richmond Valley, Clarence Valley, Coffs Harbour, Bellingen, Nambucca, Kempsey, Hastings, Greater Taree, Great Lakes and Port

Stephens, but may occur elsewhere in this bioregion. Bioregions are defined in Thackway and Creswell (1995). Major examples once occurred on the floodplains of the Tweed, Richmond, Clarence, Macleay, Hastings and Manning Rivers, although smaller floodplains would have also supported considerable areas of this community.

4. Subtropical Coastal Floodplain Forest of the NSW North Coast bioregion has a tall open tree layer of eucalypts, which may exceed 40 m in height, but can be considerably shorter in regrowth stands or under conditions of lower site quality. While the composition of the tree stratum varies considerably, the most widespread and abundant dominant trees include *Eucalyptus tereticornis* (forest red gum), *E. siderophloia* (grey ironbark), *Corymbia intermedia* (pink bloodwood) and, north of the Macleay floodplain, *Lophostemon suaveolens* (swamp turpentine). Other trees may be scattered throughout at low abundance or locally common at few sites, particularly where there is an influence from lithic substrates upslope. These include *Eucalyptus moluccana* (grey box), *E. propinqua* (grey gum), *E. seeana* (narrow-leaved red gum), *Angophora subvelutina* (broad-leaved apple), *E. robusta* (swamp mahogany), *Eucalyptus resinifera* subsp. *hemilampra* (red mahogany), *E. acmenoides* (white mahogany), *Angophora woodsiana, A. paludosa* and rainforest trees such as *Ficus* spp. (figs) and *Cupaniopsis* spp (tuckeroos). A layer of small trees may be present, including *Allocasuarina torulosa* (forest oak), *Alphitonia excelsa* (red ash), *Glochidion ferdinandi* (cheese tree), *Callistemon* spp. (bottlebrushes), *Melaleuca* spp. (paperbarks) *and Casuarina glauca* (swamp oak). Scattered shrubs include *Breynia oblongifolia* (coffee bush), *Acacia concurrens* (curracabah), *Commersonia* spp., and *Hibiscus* spp. *Occasional vines include Eustrephus latifolius (wombat berry), Parsonsia straminea (common silkpod) and Geitonoplesium cymosum (scrambling lily). The groundcover is composed of abundant forbs, scramblers and grasses including Imperata cylindrica var. major (blady grass), Themeda australis (kangaroo grass), Vernonia cinerea, Dianella caerulea (blue flax lily), Pratia purpurascens (whiteroot), Cheilanthes sieberi subsp. sieberi, and Dichondra repens (kidney weed). The composition and structure of the understorey is influenced by grazing and fire history, changes to hydrology and soil salinity and other disturbance, and may have a substantial component of exotic grasses, vines and forbs.*

5. Subtropical Coastal Floodplain Forest of the NSW North Coast bioregion provides habitat for a broad range of animals, including many that are dependent on trees for food, nesting or roosting (Law et al. 2000). These include species of Cormorant (Phalacrocorax spp.) and Egret (Ardea spp. and Egrettia spp.), the Black-necked Stork (Ephippiorhynchus asiaticus), Osprey (Pandion haliaetus), Brahminy Kite (Haliastur indus), Whistling Kite (Haliastur sphenurus), White-bellied Sea-eagle (Haliaeetus leucogaster), as well as the Brush-tailed Phascogale (Phascogale tapoatafa), Squirrel Glider (Petaurus norfolcensis), Common Blossum Bat (Syconycteris australis) (Law 1994) and Grey-headed Flying Fox (Pteropus poliocephalus). The fauna of Subtropical Coastal Floodplain Forest also includes several species of southern frog (family Myobatrachidae) and tree frog (family Hylidae), such as the threatened Litoria brevipalmata, , and many species of forest birds including honeyeaters, kingfishers, cuckoos, owls, doves, whistlers and fantails.

6. Subtropical Coastal Floodplain Forest of the NSW North Coast bioregion forms part of a complex of forested and treeless wetland communities found throughout the coastal floodplains of NSW. A recent analysis of available quadrat data from these habitats identified a distinct grouping of vegetation samples attributable to this community (Keith and Scott 2005). The combination of features that distinguish Subtropical Coastal Floodplain Forest from other endangered ecological communities on the coastal floodplains include: its dominance by a mixed eucalypt canopy, often with Lophostemon suaveolens; the presence of rainforest elements as scattered trees or understorey plants; the relatively low abundance or sub-dominance of Casuarina and Melaleuca species; the relatively low abundance of Eucalyptus robusta; and the prominent groundcover of soft-leaved forbs and grasses. It may occupy central or marginal parts of floodplains and sandy flats, including Pleistocene back-barrier flats (Pressey and Griffith 1992); habitats where flooding is periodic and soils are rich in silt and sand, sometimes humic, and show little influence of saline ground water.

7. Subtropical Coastal Floodplain Forest may adjoin or intergrade with several other endangered ecological communities, which collectively cover all remaining native vegetation on the coastal floodplains of New South Wales. These include Lowland Rainforest on Floodplain in the NSW North Coast bioregion, River-Flat Eucalypt Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions (including the formerly listed Sydney Coastal River-flat Forest in the Sydney Basin bioregion), Swamp Sclerophyll Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions (including the formerly listed Sydney Coastal Estuary Swamp Forest in the Sydney Basin bioregion), Swamp Oak Floodplain Forest of the NSW North Coast, Sydney Basin and South East Corner bioregions and Freshwater Wetlands on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions. For example, south from the Manning valley, Subtropical Coastal Floodplain Forest of the NSW North Coast bioregion may adjoin or intergrade with River-Flat Eucalypt Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions. As soil salinity increases Subtropical Coastal Floodplain Forest may intergrade with, and be replaced by, Swamp Oak Floodplain Forest of the NSW North Coast, Sydney Basin and South East Corner bioregions. As soils become sandier and more waterlogged, Subtropical Coastal Floodplain Forest may intergrade with, and be replaced by, Swamp Sclerophyll Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions. The boundaries between all of these communities are dynamic and may shift in response to changes in hydrological regimes, fire regimes or land management practices The Determinations for these communities collectively encompass the full range of intermediate assemblages in transitional habitats.

8. A number of vegetation surveys and mapping studies have been conducted across the range of Subtropical Coastal Floodplain Forest of the NSW North Coast bioregion. In the Comprehensive Regional Assessment of the north-eastern NSW (NPWS 1999), areas mapped as 'Forest Ecosystem 46, Eastern Red Gum', and those parts of areas mapped as 'Forest Ecosystem 73, Lowland Red Gum' on coastal floodplains are included within this community. On the Tweed lowlands, this community includes Eucalyptus tereticornis-E. intermedia-Lophostemon suaveolens tall to very tall open forest' (F5) of Pressey and Griffith (1992) and parts of the 'Floodplain Wetland Complex' (FL) dominated by eucalypts or Lophostemon suaveolens (Pressey and Griffith 1992). Subtropical Coastal Floodplain Forest of the NSW North Coast bioregion is included within the 'Coastal Floodplain Wetlands' vegetation class of Keith (2002, 2004). There may be additional or unmapped occurrences of Subtropical Floodplain Forest within and beyond these surveyed areas.

9. The extent of the Subtropical Coastal Floodplain Forest of the NSW North Coast bioregion prior to European settlement has not been mapped across its entire range. However, one estimate based on a compilation of regional vegetation maps suggests that Coastal Floodplain Wetlands, which include Subtropical Coastal Floodplain Forest, currently cover 800-1400 km2, representing less than 30% of the original extent of this broadly defined vegetation class (Keith 2004). Compared to this combined estimate, the remaining area of Subtropical Coastal Floodplain Forest is likely to be considerably smaller and is likely to represent much less than 30% of its original range. For example, there were less than 350 ha of native floodplain vegetation on the Tweed lowlands in 1985 (Pressey and Griffith 1992).

10. Subtropical Coastal Floodplain Forest of the NSW North Coast bioregion has been extensively cleared and modified. Large areas that formerly supported this community are occupied by exotic pastures grazed by cattle, market gardens, other cropping enterprises (e.g. sorghum, corn, poplars, etc.) and, on the far north coast, canefields and tea-tree plantations. On the Tweed lowlands, Pressey and Griffith (1992) estimated that less than 3% of the original Floodplain Wetlands and Floodplain Forest remained in 1985. Similar estimates are likely to apply to Subtropical Coastal Floodplain Forest in other parts of the NSW North Coast bioregion (Goodrick 1970, Pressey 1989a, 1989b, NPWS 1999).

11. Land clearing continues to threaten Subtropical Coastal Floodplain Forest of the NSW North Coast bioregion. Little of the remaining area occurs on public land (e.g. Pressey and Griffith 1992), with most occurring on productive agricultural land or in close proximity to rural centres. Conversion of grazing farms to cropping often involves removal of isolated paddock trees and disturbed patches of vegetation, which locally may be the only remnants of the community. The remaining stands are severely fragmented by past clearing and further threatened by continuing fragmentation and degradation, flood mitigation and drainage works, landfilling and earthworks associated with urban and industrial development, pollution from urban and agricultural runoff, weed invasion, inappropriate grazing, trampling and other soil disturbance by domestic livestock and feral animals including pigs, activation of 'acid sulfate soils' and rubbish dumping (e.g. Pressey 1989a, b; Pressey and Griffith 1992, Boulton and Brock 1999). Anthropogenic climate change may also threaten Subtropical Coastal Floodplain Forest if future flooding regimes are affected (IPCC 2001, Hughes 2003). Localised areas, particularly those within urbanised regions, may also be exposed to frequent burning which reduces the diversity of woody plant species. Clearing of native vegetation; Alteration to the natural flow regimes of rivers, streams, floodplains and wetlands; Invasion of native plant communities by exotic perennial grasses; Predation, habitat destruction, competition and disease transmission by feral pigs; Anthropogenic climate change; High frequency fire and Removal of dead wood and dead trees are listed as Key Threatening Processes under the Threatened Species Conservation Act (1995).

12. Large areas of habitat formerly occupied by Subtropical Coastal Floodplain Forest have been directly drained by construction of artificial channels (e.g. Pressey 1989a, Boulton and Brock 1999). By the early 1900s, drainage unions or trusts were formed on the major floodplains to enable adjacent landholders to arrange for co-ordinated drainage systems, which were designed and constructed by the NSW Department of Public Works. Additional areas that have not been directly drained may have been altered hydrologically by changed patterns of flooding and drainage following

flood mitigation works, particularly the construction of drains, levees and floodgates (Pressey and Griffith 1992). On the north coast of NSW, expansion of Melaleuca quinquenervia and Casuarina glauca has been attributed to artificial drainage and shortening of the hydroperiod (Johnston et al. 2003). These changes appear to be closely associated with enhanced acidity, altered ionic ratios, increased dissolved organic carbon and sulfide oxidation in the soil profile (Johnston et al. 2003).

13. Very few examples of Subtropical Coastal Floodplain Forest remain unaffected by weeds. The causes of weed invasion include physical disturbance to the vegetation structure of the community, dumping of landfill rubbish and garden refuse, polluted runoff from urban and agricultural areas, construction of roads and other utilities, and grazing by domestic livestock. The principal weed species affecting Subtropical Coastal Floodplain Forest include Araujia sericiflora (moth plant), Asparagus asparagoides (bridal creeper), A. plumosus (climbing asparagus fern), Axonopus spp. (carpet grasses), Baccharis halimifolia (groundsel bush), Bidens pilosa (cobbler's peg), Cinnamonum camphora (camphor laurel), Conyza spp. (fleabanes), Hypochaeris radicata (catsear), Ipomoea spp. (morning glories), Lantana camara, Ligustrum sinense (small-leaved privet), L. lucidum (large-leaved privet), Lonicera japonica (Japanese honeysuckle), Olea europacea subsp. cuspidata (African olive), Paspalum dilatatum (paspalum), Pennisetum clandestinum (kikuyu), Rubus fruticosis agg. (blackberries), Senecio madagascariensis (fireweed), Setaria parviflora (slender pigeon grass), Sida rhombifolia (Paddy's lucerne), Solanum mauritianum (wild tobacco bush), S. nigrum (black-berry nightshade), Tradescantia fluminensis (wandering jew) and Verbena bonariensis (purpletop) (Keith and Scott 2005).

14. Small areas of Subtropical Coastal Floodplain Forest of the NSW North Coast bioregion are contained within existing conservation reserves, including Stotts Island, Ukerebagh and Limeburners Creek Nature Reserves and Bundjalung and Myall Lakes National Parks, and these are unevenly distributed throughout the range and unlikely to represent the full diversity of the community.

15. In view of the above the Scientific Committee is of the opinion that Subtropical Coastal Floodplain Forest of the NSW North Coast bioregion is likely to become extinct in nature in New South Wales unless the circumstances and factors threatening its survival or evolutionary development cease to operate.

Associate Professor Paul Adam

Chairperson

Scientific Committee

Proposed Gazettal date: 17/12/04

Exhibition period: 17/12/04 - 28/01/05

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About the NSW Scientific Committee

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Ecological Constraints & Development Opportunities

Appendix E
Water Guage Data for Lewvels in Hearnes Lake
Cardno Treloar

3rd August 2010

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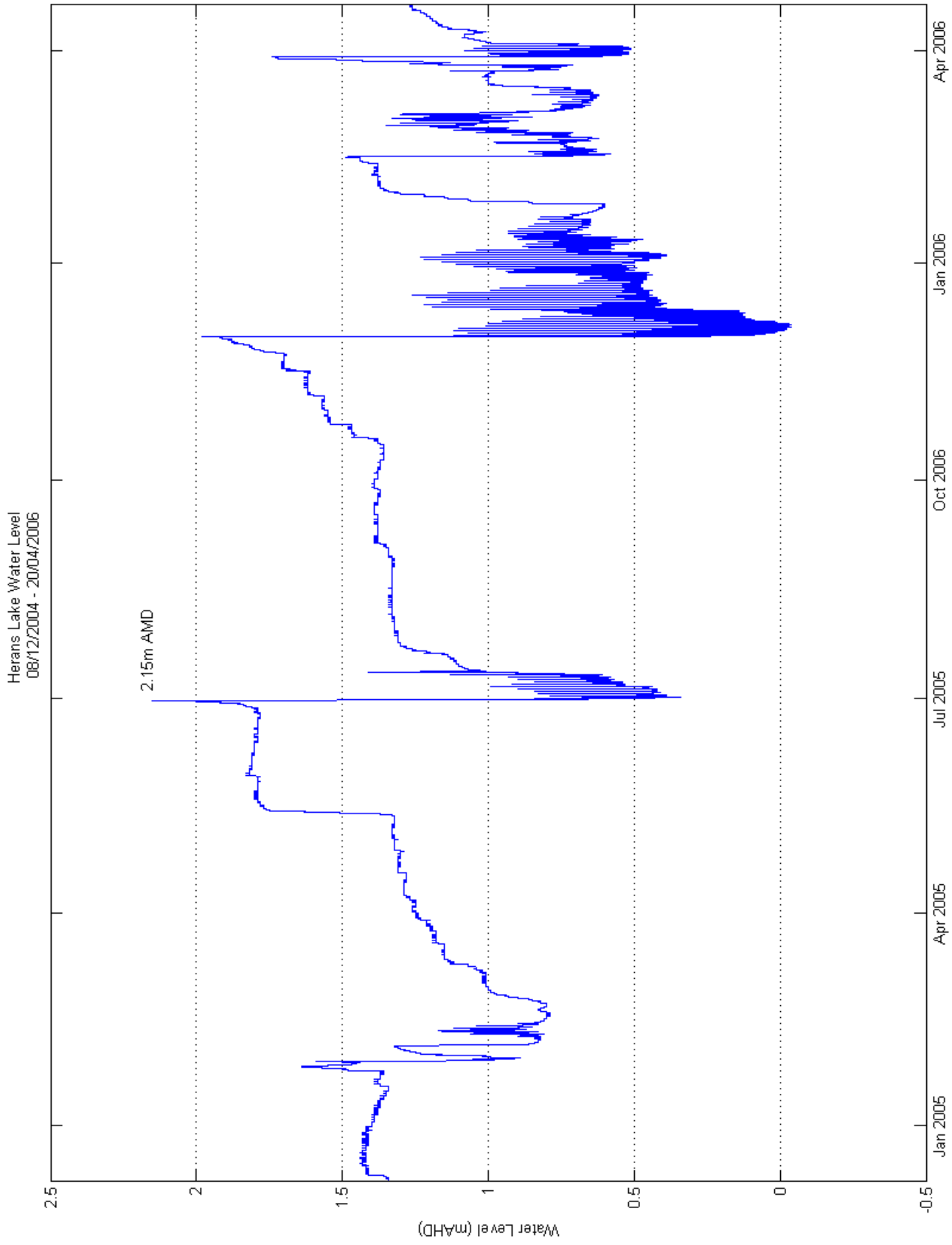
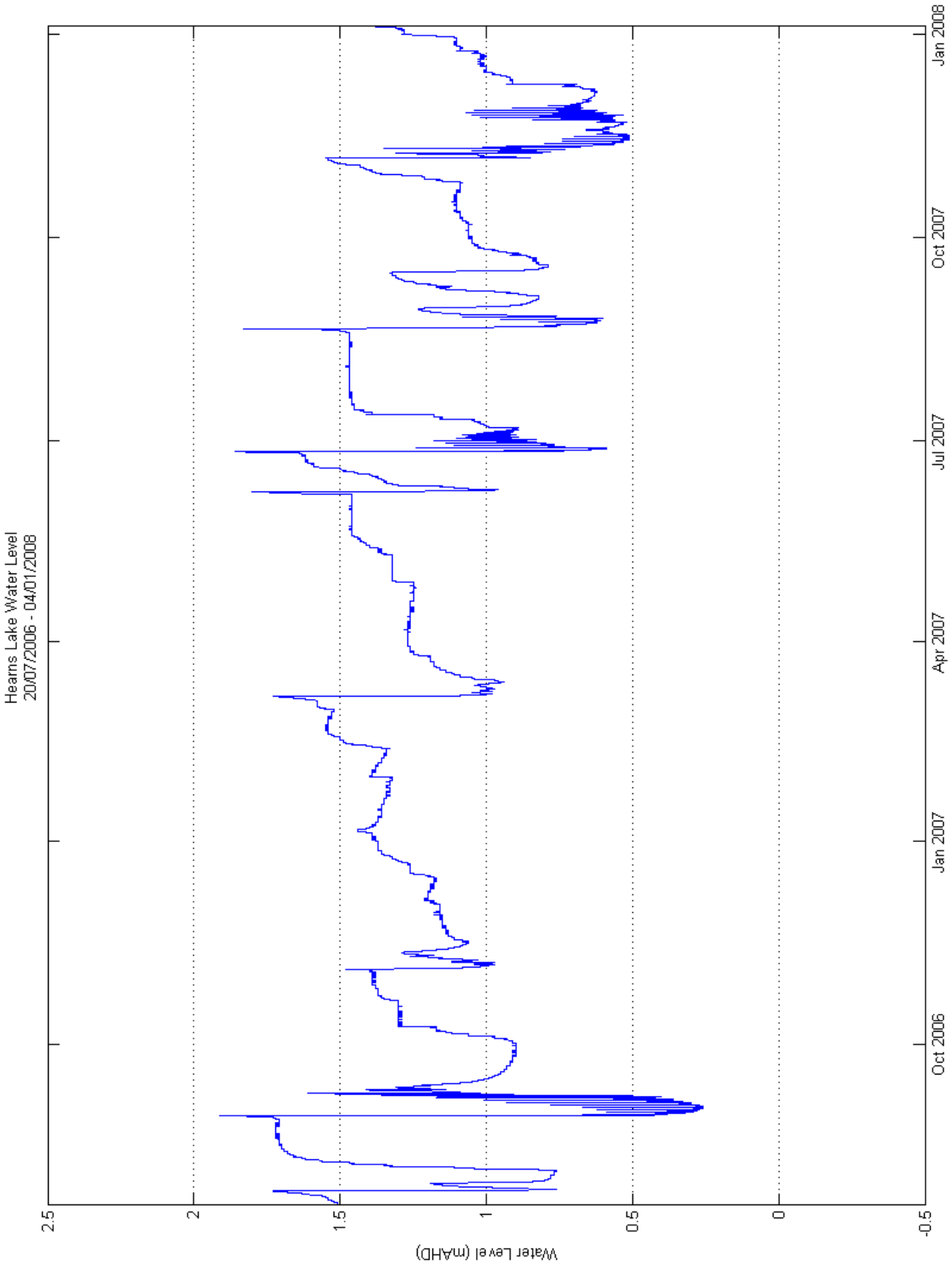


Cardno Lawson Treloar

HEARNS LAKE WATER LEVEL
DEC 2004 – APR 2006

July 2010



Cardno Lawson Treloar

HEARNS LAKE WATER LEVEL
JUL 2006 – JAN 2008

July 2010