Bonville Rural Residential

Local Environment Study

Prepared for
Coffs Harbour City Council

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DOCUMENT TRACKING

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Abbreviations

ABBREVIATION	DESCRIPTION
APM	Australian Paper Manufactures
ATLAS	Wildlife Database records Administered by National Parks & Wildlife Service
BIG Club	Bonville International Golf Club
CBD	Central Business District
CHCC	Coffs Harbour City Council
CKPoM	Coffs Harbour Koala Plan of Management
DCP	Development Control Plan
DoPI	Department of Planning and Infrastructure
DSEWPaC	Department of Sustainability, Environment, Water, Population and Communities
EEC	Endangered Ecological Community
ELA	Eco Logical Australia Pty Ltd
EPBC	Environment Protection and Biodiversity Conservation Act 1999
GIS	Geographic Information System
GPS	Global Positioning System
LEP	Local Environment Plan
LES	Local Environment Study
LGA	Local Government Area
NES	National Environmental Significance
NOW	NSW Office of Water
NPWS	National Parks and Wildlife Service (now known as Office of Environment and Heritage)
OEH	Office of Environment and Heritage
PHaCS	Priority Habitats and Corridors Strategy
PMST	Protected Matters Search Tool
RAMA	Routine Agricultural Management Activity
RoTAP	Rare or Threatened Australian Plants
SEPP	State Environmental Planning Policy
TSC Act	Threatened Species Conservation Act
VMP	Vegetation Management Plan
VRZ	Vegetated Riparian Zone
WM Act	Water Management Act

Executive Summary

The Bonville Local Environmental Study (LES) considers an area covering approximately 1860 hectares (ha) of coastal flats, undulating hills and steep slopes. The area a coastal location has experienced landuse utilisation from forestry and agricultural development for approximately the last 150 years. Currently the area is supplying a range of rural residential living opportunities, with development demand likely to increase under the current planning proposal and with recent approvals for residential development centred on the BIG club (Bonville International Golf Club) lands.

Significant areas of native vegetation; regrowth and remnant natural habitats occur throughout the study area. These provide a range of habitats for a limited number of threatened fauna species including areas of mapped Endangered Ecological Communities (EECs).

Significant environmental values for the Bonville LES study are:

- Vertebrate animal species recorded - 170
- Vascular plant species - 197
- Threatened plants - 1 (from previous study)
- Threatened animals species recorded during current survey - 8
- Threated animals recorded from all studies - 18
- Native vegetation cover - 25 % of study area
- Exotic vegetation cover - 15 % of study area
- Hardwood plantation cover - 10% of study area
- Mapped Endangered Ecological Communities approximately - 38 ha
- Mapped Rainforest - < 2 ha

Environmental values collated from this study have been combined with data from statutory planning requirements such as existing environmental protection zones, koala habitat and drainage buffers in an environmental constraints analysis process (Figure 11). Environmental constraints have been then represented in suggested zones (Figure 12) for the whole study but note only select areas will likely receive rezoning planning approval.

This analysis provides a comprehensive spatial representation of all environmental constraints to be considered in conjunction with other planning themes (bushfire and engineering constraints) in the full planning assessment for the future Bonville rural residential land rezoning and release.

1 Introduction

This report was commissioned by Coffs Harbour City Council (CHCC) as part of a local consortium of consultants headed by Geoff Smyth Consulting and de Groot & Benson Pty. Ltd. in preparation for an amendment to the Draft Coffs Harbour Local Environment Plan 2013 (DLEP 2013) in regards to the proposed rural residential release area for Bonville.

1.1 STUDY AREA

The Bonville study area is located approximately 13 kilometres (km) south of the Coffs Harbour Central Business District on the western side of the Bonville extension to the Pacific Highway on the North Coast of NSW (Figure 1). The study area covers approximately 1860 ha (Figure 2).

The current land uses in the Bonville locality consist of existing rural residential subdivisions and agriculture (including intensive horticulture cropping), private recreation (Bonville Golf Resort) and small rural allotments. The study area is bounded by Boambee and Pine Creek State Forests to the north, west and south and Bongil Bongil National Park to the east. The Pacific Highway defines the eastern boundary of the study area, with the old Pacific Highway (now Pine Creek Way) as the main access road running north-south through the study area. The roads providing access to the upper and lower Bonville Valley from Pine Creek Way (north to south) are as follows:

- Titans Close;
- Irvines Road;
- Williams Road;
- North Bonville Road (linking to Cassidy's Road and Bradford Drive);
- Bonville Station Road;
- Glennifer Road (linking to Crossmaglen Road);
- East Bonville Road; and
- Butlers Road.

1.2 PAST AND PRESENT ENVIRONMENT

An understanding of the settlement history of an area, the demographic and the industries that utilised its local resources can provide valuable information on present day environmental values.

The Bonville and wider Coffs Harbour area were settled later than surrounding areas (during the 1870's – 1880's), preceded by southerly areas such as the Bellinger Valley (during the 1840's -1860's) and northerly areas such as the Clarence Valley (during 1838) (Yeates 1990). This pattern of settlement was a consequence of available navigable river systems which were utilised to access extensive floodplain forests. The impetus for coastal exploration by early settlers was timber-getting, particularly for rainforest timbers such as *Toona australis* (Red Cedar). Bonville and Pine Creeks were similarly utilised for access to their timber resources from the late 1800's by floating Red Cedar logs down-stream to the mouth of Bonville Creek for loading onto ocean-going steamers (Andren 1988).

By the late 1880's enough cleared land existed to allow farming enterprises to commence between Bonville and Pine Creeks. Road access to Coffs Harbour (via bullock dray) was formed once the Coffs

Jetty was built in 1892. In 1903 the main industry in the Bonville area was dairying after the establishment of a cheese factory.

Timber mills were established in 1912 at Crossmaglen with tramways built to access the north-coast railway under construction which was completed by mid-1920's. The North Coast rail line further enhanced the trading ability of the local farming and timber extraction industries. After the Second World War agricultural development continued including small horticulture enterprises. Timber plantations were established in the 1960's and 70's on ex-dairy properties as part of a proposed paper processing industry.

Present day Bonville retains small scale industries, a primary school, a local hall, a fuel station and a post office. Following the recent completion of the Pacific Highway bypass local business has seen a decline with a fuel station and fruit stalls closing largely due to reduced traffic.

The area currently caters for rural residential living through small rural landholdings, existing rural residential subdivisions, a caravan park and an over 50's retirement village. A recent Master Plan approval for an expansion of residential living using the Bonville Golf Course lands will continue the growth of this sector.

1.3 OBJECTIVES

Bonville has been identified as a priority release area under the Rural Residential Study (CHCC 2009). To allow rezoning for rural residential purposes environmental studies are required to assist the planning process. In particular this study aims to identify significant flora and fauna habitats, threatened species and important wildlife corridors that exist within the study area.

This study does not include a comprehensive flora and fauna survey. The objectives of the study are to highlight the ecological values of the area through habitat assessment, a range of limited and targeted fauna survey techniques, review of previous studies and conservation planning initiatives. The process will identify major ecological values that should be maintained or enhanced, and outlines any ecological constraints to the development process.

The scope of work includes the following tasks:

- Prepare a detailed vegetation map which identifies major plant assemblages within the study area and connective importance of vegetation;
- Identify areas of significant vegetation within the study area via field investigations. Significant flora would include listed RoTAP species and species listed under the Threatened Species Conservation Act 1995 (TSC Act) or the National Parks and Wildlife Act 1974 (NPW Act);
- Identify threatened flora and fauna recorded within a one km radius of the site or which could utilise the existing habitats within the study area;
- Conduct a limited fauna survey utilising spotlighting and Anabat detection techniques;
- Assess the conservation significance of all fauna identified habitats, particularly their importance as linkages in a regional context and their resilience to potential development;
- Identify measures for the conservation of flora and fauna within the meaning of the TSC Act and the Fisheries Management Act 1994 (FM Act) and their habitats;
- Identify measures for the conservation of existing wildlife corridor values and / or any connective importance of vegetation within the study area and adjoining lands, including buffer zones to protect remnant vegetation and riparian areas; and

- Outline measures for the long-term management of conservation / open space areas proposed within the study area, including measures for revegetation, rehabilitation, ownership and access.

Figure 1: Locality

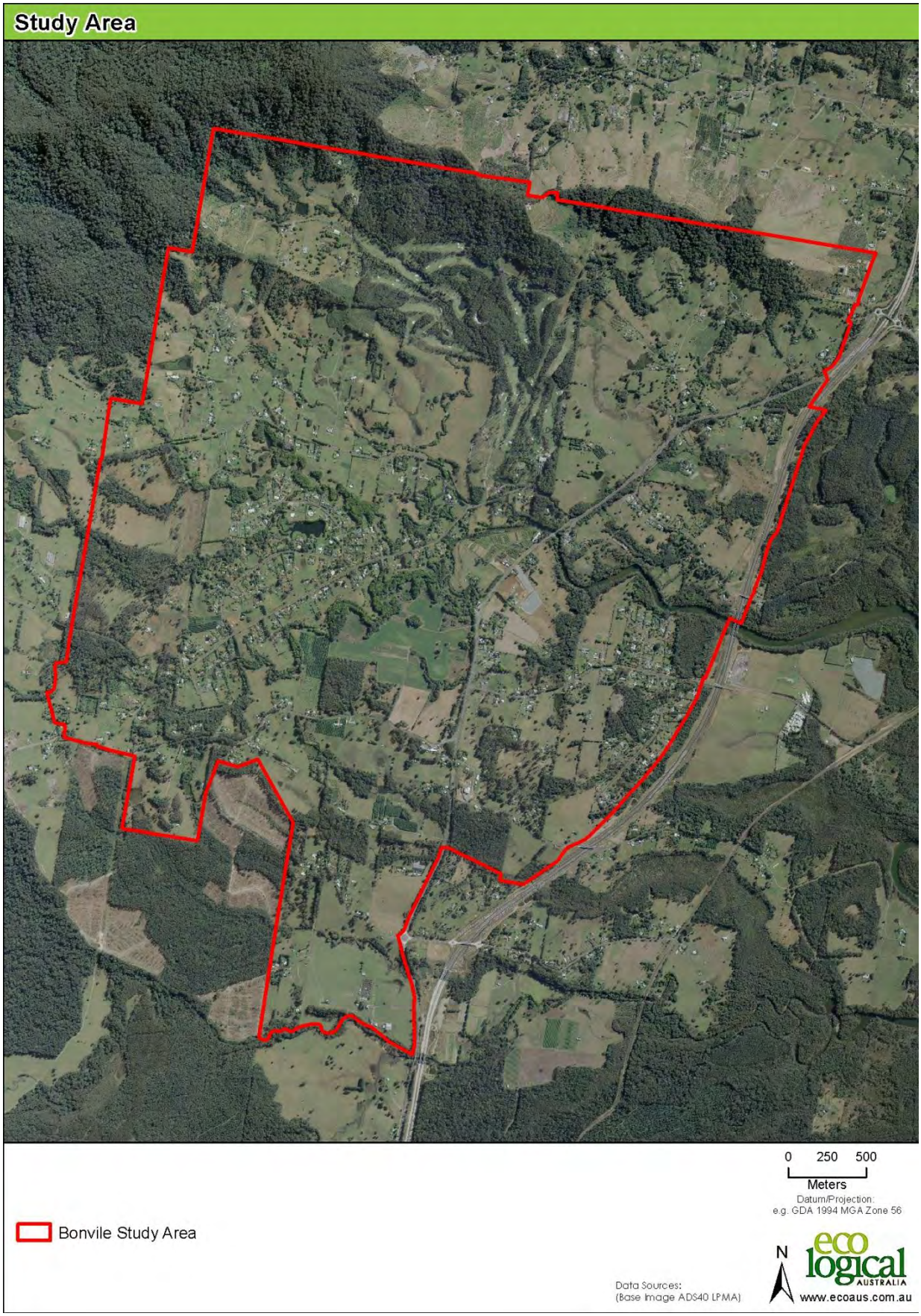

Figure 2: Bonville study area

2 RELEVANT LEGISLATION AND POLICIES

2.1 THE ENVIRONMENT PROTECTION AND BIODIVERSITY CONSERVATION ACT 1999 (EPBC ACT)

The Commonwealth Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act) establishes a requirement for Australian Government environmental assessment and approval of:

- actions that are likely to have a significant impact on matters of national environmental significance;
- actions that are likely to have a significant impact on the environment on Commonwealth land;
- actions taken on Commonwealth land that are likely to have a significant impact on the environment anywhere; and
- Actions by the Commonwealth that are likely to have a significant impact on the environment anywhere.

The matters of national environmental significance (commonly referred to as matters of NES) are:

- World Heritage properties and National heritage places.
- Wetlands of international importance (Ramsar wetlands).
- Listed migratory species, threatened species and ecological communities.
- Commonwealth marine areas.
- Nuclear actions (including uranium mining).

It is considered that the majority of these matters, areas, actions, species or ecological communities are unlikely to be affected by the proposal. Certain migratory species will periodically utilise the study area for habitat. The recently listed (2012) nationally threatened species Koala (*Phascolarctos cinereus*) occupies the study area. A discussion of the relevant issues relating to Koalas and their habitat is presented in Section **Error! Reference source not found.** of this report.

2.2 ENVIRONMENTAL PROTECTION AND ASSESSMENT ACT 1979 (EP&A ACT)

The Environmental Protection and Assessment Act 1979 (EP&A Act) is the principal planning legislation in NSW. Part 3 of the EP&A Act sets the framework for preparation of environmental planning instruments such as LEPs.

Parts 3A, 4 and 5 of the EP&A Act indicate the decision making processes for assessment of proposed development and activities. When deciding if a proposal should be approved, the consent / determining authority (Coffs Harbour City Council, and Department of Planning and Investment) must consider a range of environmental matters including maintenance of biodiversity and the likely impact on threatened species, populations or ecological communities.

Part 5A of the EP&A Act requires proponents to consider likely impacts on threatened species, populations or ecological communities, or their habitats. While the assessment of impacts is conducted at the development application stage, this report highlights environmental values considered a

constraint to development. There are a number of threatened species known to occur in the study area including one Endangered Ecological Community (EEC). These species and their habitats are taken into account in the planning process and documented in the results section of this report.

2.3 THREATENED SPECIES CONSERVATION ACT 1995 (TSC ACT)

The Threatened Species Conservation Act 1995 (TSC Act) and amendments in 2002 and 2005 identifies threatened species, communities and populations. The TSC Act indicates the assessment process for proposed development that is likely to have a significant effect on biodiversity. This Local Environment Study (LES) takes into account species likely to occur within the available habitat based on existing records of threatened species and new occurrences identified through field surveys. Threatened species records are generally more prevalent on public land where more survey effort has been performed compared to private tenure.

This LES builds on existing threatened species knowledge by considering previously undocumented records for the Bonville valley. These records are presented in the Section 4 of this report.

2.4 WATER MANAGEMENT ACT 2000 (WM ACT)

The *Rivers and Foreshores Improvement Act 1948* (RFI Act) has been repealed and the controlled activity provisions in the *Water Management Act 2000* (WM Act) have now commenced. A controlled activity approval under the WM Act is required for certain types of developments and activities that are carried out in or within 40 metres (m) of a river, lake or estuary.

The WM Act provides a number of mechanisms for protection of water sources via the water management planning process. If a 'controlled activity' is proposed on 'waterfront land', an approval is required under Section 91(2) of the WM Act. 'Controlled activities' include the construction of buildings or carrying out of works, the removal of material or vegetation from land by excavation or any other means and the deposition of material on land by landfill or otherwise. 'Waterfront land' is defined as 'the bed of any river or lake, and any land lying between the river or lake and a line drawn parallel to and 40 metres inland from either the highest bank or shore'.

Approvals for controlled activities are administered by NSW Office of Water (NOW) and a set of guidelines have been developed to assist applicants who are considering carrying out a controlled activity on waterfront land. The guidelines provide information on the design and construction of a controlled activity, and other mechanisms for the protection of waterfront land and include:

- In-stream works;
- Laying pipes & cables in watercourses;
- Outlet structures;
- Riparian corridors;
- Vegetation Management Plans; and
- Watercourse crossings.

These guidelines are available from:

www.water.nsw.gov.au/Water-licensing/Approvals/Controlled-activities/Controlled-activities/default.aspx

A section describing riparian corridors and associated vegetated buffers has been incorporated into the CHCC Draft Development Control Plan (DCP) Component for Biodiversity (B8.4). The vegetation buffer criteria have been incorporated into this ecological assessment process as they are a potential restriction on development. They provide a mechanism for maintaining and improving the connectivity of isolated and fragmented patches of riparian vegetation and developing a robust wildlife corridor network. The proponents' responsibility under the WM Act is to assess impact and adjacency to 'waterfront land' (i.e. within 40 m) and to apply guidelines for permits required under s91 of the WM Act.

Riparian buffers based on stream order for all drainage lines in the study area are depicted in Figure 10 of this report.

2.5 LOCAL AND STATE PLANNING INSTRUMENTS

2.5.1 Coffs Harbour City Council Local Environment Plan (LEP) 2000

The majority of the study area is zoned as 'Rural 1A Agricultural Zone' under the Coffs Harbour City Council LEP 2000 (Figure 3). The existing rural residential subdivisions on Bradford Road and Bonville Station Road are zoned as 'Rural 1B Living'. Bonville Golf Resort is zoned as 'Open Space 6C Private Recreation'. Two parcels of land east and west of the Bonville Golf Resort are zoned as 'Residential 2E Tourist'. The majority of the forest remnants and drainage lines within the valley are zoned 'Environmental Protection 7A' (Figure 3) and are focused on protection of Primary and Secondary Koala Habitat. There is one Public Reserve (Open Space 6A) within the study area at the western end of the Bradford Road subdivision, Baker Drive Reserve.

The aim of the *Rural 1A* zone is to provide for the preservation of existing or potentially productive agricultural land. Its objectives are to enable development which is compatible with agricultural practices, with the amenity and character of the rural environment of the area and which can be adequately serviced (CHCC, 2000).

The aim of the Rural 1B zone is to provide for rural residential living opportunities. Its objectives are to enable development which is compatible with the character and amenity of the rural living environment of the area and to ensure that development is adequately serviced (CHCC, 2000).

The aim of the Open Space 6E Private Recreation zone is to provide for private recreation and associated services. The objectives of this zone are to enable development for private recreation or tourism and other land uses compatible with the surrounding area, and to ensure that development is within the environmental capacity of the land and is adequately serviced (CHCC, 2000).

The aim of the Residential 2E Tourist zone is to provide for tourist accommodation and recreational land uses. Its objectives are to enable tourist development and other development that is compatible with the surrounding environment and to provide for development that is within the environmental capacity of a high density residential environment and can be adequately serviced (CHCC, 2000).

The aim of the 7A zoning is to protect and enhance sensitive natural habitat and waterway catchments. Its objectives are to protect habitat values and water quality and enable development which does not adversely impact upon these, to enable development that is within the environmental capacity of the land and can be adequately serviced, and to enable protection of archaeological sites of Aboriginal significance (CHCC, 2000). The zoning nomenclature under the CHCC LEP 2000 is now superseded by the new standard instrument and any reference to zones will be as per the draft LEP 2013 (CHCC DLEP, 2013).

2.5.2 Coffs Harbour City Council Draft Local Environment Plan (DLEP) 2013

The new draft instrument LEP (DLEP 2013) is not yet finalised, but its zonings are in similar context with those of the previous LEP 2000. The planning process of this study will express proposed zonings in

line with the DLEP 2013 format. An example of this is instead of '7A Environmental Protection' under the new DLEP the zone will be 'E2 - Environmental Conservation' or 'E3 - Environmental Management'.

One significant difference between LEP 2000 and DLEP 2013 is the introduction of Water zones (1 and 2) over Bonville and Burgess Creeks (Figure 3). These zones allow for the protection of natural waterways and additionally permissibility of recreation facilities respectively. Table 1 shows the previous zones for the Bonville study area and corresponding current zones under the DLEP 2013.

Table 1: Local environment zones

LEP 2000	Draft LEP 2013
Rural 1A Agriculture	RU2 Rural Landscape
Residential 2A Low Density Zone	R1 General Residential
Rural 1B Living Zone	R5 Large Lot Residential
Open Space 6A Public Recreation Zone	RE1 Public Recreation
Open Space 6C Private Recreation Zone	RE2 Private Recreation
Environmental Protection 7A Habitat and Catchment Zone	E2 Environmental Conservation
Environmental Protection 7A Habitat and Catchment Zone	E3 Environmental Management
Environmental Protection 7A Habitat and Catchment Zone	W1 Natural Waterways
Environmental Protection 7A Habitat and Catchment Zone	W2 Recreational Waterways
Special Uses Zone 5A Community Purposes Zone	SP2 Special Purposes Infrastructure

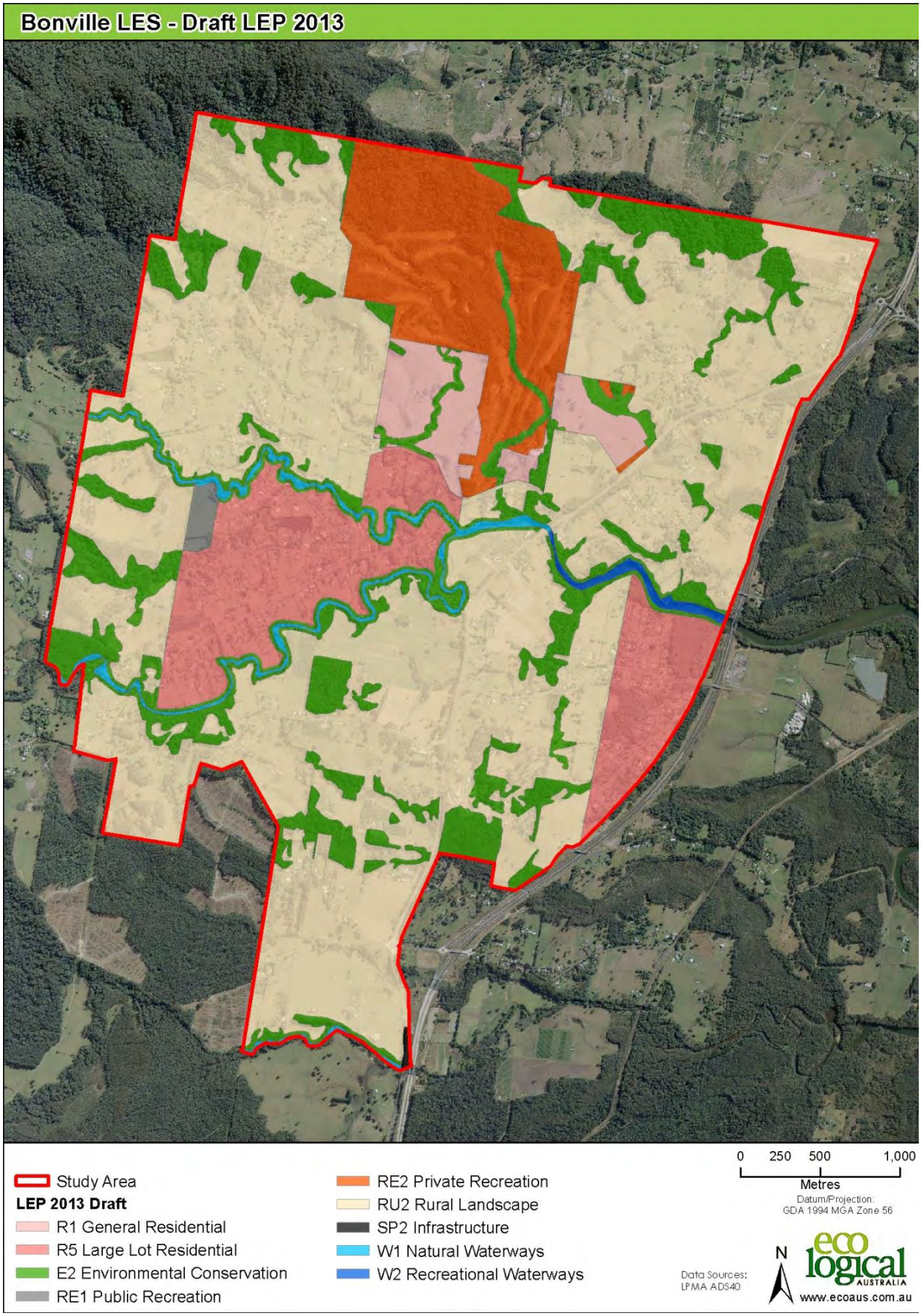

Figure 3: Draft Local Environment Plan 2013

2.5.3 State Environmental Planning Policy (SEPP) 14: Coastal Wetlands

This Policy ensures coastal wetlands are preserved and protected for environmental and economic reasons. SEPP 14 provides that mapped wetlands in coastal Local Government areas should not be cleared, drained or filled or have a levee constructed on them without the consent of CHCC and the concurrence of the Director- General of the Department of Planning.

No SEPP 14 Coastal Wetlands are found within the study area.

2.5.4 State Environmental Planning Policy (SEPP) 26: Littoral Rainforests

This Policy protects littoral rainforests, a distinct type of rainforest well suited to harsh salt-laden and drying coastal winds. The Policy requires that the likely effects of proposed development be thoroughly considered in an environmental impact statement.

The legal definition of Littoral Rainforest under SEPP 26 includes that which occurs on headlands as well as on sand. This is consistent with the definition of the EPBC-listed 'Critically Endangered' *Littoral Rainforest and Coastal Vine Thickets of Eastern Australia* ecological community.

No SEPP 26 Littoral Rainforest is mapped within the study area, or any rainforest communities equating to an EEC definition.

2.5.5 State Environmental Planning Policy (SEPP) 44: Koala Habitat Protection

This Policy aims to encourage the proper conservation and management of areas of natural vegetation that provide habitat for Koalas to ensure a permanent free-living population over their present range and reverse the current trend of Koala population decline.

SEPP 44 does not apply to the study area as the CHCC Comprehensive Koala Plan of Management (CKPoM) addresses Koala habitat protection issues within the Coffs Harbour Local Government Area (LGA).

2.5.6 CHCC Comprehensive Koala Plan of Management (CKPoM)

The study area contains both Primary and Secondary Koala Habitat under the CKPoM (Figure 4). There is, however, a need to revise the Koala habitat mapping as it was based on aerial photography that is more than 15 years old. The CKPoM (Lunney et. al., 1999) was constructed from LGA-wide vegetation mapping program performed by Fisher, Body and Gill from aerial photography flown in 1996. The CKPoM utilised this vegetation mapping and Koala population survey information to delineate a three-tiered habitat model.

The underlining vegetation mapping has been revised for this LEP process which has implications for Koala habitat emphasis and interpretation. This concept is discussed further in the vegetation mapping section of this report (Section 4).

Primary Koala Habitat

The objective of this habitat zone under the CKPoM is:

To prevent further clearing, disturbance, fragmentation or isolation of existing primary koala habitat, and where appropriate, restore habitat and encourage sympathetic management to ensure the maintenance of koalas.

The consent authority shall not grant consent to the carrying out of development on areas identified as Primary Koala Habitat, whether zoned 7(A) or otherwise, which will remove the following tree species: Tallowwood (Eucalyptus microcorys), Swamp Mahogany (E. robusta), Broad-leaved Paperbark (Melaleuca quinquenervia), Flooded Gum (E. grandis), Blackbutt (E. pilularis), Forest Red Gum (E. tereticornis), Small-fruited Grey Gum (E. propinqua), or Forest Oak (Allocasuarina torulosa), unless the

development will not destroy, damage or compromise the values of the land as koala habitat. In assessing an application the consent authority shall take into consideration:

- *That there should be zero net loss of Primary Koala Habitat;*
- *The threats to koalas which may result from the development.*
- *The likely impacts to adjacent or nearby Primary Koala Habitat and existing or potential koala movement corridors;*
- *All other options for preventing or ameliorating impacts from the development on koalas; Whether the land is accredited under the Timber Plantation (Harvest Guarantee) Act1995*

Secondary Koala Habitat

In regard to this habitat zone, the CKPoM objective is:

"To minimise further loss, fragmentation or isolation of existing secondary koala habitat and the creation of barriers to koala movement and, where appropriate, to encourage restoration of koala habitat.

Areas of Secondary Koala Habitat contribute to the overall habitat available to Koalas and play a vital role in linking areas of Primary Koala Habitat. They are also important to dispersing and juvenile koalas, provide seasonal and drought foraging habitat, and may act as fire refuges.

The consent authority shall not grant consent to the carrying out of development on areas identified as Secondary Koala Habitat which will remove the tree species listed above unless the development will not significantly destroy, damage or compromise the values of the land as koala habitat. In assessing an application the consent authority shall take into consideration:

- *that there will be minimal net loss of Secondary Koala Habitat;*
- *the level of significance to koalas of the trees proposed to be removed;*
- *the number of trees proposed to be removed in relationship to the extent and quality of adjacent or nearby Primary and/or Secondary Koala Habitat;*
- *the threats to koalas which may result from the development;*
- *all other options for protecting koala trees as listed above;*
- *the impacts to existing or potential koala movement corridors; and*
- *whether the land is accredited under the Timber Plantation (Harvest Guarantee) Act 1995.*

The consent authority shall not grant consent to the carrying out of development in areas identified as Secondary Koala Habitat unless the proposal demonstrates that appropriate measures are taken to:

- *minimise barriers to koala movement;*
- *reduce the risk of koala mortality by road kill by appropriate road design, lighting and traffic speed limits;*
- *minimise the removal of koala tree species listed above under Tertiary Koala Habitat;*
- *provide preferred Koala trees in landscaping where suitable;*
- *minimise threats to Koalas by dogs i.e. banning of dogs or confining of dogs to Koala proof yards;*
- *minimise removal or disturbance of Tertiary Koala Habitat in fire protection zones, including fuel reduced zones and radiation zones".*

A comprehensive Koala fauna survey was not undertaken as part of the current LES survey effort. However active searching for Koala sign was performed at sites where potential Koala habitat was present. An evaluation of Koala activity within the study area is outlined fully in Sections 4 and 5 of this report.

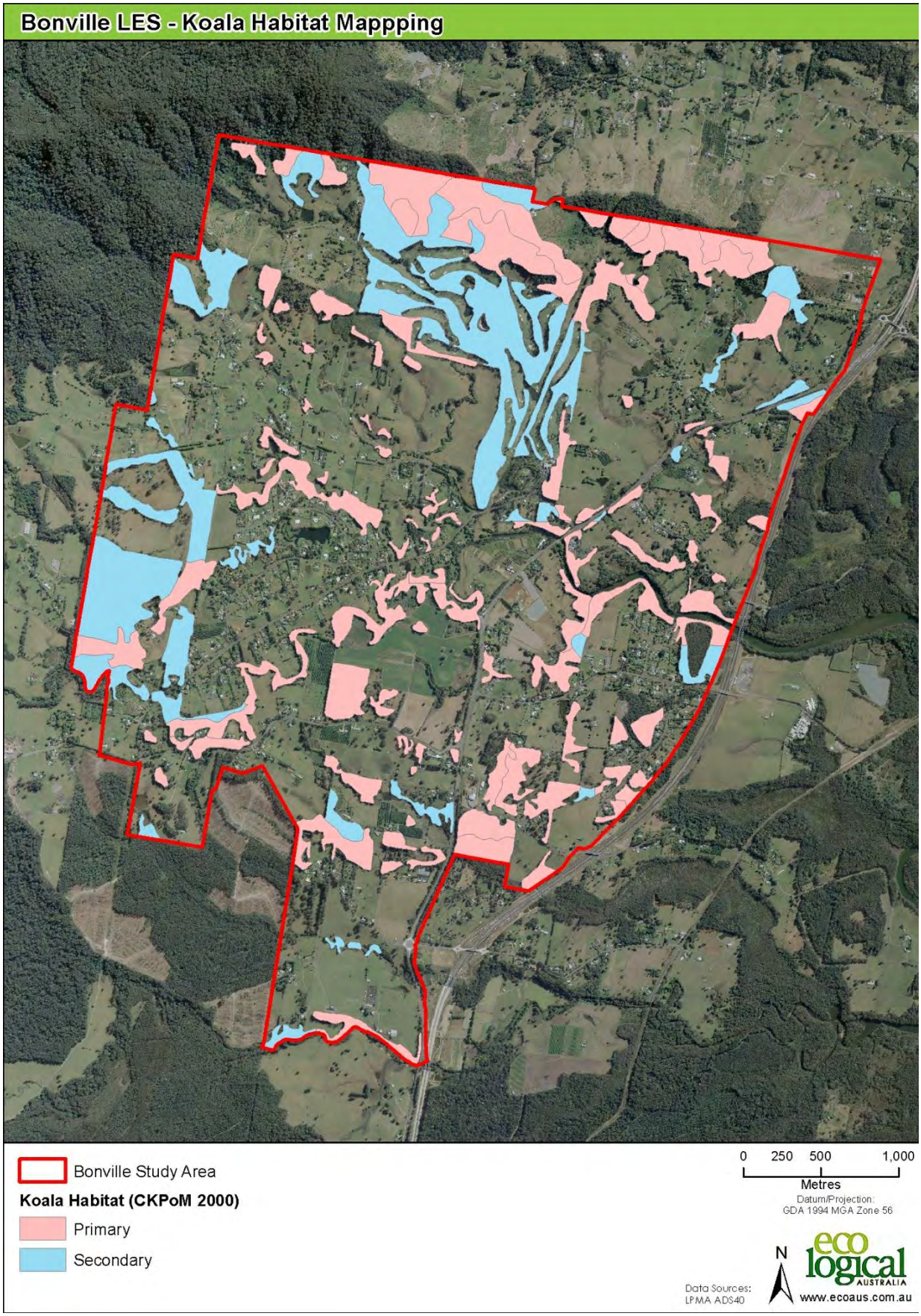

Figure 4: Koala habitat mapping (CKPoM)

2.5.7 State Environmental Planning Policy (SEPP 71): Coastal Protection

This Policy aims to protect and manage the natural, cultural, recreational and economic attributes of the NSW coast and to ensure that the type, bulk, scale and size of development is appropriate for the location and protects and improves the natural scenic quality of the surrounding area.

Developments to which SEPP 71 applies include lands categorised as 'sensitive coastal locations'. These include "*land within 100m of land reserved or dedicated under the National Parks and Wildlife Act 1974 as National Parks estate; and land within 100m above mean high water mark of the sea, a bay or an estuary".*

A very small portion of the study area is located on the edge of the coastal zone, east of Pine Creek Way surrounding Williams Road and Bonville Station Road. This area is located within 100 m of Bongil Bongil National Park and the tidal section of Bonville Creek. SEPP 71 applies to this land and requires that consideration be given to the impacts of development upon existing wildlife corridors and threatened species, populations and EECs, water quality of coastal water bodies, heritage and cultural places (including values, customs, beliefs and traditional knowledge of Aboriginal people) and the likely impact of coastal processes and hazards (e.g. sea level rise) upon the development and vice versa. Any development application for subdivision of land mapped as SEPP 71 requires a Master Plan to be submitted to the Director General for consideration and approval.

2.5.8 SEPP (Rural Lands) 2008

This policy aims to facilitate the orderly and economic use and development of rural lands for rural and related purposes by identifying the Rural Planning Principles and the Rural Subdivision Principles. In this way SEPP (Rural Lands) 2008 aims to assist in the proper management, development and protection of rural lands for the purpose of promoting the social, economic and environmental welfare of the State.

The broad aims of the Rural Planning Principles are to highlight the importance of rural lands and agriculture to the social and economic wellbeing of the State and rural communities, to identify and protect natural resources for the maintenance of biodiversity and water quality, to ensure current and potential productive and sustainable activities can be carried out in rural areas without conflict and with appropriate levels of services and infrastructure.

The Rural Subdivision Principles aim to minimise conflicts, particularly between residential land uses and other rural land uses and to minimise the fragmentation of rural land by considering the natural and physical constraints and opportunities of the land when planning for rural housing.

Matters to be considered in determining development applications for rural subdivisions or rural dwellings:

a) the existing uses and approved uses of land in the vicinity of the development;
b) whether or not the development is likely to have a significant impact on land uses that, in the opinion of the consent authority, are likely to be preferred and the predominant land uses in the vicinity of the development;
c) whether or not the development is likely to be incompatible with a use referred to in the above two points;
d) if the land is not situated within a rural residential zone, whether or not the development is likely to be incompatible with a use on land within an adjoining rural residential zone; and
e) any measures proposed by the applicant to avoid or minimise any incompatibility referred to in paragraph (c) or (d).

Given the surrounding land use is predominantly rural residential or rural agricultural operations, the proposal to rezone selected areas of rural agricultural land as rural residential land seems justified and in keeping with the surrounding land use. Provided CHCC allows for corresponding development of essential services and supporting infrastructure, the proposed rezoning within the Bonville study area will meet the objectives of SEPP (Rural Lands).

2.6 NATIVE VEGETATION ACT 2003 (NV ACT)

The objects of this Act include the protection of "native vegetation of high conservation value having regard to its contribution to such matters as water quality, biodiversity, or the prevention of salinity or land degradation".

Within Clause 7 of this Act, the definition of clearing native vegetation (relevant to the study area) is as follows:

"*cutting down, felling, thinning, logging or removing native vegetation*".

The Minister is the consent authority for clearing native vegetation, and for the purposes of the EP&A Act, the Minister is the consent authority for any development application made under that Act for any clearing that requires development consent.

Land currently zoned Agricultural or Rural Residential requires assessment under the NV Act for vegetation removal.

The maximum clearing distances applying to Routine Agricultural Management Activity (RAMA) and rural infrastructure are as follows:

2.6.1 Small holdings or holdings zoned Rural Residential

A small holding is a single piece of land in the same ownership that is less than 10 ha.

The maximum clearing distances or areas are:

- permanent boundary fence six metres either side (adjoining landholder agreement is needed);
- permanent internal fence three metres either side;
- temporary fence one metre total width of clearing;
- roads and tracks four metres total width of clearing;
- windmills and bores three metres from the structure;
- stockyards three metres from the structure;
- habitable buildings – the asset protection zone identified for the land in a bush fire risk management plan in force under the Rural Fires Act 1997; and
- buildings other than habitable buildings five metres.

There is potential for increased clearing of native vegetation due to rezoning and / or subdivision of land in the Bonville release area due to property boundary and infrastructure management under the range of RAMAs listed above. This issue should be taken into consideration when planning rural residential subdivision layouts.

2.7 PLANTATIONS AND REAFFORESTATION ACT 1999 (PR ACT)

Within the Bonville study area fragments of past hardwood plantations exist that were established post 1958 by the Australian Paper Manufactures, generally on old farm or dairy lands. The main species planted were *Eucalyptus grandis* (Flooded Gum), *E. pilularis* (Blackbutt) and *E. saligna* (Blue Gum).

The paper mill proposed for the area never eventuated and the majority of those lands were either sold to NSW State Forests or private ownership. The most obvious existing plantation lands were converted into the Flooded Gum fairways of the Bonville golf course. Small areas on private land still exist north of Crossmaglen Road and south of North Bonville Road on the western edge of the study area.

Plantations that are retained on private land still hold their plantation status under the PR Act and are therefore able to be logged under the Acts harvest guarantee. Plantation areas will be further discussed in regards to their habitat quality and environmental significance within this document. The recently completed CHCC Class 5 fine-scale vegetation mapping (OEH 2012) defines these areas, but certain plantations have been harvested since the time of photography for that project.

2.8 LOCAL PLANNING POLICY

As part of the change to the new planning instrument DLEP 2013 a set of draft Development Control Plans (DCPs) are also proposed. Included in the draft DCP is component 8B Biodiversity requirements. This DCP provides guidelines for environmental assessment at the Development Application (DA) stage, including vegetation protection of Koala Habitat, EECs, significant wetlands and riparian buffers for drainage lines. The vegetation buffers around drainage lines or waterfront lands are directly related to the conditions from the NSW Office of Water (NOW) and are applied to this study area in the conservation framework (Section 6) and the guidelines in Appendix G.

2.8.1 Priority Habitats and Corridors Strategy (PHaCS)

There has been significant emphasis in conservation planning about addressing functional connectivity of fragmented landscapes. The planning and rezoning stage of land development is an appropriate stage to implement and integrate these criteria. In 2003, the former National Parks and Wildlife Service (NPWS) released the paper and geographic data for *Key Habitats and Corridors for Forest Fauna: A Landscape Framework for Conservation in North-east New South Wales* (Scotts 2003). This set the framework for examining regional scale habitat connectivity.

Local Government has, through the planning process, been encouraged to develop local corridor information. CHCC placed on public display the *Coffs Harbour City Council NSW 2009 Draft Priority Habitats and Corridors Strategy 2010 – 2030*, as the first stage to identifying local corridor networks. A definition of corridors, a key objective of this study, was used in conjunction with other statutory requirements (such as riparian buffers) to create a practical framework for corridor context within the Bonville study area.

2.8.2 Tree Preservation Order

The CHCC Tree Preservation Order (CHCC, 2004) aims to promote the retention of trees and tree cover and to conserve the existing pattern of vegetation, to maintain landscape quality and remaining natural ecosystems; and to encourage the planting of trees to provide integration of trees into existing land uses. Any native vegetation is protected from clearing or damage by the TPO which is administered by CHCC.

Any land zoned as ‘RU2 Rural Landscape’ under CHCC DLEP 2013 (greater than one ha) is governed by the TPO. The TPO states that both CHCC and the Northern Rivers Catchment Management Authority (NR CMA) are responsible for granting consent for vegetation clearing and that a DA is required to remove trees. Land zoned as ‘RU2’ (less than one ha) is not covered by the TPO; however landowners must seek approval from the NR CMA to remove trees under the NV Act.

3 Survey Methodology

This assessment included a desktop assessment of relevant wildlife databases, a review of previous environmental studies and field survey within the study area.

3.1 DATABASE SEARCHES AND LITERATURE REVIEW

A literature review of the aforementioned planning and legislative documents and their associated assessment requirements was conducted prior to fieldwork commencing.

Preliminary lists of species likely to occur within the subject site were obtained by conducting searches of the Office of Environment and Heritage's (OEH) Atlas of NSW Wildlife (Wildlife Atlas), for species and communities listed under the TSC Act. The Department of Sustainability, Environment, Water, Population and Communities (DSEWPaC) Protected Matters Search Tool (PMST) for Matters of National Environmental Significance (NES) and species / communities listed under the EPBC Act was also utilised. These data searches were undertaken on 19th June, 2013.

The OEH Wildlife Atlas and PMST data searches were each based upon a 10 by 10 kilometre search window which was then limited to a one km buffer of the study area as per the project brief requirement from CHCC. The resultant lists were filtered to identify threatened and communities species considered likely or with the potential to occur on, or utilise, the subject site and these species appear in bold in Appendices C - F. Common species recorded within the study area were combined with field observations to create an overall flora and fauna species list (Appendices A and B).

3.2 GEOGRAPHIC DATA

A range of Geographic Information System (GIS) datasets were sourced from CHCC which were relevant to the planning and ecological information available for this study.

GIS layers which were utilised included:

- Cadastre (Property boundaries);
- Vegetation mapping (Latest Class 5 fine-scale mapping);
- Drainage (1:25000);
- Contours (derived from LiDAR data);
- LEP 2000 zonings;
- Koala Habitat mapping; and
- Corridor information - regional (OEH) and local (PHaCS).

3.3 SURVEYS

Flora, fauna habitat and limited fauna assessments were conducted over three days (totalling six person days) on the 14th, 16th, and 20th May, 2013. Survey effort during autumn is not optimal for many fauna species that could occupy the range of habitats available within the Bonville area. Certain

species are migratory and will only occupy these landscapes at certain times of the year, such as summer migrant bird species like the Common Koel (*Eudynamys scolopacea)*, Dollarbird (*Eurystomus orientalis*), and Channel-billed Cuckoo (*Scythrops novaehollandiae*). Other species (e.g. frogs) are more easily detected during warm and rainy weather primarily by their call. Reptiles (particularly snakes) are less active during the colder months and are therefore not highly represented during autumn surveys.

Selection of land parcels for targeted survey was based upon on the patch size of remnant vegetation, representative vegetation types, proximity to potential development precincts and the agreement of landholders in granting access for surveys. Not all discreet vegetation patches were surveyed and assessed due to landholder access restrictions and availability at time of survey. All roads within the study area were also utilised to ascertain the vegetation and fauna habitat condition assessments.

Meandering transects were performed within vegetation units which were selected to validate mapped vegetation types, condition, significant species and significant habitat features. Active searches for wildlife evidence was undertaken, particularly searches for Koala faecal pellets under the main primary listed Koala feed tree species in the valley (e.g. Tallowwood and Swamp Mahogany). Searches for Koala activity were also undertaken within numerous road reserves where suitable habitat was located.

The locations of significant features or threatened species sightings were recorded with a Global Positioning System (GPS). As part of ELA's scientific licence agreement significant records are supplied back to the Wildlife Atlas (OEH).

Diurnal fauna survey effort included actively searching for any animal evidence including tracks, scats or scratch marks on trees. Nocturnal survey effort included spotlighting, stag-watching and night-long microbat echolocation call recording.

3.3.1 Vegetation assessment

The OEH and CHCC have recently completed the *Coffs Harbour Class 5 Vegetation Mapping Project* for the entire LGA (OEH 2012). The class system of vegetation mapping is defined as Class 1 (coarse) to Class 5 (fine). The Coffs Harbour vegetation mapping is therefore fine-scale mapping utilising high resolution digital imagery and produced at a scale of less than 1:5000. The minimum mappable unit is defined as 0.25 ha which is the smallest polygon size for a discreet vegetation patch.

The program for this fine-scale mapping process was conducted over a two year time frame and was informed with over 3,500 site specific vegetation plots.

It is expected that changes occur over time from the original vegetation layer including losses through clearing and re-growth of certain vegetation units, some of which underpin Koala habitat definition. Landuse changes also occur with increased or decreased disturbance regimes affecting the vegetation significance and fauna habitat quality. Loss of vegetation through clearing or thinning is the most obvious possible change with re-growth usually only detectable over a longer time frame.

Any anomalies from the original vegetation mapping have been revised via field-based verification where possible. It is believed most discrepancies are associated with the data age and coding errors during the initial study resulting from limited private property access to ground-truth vegetation polygons.

3.3.2 Vegetation condition

The vegetation quality was assessed using parameters such as intactness, diversity, history of disturbance and weed invasion. This somewhat subjective rating scheme is not solely based on hard evidence and quantifiable criteria but utilises Class 5 vegetation mapping as a basis for the assessment. Much information can be inferred from the vegetation communities information, landuse history and weed composition combined with field-based verification of specific sites.

Three categories were used to describe the condition of vegetation communities:

- Good: Vegetation still retains the species and structural characteristics of its pre-European equivalent. Such vegetation has usually changed minimally over time and displays resilience to weed invasion due to intact ground cover, shrub and canopy layers.
- Moderate: Vegetation generally still retains its structural integrity but has been disturbed and has lost some component of its original species complement. Weed invasion can be significant in such remnants.
- Poor: Vegetation that has lost most of its species and is significantly modified structurally. Often such areas have a discontinuous canopy of the original tree cover and very few shrubs. Exotic species (such as introduced pasture grasses or weeds) replace much of the indigenous ground cover or are co-dominant with the original indigenous species.

3.3.3 Fauna habitat

The fauna survey of the study area was limited to a few specific techniques outlined below (spotlighting and microbat call recording). Habitat assessment generally searched for signs of fauna presence (e.g. tracks, scats, hair, bone and feathers) and habitat features necessary to support the lifecycle of certain fauna guilds (e.g. Koalas food trees and hollow-bearing trees for gliders and owls). Fauna species were determined by opportunistic occurrence by sight or listening for their calls (e.g. birds and frogs).

Recording threatened species during surveys confirms their presence however a lack of threatened species records cannot necessarily be used to argue the species' absence when suitable habitat is present. Threatened species are often difficult to detect due to their general rarity, seasonal occupation or cryptic nature. Suitable habitat is therefore one of the most important factors to consider when determining the potential presence of threatened species.

Fauna habitats within the study area were assessed by examining characteristics such as the structure and floristic composition of the canopy, understorey and ground vegetation. The structure and composition of the litter layer and other habitat attributes important for feeding, roosting and breeding was also considered. The following criteria were used to evaluate fauna habitat values:

- Good: A full range of fauna habitat components are usually present (e.g. old-growth trees, hollow-bearing trees, fallen timber and foraging resources) and habitat linkages to other remnant ecosystems in the landscape are intact.
- Moderate: Some fauna habitat components are often missing (e.g. old-growth trees, hollow-bearing trees and fallen timber), although linkages with other remnant habitats in the landscape are usually intact but sometimes degraded.
- Poor: Many fauna habitat elements in low quality remnants have been lost, including old-growth trees (e.g. due to past timber harvesting or land clearing) and fallen timber, and tree canopies

are often highly fragmented. Habitat linkages with other remnant ecosystems in the landscape have usually been severely compromised by extensive past clearing.

The vegetation condition and fauna habitat assessment generally consider similar components of habitat from different perspectives (either flora or fauna). The main driver of condition is usually land use history and time since particular land uses have commenced or ceased. For example, a cleared area which is in a re-growth phase may have a poor vegetation condition ranking but under the fauna habitat criteria may be ranked higher because it provides a crucial habitat connection between good quality habitat patches. Instead of producing a condition statement from these two perspectives a single vegetation / fauna habitat condition layer will be produced to depict the overall status of the vegetation communities within the study area. Water features (e.g. dams) are not included as a habitat feature in this layer. It is acknowledged that water features provide a range of resources for numerous fauna guilds; however the objective of this component was to classify vegetated areas.

3.3.4 Targeted fauna survey

A limited range of targeted fauna survey methods were undertaken, as described below.

Spotlighting

This fauna survey technique targets arboreal, flying and large ground-dwelling mammals, nocturnal birds, reptiles and amphibians (in appropriate seasons). Spotlighting was conducted on foot at two locations for a total of six person hours using hand-held 50 watt spotlights and a 100 watt variable spotlight.

Microchiropteran Bat Surveys

Ultrasonic Anabat Bat detection (Anabat^{tm}Titley Electronics) was used to record and identify the echolocation calls of microchiropteran bats foraging at five sites throughout the study area. All Anabat Bat detectors were set to record bat vocalisations throughout the night, with the recording commencing at 6pm and finishing at 6am. Additionally a hand-held unit was used during spotlighting sessions, allowing the user to follow the flight of a bat. This increases the clarity of the recorded call profile and generally improves the ability to identify the call of the species. Calls recorded were analysed by Alicia Scanlon of Eco Logical Australia (ELA) and results are presented in Appendix C.

Koala Habitat Assessment

The fauna habitat assessment process included active searches for Koala signs. Koala feed trees, particularly *E. microcorys* (Tallowwood) and *E. robusta* (Swamp Mahogany), were searched for Koala scats at their base and immediate surrounds. The search technique was based on the SPOT assessment technique (Philips and Callahan 2000) where a time-based search under appropriate trees within habitat patches is undertaken. A full SPOT survey was not conducted as habitat patches were generally small and linear, and the aim was to detect koala activity. All habitat patches and suitable roadside reserves were accessed and searched for Koala activity.

Opportunistic Sightings

Opportunistic recordings of species were made through observation methods such as incidental sightings, identifying bird calls and sighting indirect evidence of species presence (e.g. scats, nests, roost sites, feathers, hair, tracks, diggings and feeding marks on and around trees). Common species are recorded in Appendix A and significant records or signs corresponding to threatened species were marked with GPS and mapped in Section 4 and Appendix D.

3.3.5 Survey limitations

The field investigations conducted as part of this study are not considered to comprise a comprehensive flora and fauna survey. Selected fauna survey detection techniques were used as described in Section 3.3.4. Not all vegetation remnants could be accessed and therefore were not assessed (e.g. for Koala presence). Flora searches were based on the random meander technique and not comprehensive plot-based assessment.

Survey effort was conducted during autumn (May 2013) which is not considered as an optimal time to detect certain fauna gilds (e.g. reptiles and frogs). Microbat species are generally considered to be less active during winter however good species diversity was obtained through the Anabat echolocation recordings.

The large study area was not fully accessible during the current assessment due to access restrictions and time constraints.

4 Results

4.1 VEGETATION INFORMATION

The vegetation community information provided in this report is sourced from the Class 5 vegetation mapping recently completed by OEH and CHCC for the Coffs Harbour LGA (OEH 2012). This mapping product utilised the latest aerial digital imagery (2009) to produce a high resolution and accurate digital product. A summary and full vegetation description report documenting all vegetation communities in the CHCC LGA can be sourced on the CHCC website (OEH 2012).

Where site access was possible the vegetation layer for this study was ground-truthed via field survey. Where discrepancies or changes had occurred amendments were made to a subset of the mapped product for this report only, as is reflected in the following figures, tables and discussion.

Mapped vegetation formations within the study area included units mapped as Sclerophyll (Wet and Dry) Rainforest, Native Remnant, Native Pioneers, Exotic, Plantation (includes horticulture), Forested Wetlands and Freshwater Wetlands (Table 2). These formations totalled 745 ha within 664 polygons throughout the study area. Sixteen contiguous vegetation patches within the study area are greater than 10 ha in size. Areas of derived grassland were not included within the mapping for this study. Riparian zones within the valley are generally very narrow and too small to delineate and therefore aren't mapped as a separate unit.

Additionally, certain portions of the study area were considered to be highly modified by agricultural (horticultural) or utilised for other purposes.

The mapping is categorised as a fine-scale vegetation product (Class 5) - for an area the size of the Bonville study area vegetation communities have been mapped to a fine level of detail.

4.1.1 Vegetation classes

Broad vegetation classes for the Bonville study area are depicted in Figure 5, with Table 2 providing the vegetation categories, area figures, forested vegetation percentage cover and percentage cover across the study area.

Table 2: Vegetation class areas

Class	Count (polygons)	Area (ha)	Forested vegetation cover (%)	Study area cover (%)
Dry Sclerophyll Forests	28	28.07	3.76	1.52
Exotic Vegetation	240	184.80	24.78	10.00
Forested Wetlands	25	36.11	4.84	1.95
Freshwater Wetlands	17	11.88	1.59	0.64
Native Pioneers	11	5.30	0.71	0.29
Native Remnant Vegetation	91	43.49	5.83	2.35
Plantation	72	99.72	13.37	5.39
Rainforest	2	1.79	0.24	0.10
Wet Sclerophyll Forests	178	334.70	44.87	18.10
Cleared / not mapped	NA	1103.00	NA	59.66
Total	**664**	**1848.87**	**100.00**	**100.00**

Table 2 indicates the majority of the study area is currently cleared (60%). When areas of non-native vegetation cover (plantation, exotic vegetation and horticulture) are considered the level of non-native

vegetation cover increases (>75%). This reflects changing landuses over time where relatively flat to undulating lands have been cleared for agricultural and horticultural purposes. These figures indicate how the landscape has regrown with exotic vegetation after the decline of the dairy, grazing and horticultural industries and following the increase of rural residential living.

4.1.2 Vegetation community data

The vegetation community table (Table 3) has been extracted from the Class 5 mapped vegetation layer (OEH 2012). Using this information 22 communities have been delineated within the study area, of which only 15 are recognised as supporting remnant native vegetation. The remainder were allocated to derived communities or non-natural vegetation states due to previous land uses, clearing and re-growth events or landform modifications. For example, the freshwater wetland community is largely comprised of derived communities resulting from clearing forested drainage lines and damming or creating impediments to drainage. These actions result in the formation of a water feature or artificial wetland community. Overtime these water features can become important areas for wildlife in the landscape such as water birds (e.g. water fowl and waders) and herpetofauna (e.g. frogs and reptiles) as well as providing water resources for domestic or rural uses.

More specific detail about each vegetation community can be found for each community in the summary and / or full mapping reports on the CHCC website (OEH 2012).

Table 3: Vegetation community areas

Class	Vegetation Code	Vegetation Community	Polygons	Area Ha
Dry Sclerophyll	(CH_DOF01)	Coast and Escarpment Blackbutt Dry Forest	27	24.30
Dry Sclerophyll	(CH_DOF05)	Foothills Grey Gum - Ironbark - Mahogany Dry Forest	1	3.77
Exotic Vegetation	(CH_EX02)	Camphor laurel	90	78.99
Exotic Vegetation	(CH_EX03)	Exotic vegetation	150	105.81
Forested Wetlands	(CH_FrW01)	Coastal Paperbark Swamp Oak Floodplain Forest	10	9.38
Forested Wetlands	(CH_FrW02)	Coastal Swamp Mahogany Forest	10	18.84
Forested Wetlands	(CH_FrW04)	Coastal Paperbark Sedgeland Dominated Forest	5	7.90
Freshwater Wetlands	(CH_FW08)	Coastal Freshwater Wetland	17	11.88
Native Pioneers	(CH_NP01)	Acacia pioneers	11	5.30
Native Remnant	(CH_NRV01)	Native remnant vegetation	91	43.49
Plantation	(CH_P01)	Plantation - native species	23	83.77
Plantation	(CH_P02)	Plantation - exotic/pine species	1	0.19
Plantation	(CH_P03)	Environmental plantings	48	15.76
Rainforest	(CH_RF11)	Escarpment and Lowland Bangalow - Carabeen - Black Booyong Palm Gully Rainforest	2	1.79
Wet Sclerophyll	(CH_WSF01)	Coast and Hinterland Riparian Flooded Gum Bangalow Wet Forest	65	92.87
Wet Sclerophyll	(CH_WSF02)	Hinterland Blackbutt - Bangalow - Turpentine Wet Shrubby Tall Forest	1	0.16

Wet Sclerophyll	(CH_WSF03)	Foothills and Escarpment Blue Gum Tallowwood - Turpentine Wet Shrubby Forest	18	41.52
Wet Sclerophyll	(CH_WSF05)	Foothills to Escarpment Brush Box - Tallowwood - Blackbutt Wet Forest	27	66.27
Wet Sclerophyll	(CH_WSF08)	Southern Foothills Blackbutt - Turpentine - Tallowwood Wet Ferny Forest	31	48.33
Wet Sclerophyll	(CH_WSF09)	Northern Escarpment Blackbutt - Apple Wet Ferny Forest	18	34.97
Wet Sclerophyll	(CH_WSF10)	Hinterland and Escarpment Tallowwood - Blackbutt - Blue Gum Wet Ferny Forest	16	45.56
Wet Sclerophyll	(CH_WSF17)	Foothills Turpentine - Grey Gum - Ironbark Moist Shrubby Forest	2	5.01

4.1.3 Vegetation communities

The following vegetation community descriptions provide an indication of forest structure, previous land use and disturbance regimes within the study area.

Wet Sclerophyll Types

The vegetation community data presented in Tables 2 and 3 (Figures 5 and 6) represents predominately wet sclerophyll types of which eight specific mapped units were delineated. The majority of these mapped units occur on the southern fall of the main northerly ridgeline of the study area. These vegetation types occupy the low coastal hills, gully riparian systems and lower slopes on floodplains of the coastal lowlands within the study area and the wider Coffs Harbour LGA.

These forest types are tall, occurring on moderately fertile soils in high rainfall areas and support a luxuriant understory of soft-leaved shrubs, ferns and herbs. Many of the understory plants are closely related to or are rainforest species and often represent a blend between rainforest and wet sclerophyll forest types.

These wet sclerophyll vegetation types are relatively common and do not represent any EECs listed under the NSW TSC Act. These vegetation units represent 334 ha of the total vegetation mapped within the study area (or 18% of total vegetation cover).

Rainforest

This class is represented by one community *Escarpment and Lowland Bangalow - Carabeen - Black Booyong Palm Gully Rainforest* which has been mapped in the north-westerly portion of the study area. This unit equates to less than two ha and appears to be in a disturbed / regenerative state. The canopy of this unit supports species such as *Sloanea woollsii* (Yellow Carabeen), *Heritiera actinophylla* (Black Booyong), *Geissois benthamiana* (Red Carabeen), *Caldcluvia paniculosa* (Soft Cordwood), *Sloanea australis* (Maiden's Blush), *Neolitsea dealbata* (Hairy-leaved Bollygum) and *Lophostemon australis* (Brush Box). These forest systems are highly diverse when in a static state but in a disturbed regenerative phase they may be missing some of the listed overstorey species and heavily disturbed by weeds.

Plantation

Approximately 100 ha of mapped plantation occur within the Bonville study area. This class includes native hardwood plantations established in the 1960's and 1970's on old dairy farms through to small areas identified as environmental plantings (e.g. adjacent to the Bonville Pacific Highway). The last remnants of hardwood plantation areas occur within the BIG club grounds and small areas on the western edge of the study area (bounded by North Bonville and Crossmaglen Roads). Harvesting continues in certain small plantation areas (as was noted during the current study) while other areas have been cleared after completion of the mapping product.

The small plantation holdings on private property have maintained their forest harvest guarantee under the PF Act and therefore are continuing to be harvested or cleared. Most of these areas have been converted back to open grassland or a mosaic of forest and grassland areas. Very little of these areas appear to have been utilised for their intended purpose of forestry resource production.

Plantations generally support lower ecological values as they are monoculture tree crops planted very close together to achieve a tall, straight growth form with minimal branching. Previously these areas have been characterised as secondary Koala habitat, yet it is unclear how important these areas have been for Koala habitat utilisation. Plantations play a role in maintaining forest cover, allow for ground and mid-storey species restoration, provide a range of fauna resources and potentially allow re-growth of more favourable Koala feed trees (e.g. Tallowwood). The BIG club lands are likely to provide forest cover and a less intensive land use, thus allowing wildlife movement through the area.

Native Remnants

This unit captures small to medium sized native-dominated remnants that cannot be assigned to a floristic community due to their size and history of disturbance and fragmentation. Their distribution is strongly linked to cleared urban and rural landscapes but also includes remnant tree lines within forest plantation areas (CHCC 2013).

Native Pioneers

This unit corresponds to Acacia re-growth predominated by two species *Acacia irrorata* (Green Wattle) and *A. melanoxylon* (Black Wattle). Areas within this class are represented by small mapped units found in the rural, urban and semi urban environments. They will generally support low ecological values but provide a stepping stone to longer-term regeneration and are an indicator of potential land use changes.

Freshwater Wetlands

This class is represented by one community *Coastal Freshwater Wetlands* and is predominately characterised by farm dams that have impeded flow along cleared drainage lines within the Bonville study area. Natural occurring freshwater wetlands may be attributed to the EEC *Freshwater Wetlands on coastal floodplains*. One area within the study area has been labelled a potential EEC from this mapped unit (Figure 8), however most represent man-made or derived occurrences.

Forested Wetlands

This category contains the majority of potential EECs within any class. Three vegetation communities within this class have been mapped within the study area: *Coastal Paperbark Swamp Oak Floodplain Forest, Coastal Swamp Mahogany Forest* and *Coastal Paperbark Sedgeland* dominated forest. All three vegetation communities are very closely aligned and subtle changes in elevation and or salinity can see abrupt changes to vegetation composition. These vegetation communities would align with three possible EECs:

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

These systems are found along the easterly edge of the study area adjacent to low-lying areas of Bonville and Pine Creeks and their tributaries (Figure 8). These vegetation communities are dominated by tree canopy species such as *Melaleuca quinquenervia* (Broad-leaved Paperbark), *E. robusta* (Swamp Mahogany), *Casuarina glauca* (Swamp Oak) and *Callistemon salignus* (Willow Bottle-brush). The majority of these species are primary Koala feed trees as listed under the CKPoM 2000 (Lunney et. al., 1999). These systems play a very important role in filtering run-off to coastal waterways and are potentially harmed by excessive nutrient and sediment loads as a potential consequence of poor farming practises and / or residential and rural subdivisions.

Exotic Vegetation

In excess of 180 ha of this class has been mapped within the study area and indicates re-growth of cleared drainage lines since the cessation of dairying and other intensive agricultural activities. This class is abundantly represented within the rural residential subdivisions already located in the study area. The majority of this class is represented by exotic planted vegetation with the propensity to spread as a garden escape, as observed during field surveys. Within the study area garden plants were found many hundreds of metres from the nearest known occurrence within rural residential areas.

The majority of this class is mapped as *Camphora laurina* (Camphor Laurel) which has become a dominant vegetation class in regenerative zones and has established within coastal remnant forest areas and along drainage lines. A number of native species (some of which are threatened species) may have benefited from the rise of Camphor Laurel as a foraging resource, notably Wompoo Fruit Dove (*Ptilinopus magnificus*), Rose-crowned Fruit Dove (*Ptilinopus regina*) and Purple-crowned Fruit Dove (*Ptilinopus superbus*). Large flocks of Top-knot Pigeon (*Lopholaimus antarcticus*) and White-headed Pigeon (*Columba leucomela*) were observed in the study area feeding on Camphor Laurel. During spot-lighting sessions Grey-headed Flying-fox (*Pteropus poliocephalus*) were observed feeding on Camphor Laurel fruit. Combined with highly mobile frugivorous pigeons feeding on this fruit Camphor Laurel seed can spread significant distances throughout the landscape.

Dry Sclerophyll

A relatively small area of dry sclerophyll forest occurs within the study which is dominated by Coast and *Escarpment Blackbutt Dry Forest*. This vegetation unit is dominated by *Eucalyptus pilularis* (Blackbutt) with other less dominant canopy species present such as *E. resinifera* (Red Mahogany), *Syncarpia glomulifera* (Turpentine), *Corymbia intermedia* (Pink Bloodwood) and *E. microcorys* (Tallowwood). This community is also considered likely to provide habitat foraging resources for Koalas.

This class generally occurs on slightly elevated areas of coastal floodplains and on taller coastal ridges within the study area. Several large Blackbutt trees were found within this vegetation community that were above two metres diameter-at-breast-height (DBH) and therefore are more likely to contain hollows. Hollow-bearing trees were found to be extremely rare within the study area. None of these forest types are considered likely to represent an EEC definition.

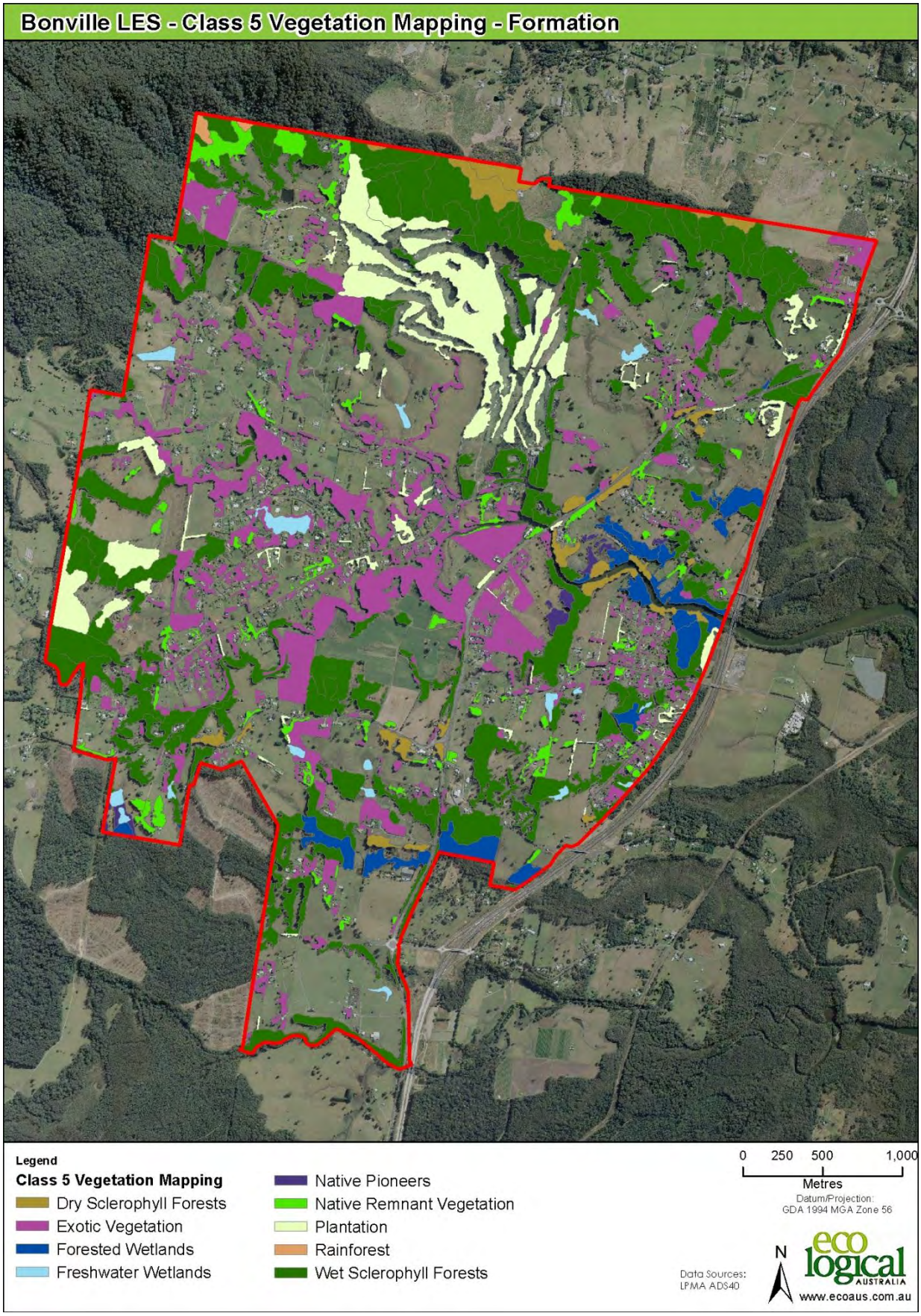

Figure 5: Vegetation formations

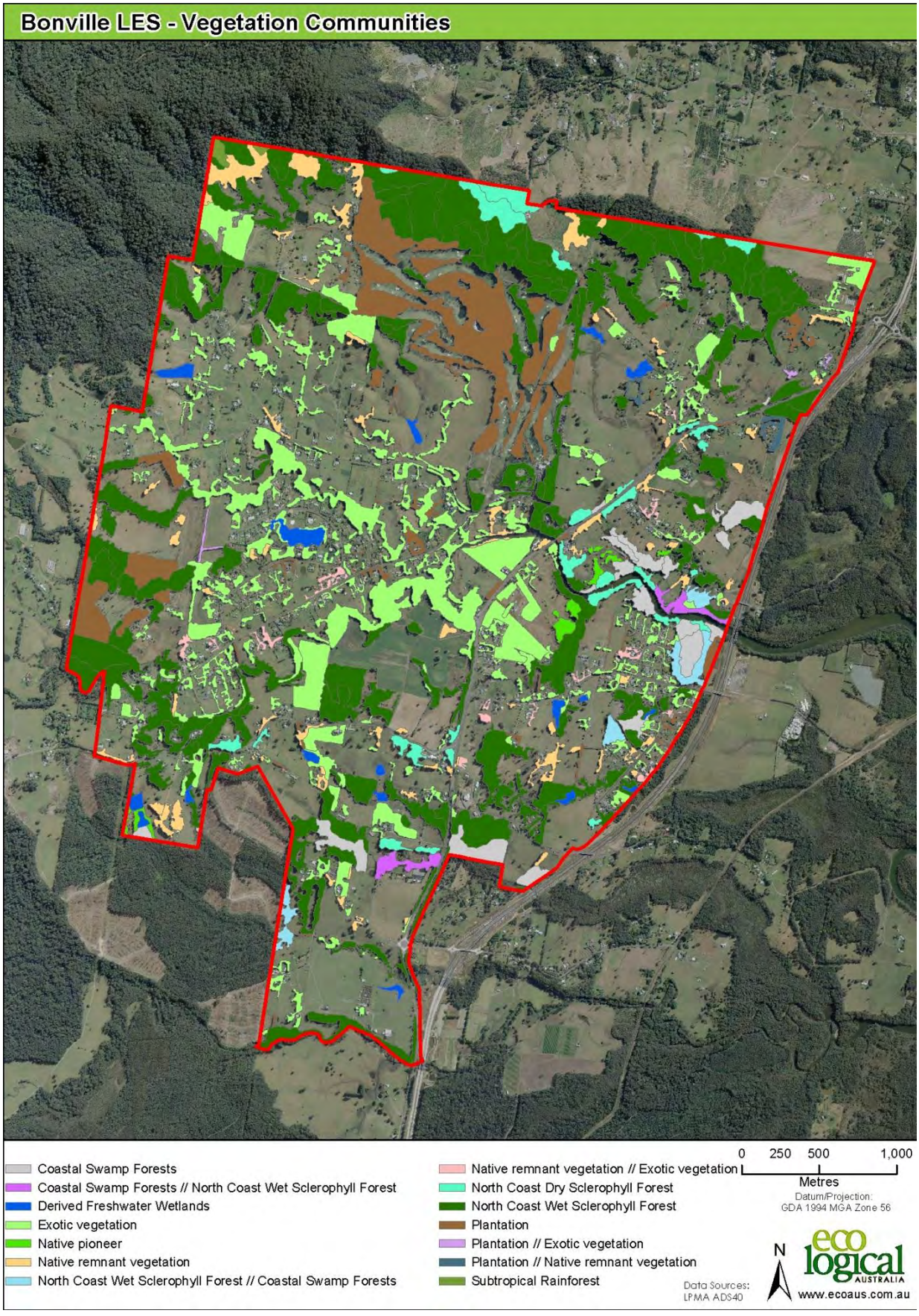

Figure 6: Vegetation communities

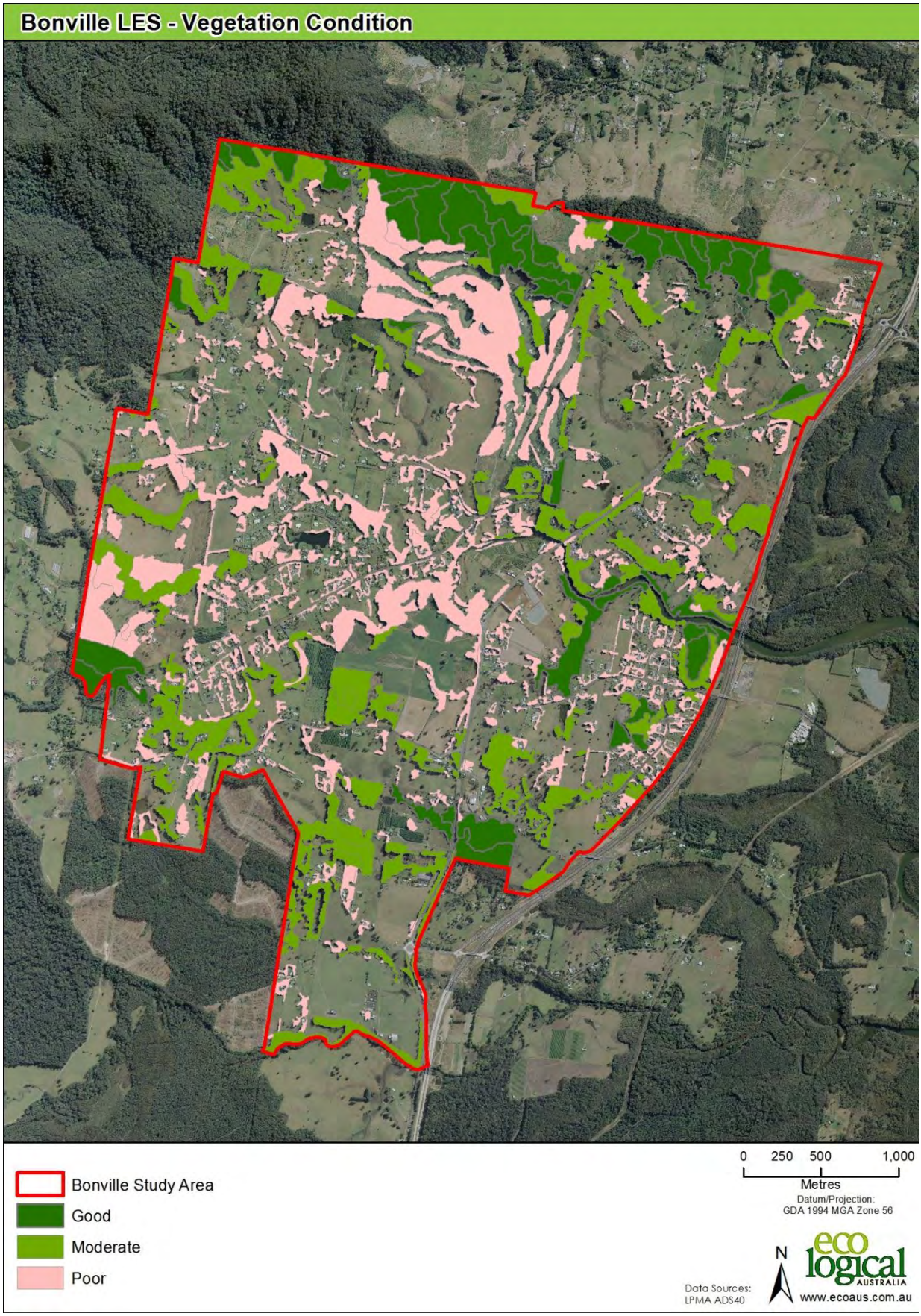

Figure 7: Vegetation condition

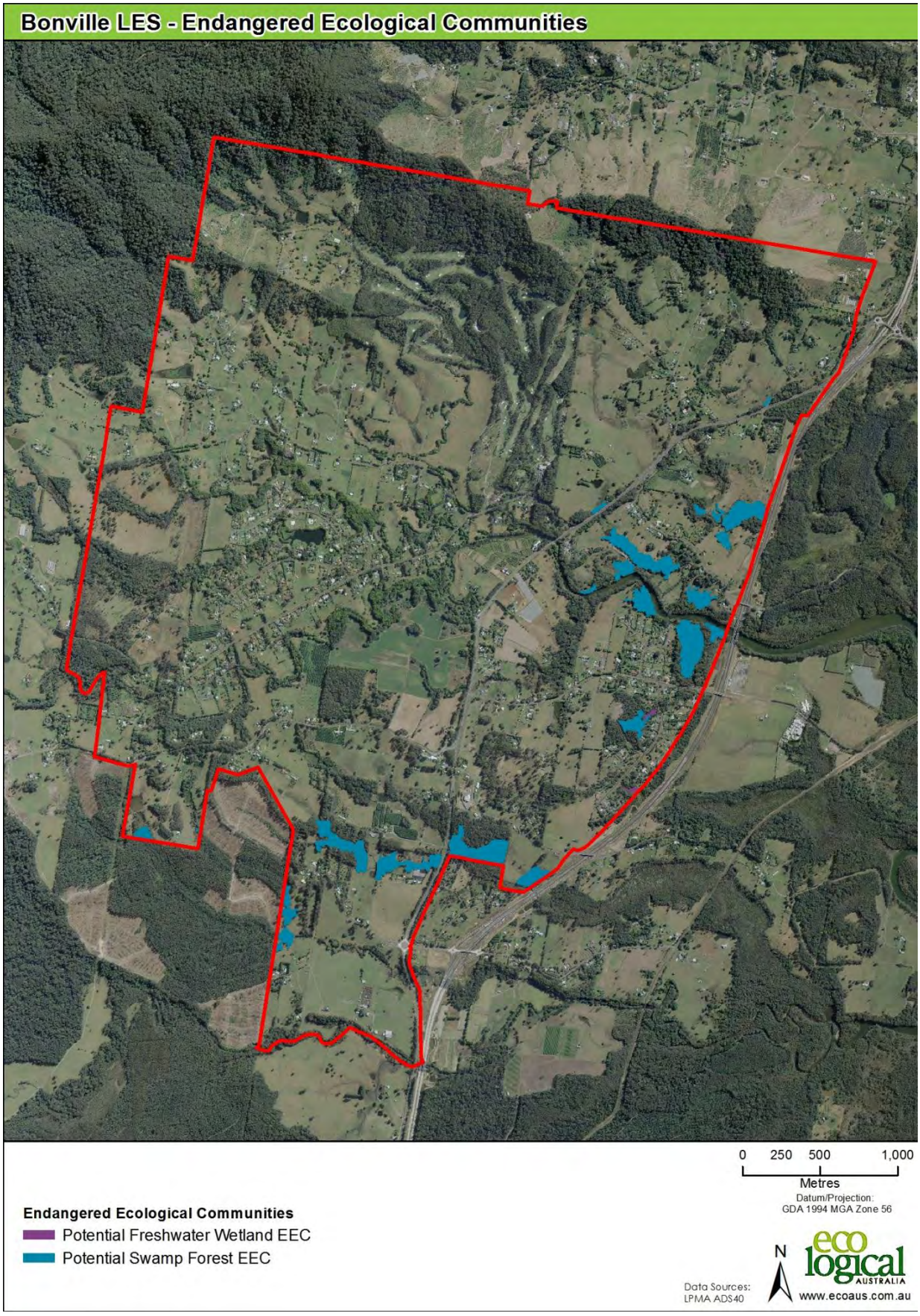

Figure 8: Endangered Ecological Communities

4.1.4 Vegetation condition

Vegetation community information described in Section 4.1.3 provides an indication of forest structure, previous land use and disturbance regimes over time. A native vegetation condition statement for each community can be developed, based on the ranking of null, good, moderate or poor condition categories.

This ranking system was used to categorise vegetation mapping and determine simple condition statements within the study area (Figure 7). This system was based on available information from the mapping project coupled with field assessment data.

The vegetation condition layer (Figure 7) will be combined with riparian buffers, potential EECs and landscape context (corridors) to create habitat significance and environmental constraints layers (Section 6).

Vegetation condition is a function of several interacting factors, including:

- previous disturbance / clearing regimes;
- subsequent re-growth of native and exotic species; and
- resilience of remnant vegetation communities.

This process attempts to sort vegetation cover into a ranked condition statement thereby determining the relative vegetation quality throughout the study area.

Four condition categories (rankings) were created by applying the following series of rule sets to the data. Table 4 provides a summary of the rankings and the area they cover within the study area.

- Data was excluded or given a *Null* rating for non-vegetated systems (e.g. farm dams or horticultural production areas).
- Areas dominated by weeds or native pioneers, small / fragmented native remnants and hardwood plantations were ranked as *Poor*.
- Areas of native vegetation categorised as specific vegetation community units and >0.25 ha were ranked as *Moderate*.
- Areas of native vegetation not connected to *Moderate* category areas and <0.25 ha were ranked as *Poor.*
- The ranking of *Medium* category vegetation patches was lowered / elevated based on field validation where forest structural components were observed to be present / absent (e.g. old-growth and hollow-bearing trees).
- The ranking of *Medium* categories was elevated to *Good* where they formed part of a large contiguous forest block (e.g. good connectivity).

Table 4: Vegetation condition rankings

Vegetation Condition	Polygons	Area (ha)
Null	36	67.97
Poor	398	285.34
Moderate	173	243.92
Good	57	148.64

A ranking of *Poor* does not necessarily indicate low conservation significance. Small regenerating and / or degraded patches of native vegetation may represent higher ecological values in a landscape

context. For example, these may represent an example of an EEC or have the potential to form part of a wildlife corridor.

4.1.5 Threats

A recent threat to certain native vegetation throughout areas of NSW and the Bonville area is the plant fungal disease Myrtle Rust (*Uredo rangelii*). This fungus attacks plants belonging to the family Myrtaceae. The disease has spread from the Central Coast of NSW through all NSW coastal LGA's into south-east Queensland and Victoria. It has been recorded on over 100 flora species within 27 genera of Myrtaceae (e.g. Eucalypt, Melaleuca, Callistemon and Angophora). The rust attacks and kills the new growth tips of the plant and is indicated by spots on leaves and stems which develop a mass of orange to yellow powdery spores. Myrtle Rust can kill young plants and severely stunt mature plants by affecting new growth over successive seasons. It was observed on *Rhodamnia rubescens* (Scrub Turpentine) within the study area (Photos 1 and 2).

Photo 1: Yellow spores of Myrtle Rust (*Uredo rangelii*) on Scrub Turpentine growth tips

Photo 2: Spotting on Scrub Turpentine leaves caused by Myrtle Rust

4.1.6 Species of plant

Within the study area 197 plant species have been recorded including 25 exotic species (13%) (Appendix B). This does not represent a comprehensive flora species list of the study area. This list is a combination of flora survey records and additional incidental sightings from the current field survey.

4.1.7 Significant flora

No significant flora (ROTAP or NSW TSC-listed species) were recorded during the survey effort for this study. A review of the OEH Atlas records for the study area highlighted *Marsdenia longiloba* (Slender Marsdenia) as a threatened species which occurs within the study area (Photo 3).

Photo 3: *Marsdenia longiloba*

Fig trees (*Ficus* spp.) are not listed as a threatened or rare species but are considered in this study to be significant as a foraging source for a range of threatened species (Figure 11).

Instances of isolated Figs were noted as stand-alone paddock trees or growing on eucalypt stumps during roadside assessment. These features should be retained in any future development area and locations will be provided as a point feature constraint.

4.2 FAUNA HABITATS

The vegetation communities described within the study area provide a range of fauna habitat resources. At a landscape scale the vegetation of the study area is a mosaic of remnant and regenerating forested patches, regenerating ephemeral drainage lines and riparian zones supporting a high density of planted and naturalised weed species.

Forested vegetation communities range from small areas of rainforest to extensive wet sclerophyll forests, isolated areas of dry sclerophyll forest and remnant swamp forest communities. These communities are largely dominated by eucalypts and support mesic or moist understoreys. Based on historic accounts of timber extraction activities and remnant vegetation patches it is likely that rainforest

and swamp forest communities may have been more widespread within the locality prior to European settlement.

Riparian zones and man-made wetlands also provide a range of resources for specific fauna guilds within the study area. Large areas within the valley have been extensively cleared of forest (60%) while regenerating and exotic vegetation accounts for a further 15% of the overall vegetation cover. Derived grasslands containing a mix of introduced and native grasses occur widely as a habitat type, and provide habitat resources for some native fauna.

The disturbance regimes applied to the Bonville area since the late 1800's have reduced the occurrence of a range of native faunal species while providing opportunities for certain other fauna species. A severely depleted habitat component throughout the study area is hollow-bearing trees. Large trees rarely occur and only a few significant trees containing a range of hollow sizes were recorded within the study area.

Eucalypts take many decades to mature and centuries to reach an age where hollows can develop. Blackbutt growth rates (measured in the Coffs Harbour area) were estimated at approximately 21 years to reach 25 cm (DBH), 52 years to 50 cm, 94 years to 75 cm, 144 years to 100 cm and 194 years to 125 cm (Mackowski 1984). The oldest trees produce the largest hollows which are a necessary requirement for certain fauna species such as the larger forest owls and glider species.

4.3 FAUNA SPECIES

The Bonville area provides a range of fauna habitats for a number of fauna species. Table 5 lists faunal groups and the number of native and exotic species recorded during field survey effort (including records from previous studies).

Table 5: Summary of fauna species

Terrestrial Fauna Groups	Native	Exotic	Total
Frogs	5	1	6
Reptiles	8	0	8
Mammals (excl. bats)	14	4	18
Bats	17	0	17
Birds	118	3	121
			170

A total of 170 vertebrate fauna species were recorded within the study area including good representation across all fauna guilds, with eight species recognised as exotic (approximately 5%). This is not a comprehensive fauna list with many more species likely to occur based on the available habitats of the study area. The full list of fauna species recorded during the current survey and previous studies is provided in Appendix A.

4.3.1 Ultrasonic microbat call identification

Analysis of ultrasonic echolocation bat calls via Anabat recorders identified 13 distinct species of microchiropteran bat within the study area (Table 6). Five of these species are listed as Vulnerable under Schedule 2 of the TSC Act. Full echolocation call results are provided in Appendix C. An additional three species were recorded during previous studies. All recorded bat species are listed in the fauna table (Appendix A).

Table 6: Summary of microbat species

Scientific Name	Common Name	Call Confidence	TSC Act	EPBC Act
Chalinolobus gouldii	Gould's wattled bat	D, Po	-	-
Miniopterus australis	Little Bentwing-bat	D, Pr, Po	Vulnerable	-
Miniopterus schreibersii oceanensis	Eastern Bentwing-bat	D, Pr, Po	Vulnerable	-
Mormopterus norfolkensis	East Coast Freetail-bat	D	Vulnerable	-
Mormopterus sp. 2	Eastern Freetail-bat	D, Po	-	-
Myotis macropus	Large-footed Myotis	D, Po	Vulnerable	-
Myotis macropus / Nyctophilus sp.		D	-	-
Nyctophilus sp.	Long-eared Bat	D	-	-
Rhinolophus megaphyllus	Eastern Horseshoe Bat	D	-	-
Saccolaimus flaviventris	Yellow-bellied Sheathtail Bat	D	Vulnerable	-
Tadarida australis	White-striped Freetail Bat	D		
Vespadelus darlingtoni	Large Forest Bat	D		
Vespadelus pumilus	Eastern Forest Bat	Pr		
Vespadelus regulus	Southern Forest Bat	Pr		

D = Definite, Pr = Probable, Po = Possible call identification

4.3.2 Significant fauna

Eight threatened species listed as Vulnerable under the TSC Act were recorded during the current field survey:

Bird

- Square-tailed Kite (*Lophoictinia isura*)

Mammals

- East Coast Freetail-bat (*Mormopterus norfolkensis*)
- Eastern Bentwing (*Miniopterus schreibersii oceanensis*)
- Grey-headed Flying-fox (*Pteropus poliocephalus*)
- Koala (*Phascolarctos cinereus*)
- Large-footed Myotis (*Myotis macropus*)
- Little Bentwing Bat (*Miniopterus australis*)
- Yellow-bellied Freetail Bat (*Saccolaimus flaviventris*)

Of these species three bats have not been previously recorded within the study area, namely the East Coast Freetail-bat, Large-footed Myotis and Yellow-bellied Freetail Bat.

OEH Atlas records show fourteen threatened species (including two insects) listed as Endangered under the TSC Act as previously recorded within the study area:

Birds

- Glossy Black-Cockatoo (*Calyptorhynchus lathami*) V
- Barred Cuckoo-shrike (*Coracina lineata*) V
- Black-necked Stork (*Ephippiorhynchus asiaticus*) E
- Little Lorikeet (*Glossopsitta pusilla*) V
- Black Bittern (*Ixobrychus flavicollis*) V
- Square-tailed Kite (*Lophoictinia isura*) V

- Eastern Osprey (Pandion cristatus) V
- Masked Owl (*Tyto novaehollandiae*) V
- Sooty Owl (*Tyto tenebricosa*) V

Mammals

- Little Bentwing-bat (*Miniopterus australis*) V
- Eastern Bentwing-bat (*Miniopterus schreibersii oceanensis*) V
- Koala (*Phascolarctos cinereus*) V

Insects

- Black Grass-dart Butterfly (*Ocybadistes knightorum*) E
- Coastal Petaltail (*Petalura litorea*) E

A combined total of 18 threatened fauna species have been recorded within the study area during current and previous studies.

4.4 SPECIES, POPULATIONS AND COMMUNITIES OF CONSERVATION CONCERN

From the database searches 94 animals (Table 7) and 40 plants listed under the TSC Act or the EPBC Act are recorded within a one km search of the study area. Of these 46 animals and 13 plants are either likely or have the potential to occur within the study area based on available habitat. Eight EECs have been recorded within this search with only the 3 following likely to occur:

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

Table 7: Summary of threatened fauna

Faunal Group	No	Unlikely	Potential	Likely	Yes	Total
Frogs	0	5	3	1	0	9
Reptiles	0	0	3	0	0	3
Mammals (excl. bats)	2	5	6	0	2	15
Mammals(bats)	0	2	5	1	6	14
Birds	17	3	20	2	7	49
Fish	0	0	0	0	0	0
Insects	0	1	1	0	2	4
Total	**19**	**16**	**38**	**4**	**17**	**94**

4.5 LANDSCAPE LINKAGES

Several large remnant forested areas and potential corridor features are located adjacent to and traversing the study area. These areas include:

- Boambee State Forest to the north-west;
- Pine Creek State Forest to the south;
- links to the lowland habitats to the east (Bongil Bongil National Park);
- the ridgeline running east along the northern boundary of the study area; and
- surrounding private property areas.

Koala populations in particular have been documented as highly significant in the Pine Creek - Bongil Bongil areas in a state and national context (Scotts 2013). This area is bisected by the Bonville Pacific Highway upgrade and forms the easterly edge of the Bonville study area.

Overall a greater separation between wildlife and vehicle traffic now exists, although the road upgrade has reduced habitat in the area via clearing and potentially severed significant east to west wildlife movement. Death and injury to wildlife by cars on roadways (particularly in high speed areas) can cause significant impacts to local wildlife population dynamics. The upgrade may have reduced these potential impacts (after an initial disruption) by providing dedicated wildlife overpass, underpass and fencing along the roadway allowing fauna movement away from vehicle interaction. However Koala monitoring research for the Bonville Pacific Highway upgrade (2000 – 2009) reported a decline in Koala numbers. High levels of disease, a low breeding rate and vehicle strike were all implicated (AMBS 2012).

Six fauna underpasses are located directly adjacent to the Bonville study area. Most of these are located along drainage lines and one dedicated fauna overpass exists just south of the study area. These drainage line linkages under the roadway allow land and water movement to fauna species. These underpasses logically align with likely local corridors traversing the study area or adjoin State Forest or National Park tenure (Figure 9). The main underpass location linkages are listed (north to south):

- Titans – Herdegen Close;
- Bonville Creek (north and south bank);
- Northern Pine Creek tributary;
- Reedy Creek; and

- Pine Creek.

Several subregional corridors traverse the study area (Figure 9) and were mapped as part of the *Key Habitats and Corridors for Forest Fauna* project (Scotts 2003). Construction of the Bonville bypass has preserved the majority of these corridors except one which would probably follow a drainage line along a tributary of Pine Creek. Post highway construction, a review of corridor connections is required to examine functional connectivity regarding the new fauna underpasses, as at least one depicted corridor is misaligned.

The *Coffs Harbour City Council NSW 2009 Draft Priority Habitats and Corridors Strategy 2010 – 2030* maps local corridors within a regional framework across the Coffs Harbour LGA. These two corridor frameworks were overlayed with existing GIS datasets to highlight areas which would improve connectivity and wildlife movement.

Both datasets show plantation habitat was not considered as an ecological unit as part of these corridor assessments. Plantation forest cover provides certain habitat features to allow wildlife movement and comprises a significant part of the potential BIG club corridor. This corridor extends from the northerly portion of the study area in a southerly direction along the Bonville Creek riparian corridor and east to Bongil Bongil National Park. Habitat corridors are explored further in Section 6 of this report.

The most practical solution to wildlife corridors within existing zoned and occupied landscapes is to utilise drainage lines and their subsequent vegetation buffers applicable to the stream order definition.

Drainage lines are natural traverse zones for a range of species particularly highly mobile bird and bat species. Data from the microbat echolocation call data indicate that microbats utilise these natural conduits for their foraging requirements indicated by 12 species recorded included several threatened species.

Local corridor definition for this study area has naturally been focused on the riparian and their associated buffer areas with the potential limits to development around water front land. Protection and improvement through environmental management; weed removal and suppression of riparian zones will also improve the ability for the iconic koala to access fauna underpasses under the Pacific Highway bypass to significant koala habitat areas in the Bongil Bongil and Pine Creek locations. Riparian buffers form a significant component of the environmental constraints derivation in section 6 of this report.

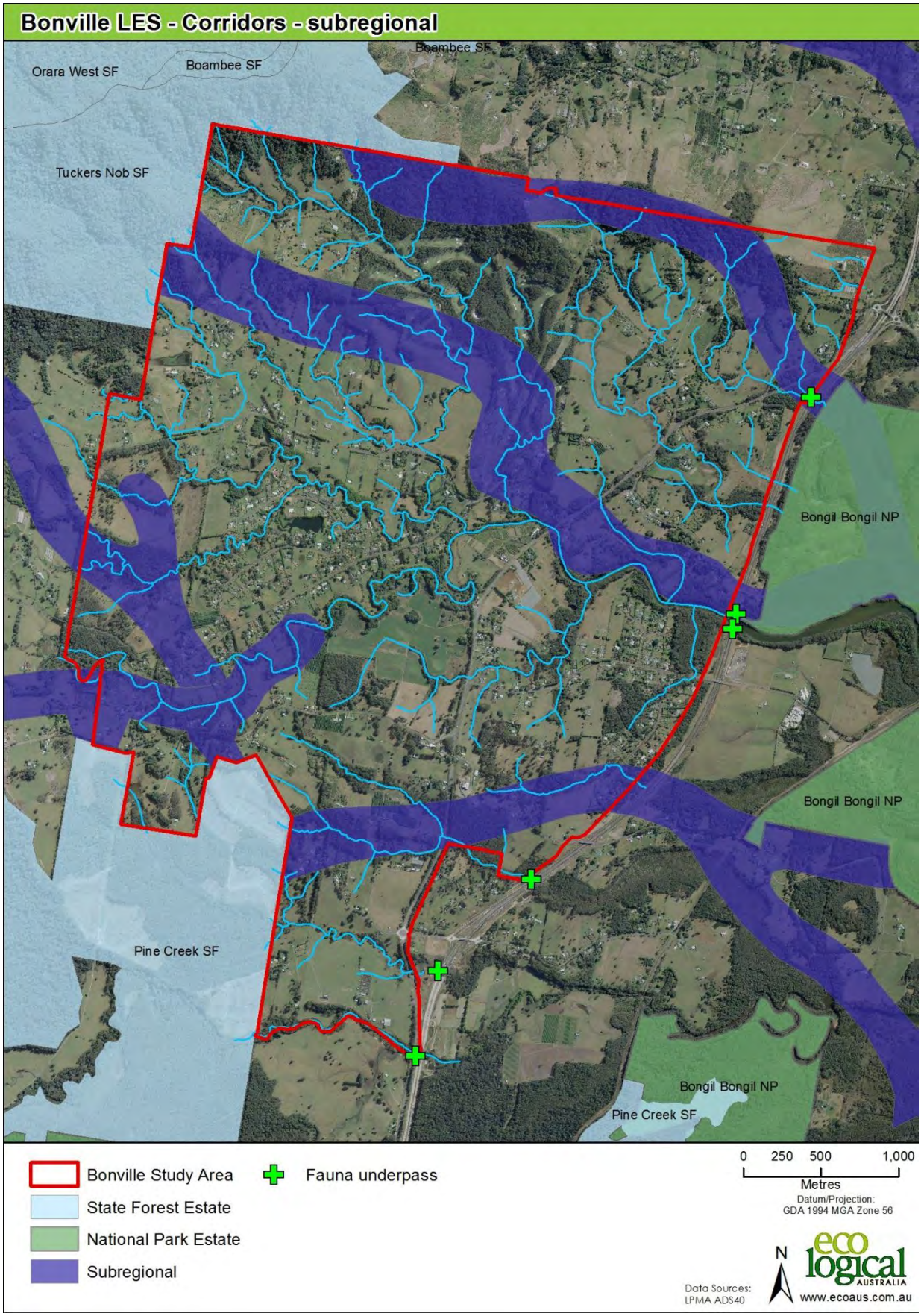

Figure 9: Regional corridors

5 Discussion

This study documents the environmental values of the Bonville study area, in the context of a planning initiative examining potential further rural residential land releases. Through the process of assessing vegetation cover and related fauna habitats throughout the study area it is apparent this area has undergone extensive clearing and modification via forestry and agricultural development. Local landuse has changed overtime as indicated by original industries which no longer persist in the area (e.g. dairying) and other discontinued industry projects (e.g. plantation products for paper manufacture). Agriculture landuse has shifted from grazing systems predominately to increased small-scale intensive horticulture developments. This area currently provides extensive rural landscape living opportunities.

Fine-scale vegetation mapping highlights that vegetation systems are fragmented overall, with steeper slopes retaining larger blocks of vegetation cover throughout the majority of the study area. Landuse changes can also be seen throughout extensive riparian zones which are mapped as primarily exotic vegetation. This fine-scale mapping also shows large areas of primary Koala habitat (mapped for CHCC LEP 2000) which support communities dominated by Camphor Laurel. This indicates a potential over-emphasis of functional Koala habitat extent in the study area.

The Bonville Pacific Highway bypass has reduced traffic flow along the old permeable highway (now Pine Creek Way) with possible longer-term benefits to fauna. Additionally wildlife exclusion fencing and fauna over and underpasses assist in separating vehicle and wildlife interaction along the Bonville Pacific Highway upgrade route.

Increased residential development throughout the study area is expected via expanded residential development in the BIG club lands. Previous planning initiatives such as Koala habitat protection and changed rural enterprises have resulted in revegetation of certain areas and vegetation losses in other developed areas. Challenges continue in the implementation of planning initiatives regarding protection of significant lands, riparian vegetated buffers, wildlife corridors and linkages between existing remnant vegetation within and downstream of the study area.

5.1 KOALA ACTIVITY

Koalas are a unique and highly specialised native species, and their populations in Coffs Harbour are relatively well documented in comparison to many throughout NSW. Coffs Harbour was the first LGA in NSW to implement an LGA-wide Comprehensive Koala Plan of Management (CKPoM, Lunney et. al., 1999). Environmental protection zones were allocated to significant areas of the LGA through the CKPoM process. CHCC and OEH are currently undertaking a review of the CKPoM and further work is being done on a KPoM for the Bellingen and Nambucca coastal and valley LGAs by OEH staff. Consequently sites that were assessed for Koala activity for the CKPoM have been revisited, including four sites within the Bonville study area. The results have yet to be published but indications are that three of the four Bonville sites provided evidence of recent Koala activity (pers. comm., M. Fisher, OEH, 2013).

During this LES process Koala activity was confirmed from several locations within the study area:

- Pine Creek Way – Titans Close Koala crossing;
- Private property adjacent to BIG club lands;
- Private property in the Crossmaglen Road – Burgess Creek area;
- Reedy Creek; and

- Pine Creek drainage lines.

A recent study was undertaken on Koala population dynamics expressed as sub-populations, regional populations and meta-populations, for a consortium of local environmental groups in conjunction with OEH Wildlife Atlas data (Scotts 2013). The findings of this study state the North Coast Koala meta–population is of national significance. Additionally the Coffs Harbour and Bellingen LGAs and more specifically Pine Creek State Forest and Bongil Bongil National Park are noted as key areas of Koala habitat. However monitoring work for the Bonville Pacific Highway upgrade indicated a decline in Koala numbers between 2000 - 2009 (AMBS 2011).

The following information from Scotts 2013 report describes the Bonville Koala sub-population, which covers a slightly larger extent to the Bonville LES study area:

Location / Landform / Habitat

Southern Coffs Harbour LGA in Bonville district – east and west of the Pacific Highway; coastal foot hills; habitats as fragmented remnants.

Threats

Area of on-going and planned intensive urban and rural-residential development – habitat loss, fragmentation and degradation; dogs, vehicle strike, stress-induced diseases.

Tenure

Predominately private land

Prognosis

This sub-population is thought to have shrunken significantly. A broad estimate of 50 – 500 individuals is estimated but the upper limit may well be a drastic over-estimate. The functional viability of this sub-population is uncertain in the face of on-going and escalating threats; essentially a sink area for dispersing individuals from the sub-population 2A (2A = Pine Creek and Bongil Bongil area).

Recommendations

Severely impacted but retention and enhancement of habitat and corridor links wherever possible, along with koala-supportive management strategies as are possible over time will be of benefit; on-going public education regarding koala conservation, impacts of road collision and management of domestic dogs is required.

This synopsis of the Bonville Koala sub-population supports results from the current LES. Koala evidence and locations were determined from the periphery of the study area and are likely to have been populated by dispersing Koalas moving from Pine Creek State Forest and Bongil Bongil National Park which are adjacent into the study area. Corridors are highlighted as crucial components which allow Koalas to traverse remnant and regenerating habitats. A focus on maintaining and improving existing Koala habitat is required for the Bonville study area.

Photo 4: Koala detected during surveys along the Crossmaglen Road within the study area.

6 Conservation and Management

The study area covers approximately 1860 ha with mapped vegetation systems ranging from the flood plain EEC's in the low-lying easterly areas through to wet sclerophyll and rainforest systems on the elevated and south-facing slopes to the north. Significant riparian vegetation systems exist with a significant percentage found in a degraded state due to previous landuses, including some small riparian remnants heavily affected by environmental weeds (e.g. exotic vines).

Fauna habitats provide varied resources for a range of (mainly) highly mobile annual and seasonal migratory and resident species. These species include state and federally-listed species such as Grey-headed Flying-fox and Koala. Microbats in particular are a unique fauna guild which represent a large percentage of the threatened species detected during the current assessment, most of which were recorded along drainage lines.

6.1 ENVIRONMENTAL CONSTRAINT DERIVATION

An environmental constraint in a planning context indicates an environmental value (usually supported by legislation) highlighted for protection or consideration regarding proposed zoning changes and development.

The following criteria were used to build the constraints layer (Figure 11).

- Evaluate and protect existing high value vegetation.
- Protect existing Koala habitat.
- Establish corridor network to link existing vegetation to improve ecological function and catchment protection.
- Quantify statutory requirements for vegetation buffers around drainage lines for drainage line stabilisation and to improve water quality.

The following GIS layers were combined and intersected to create a single environmental constraints layer (Figure 11).

- Draft LEP 2013 – zones E2, W1 and W2.
- Class 5 Vegetation mapping.
    - EEC.
    - Vegetation significance.
    - Vegetation condition values.
    - Vegetation extent.
- Drainage lines, redefined and ordered.
    - Drainage buffers.
- Point significant field data.

The following projects and associated mapping were also considered as part of this process:

- Regional Corridors (Scotts 2003); and
- Draft Priority Corridors and Key Habitats (CHCC 2009).

GIS data layers have been presented in the results section of this report, and riparian buffers will be examined in more detail as part of the full constraint assessment process.

6.2 RIPARIAN BUFFERS

Riparian buffers are a major consideration of this planning process as they present a significant environmental constraint to proposed development.

The draft CHCC Biodiversity DCP (CHCC 2013) outlines the following objectives and guidelines regarding 'Riparian Lands'.

B8.4.1 Objectives

- *To improve water quality within waterways through sustainable design.*
- *To improve the stability of the bed and banks of waterways through the management of riparian vegetation.*
- *To improve the relationship between aquatic and terrestrial habitats associated with the riparian lands interface.*
- *To improve the ecological function of riparian areas within the landscape.*
- *To identify and protect scenic and cultural values.*

B8.4.2 Controls

Riparian Buffer Zones

i) Identified riparian buffer requirements are outlined in Appendix G.

ii) Where a riparian buffer is not designated within this Component of the DCP, the riparian buffer must be consistent with controlled activity guidelines for riparian corridors issued by the NSW Office of Water (NOW) for core riparian zones and

Vegetated Buffers

iii) Cleared buffer areas are to be revegetated.

iv) Buffer zones are not to be used for private infrastructure purposes, such as onsite effluent disposal, Asset Protection Zones (APZ) and the like.

Riparian Corridor Widths

NOW recommends a Vegetated Riparian Zone (VRZ) width based on watercourse order as classified under the Strahler System of ordering watercourses and using current 1:25 000 topographic maps (see Appendix G). *The width of the VRZ should be measured from the top of the highest bank on both sides of the watercourse.*

Table 8 shows how Vegetated Riparian Zone (VRZ) buffer distances were applied to all stream orders to create a drainage buffer layer, as detailed in Section 6.3.

Table 8: Stream order and buffer distances

Watercourse type	VRZ width (each side of watercourse)	Total riparian corridor width
1st Order	10 Metres	20 m + channel width
2nd Order	20 Metres	40 m + channel width
3rd order	30 Metres	60 m + channel width
4th Order and greater (includes estuaries, wetlands and any parts of rivers influenced by tidal waters)	40 Metres	80 m + channel width

6.3 DRAINAGE DATA AND DEFINITION

CHCC provided drainage data for this study area as part of a larger set of digital geographic data. Topographic drainage was captured at 1: 25000 scale by the NSW mapping agency for their original map production series. This dataset is too coarse for application to the drainage systems and buffered areas within the study area. Inaccuracies also exist within this dataset (e.g. certain drainage channels have changed course over time).

Initially the drainage alignment was re-mapped using high resolution imagery (ADS40 LPI) and LiDAR-derived metre-accurate contour information available for the study area. The re-defined drainage layer was utilised which contained stream order as categorised by Strahler (Appendix G). Buffer distances were then applied to all stream orders (Table 8) and a drainage buffer layer was produced (Figure 10).

Stream orders (as defined in Section 6.2) range from 1st order through to 6th order for the lower section of Bonville Creek. This created buffers on both sides of each drainage line ranging from 10 - 40 m. All stream orders require buffers to be created from the top of bank on each drainage line. This requires fine-scale delineation of the entire drainage network using differential GPS technology at the DA stage of the project. The buffers are designed for use in defining environmental constraints and/or potential LEP zones.

A crucial point within the NOW guidelines states that '*where a watercourse does not exhibit the features of a defined channel with bed and banks, the Office of Water may determine that the watercourse is not waterfront land for the purposes of the WM Act'*. Many of the 1st order streams within the study area may not display defined bed and channel definition as they have been cleared and grazed for many decades. Undefined and/or degraded 1st order drainage lines will require assessment by NOW at an early stage of the development process.

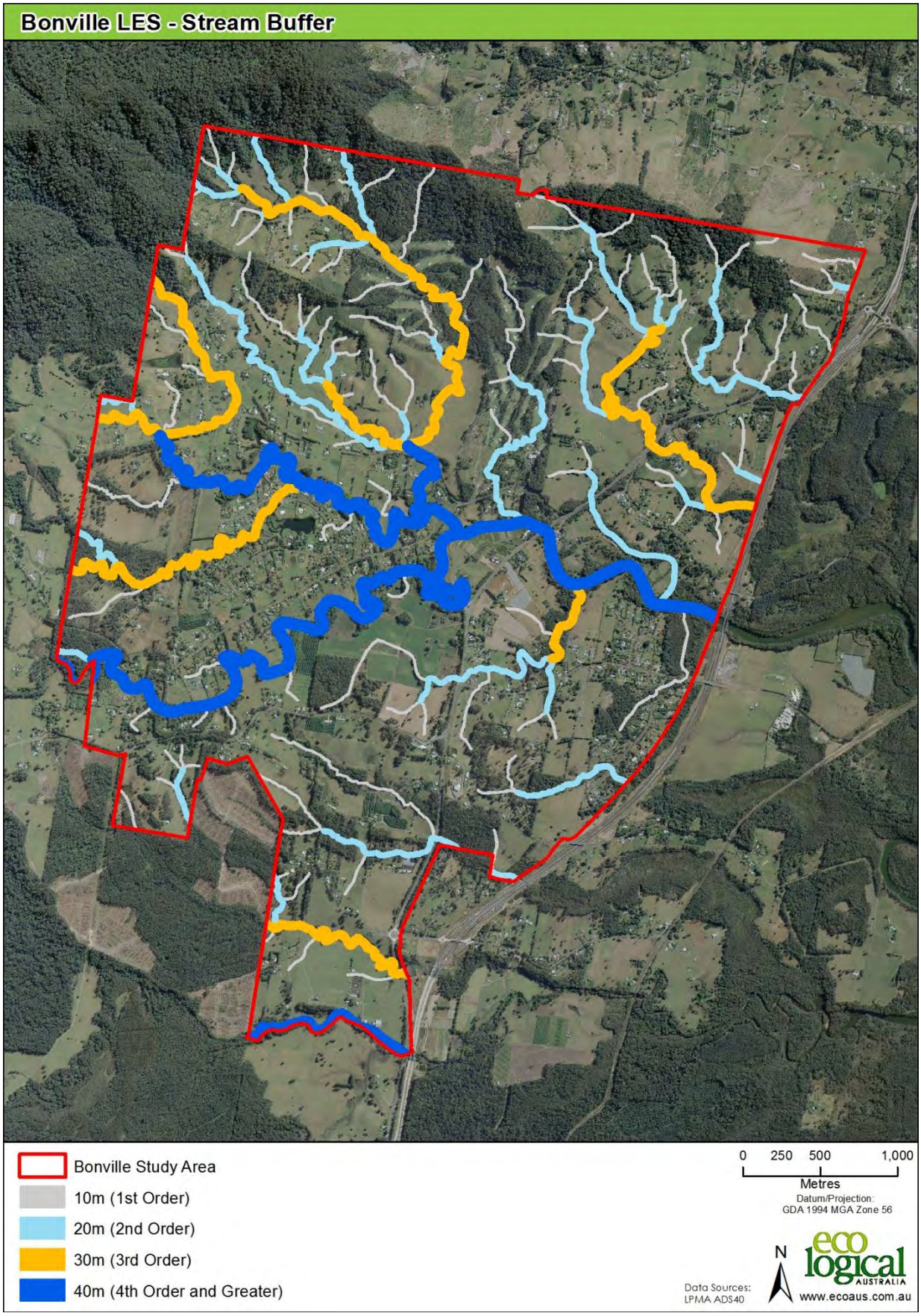

Figure 10: Drainage buffers

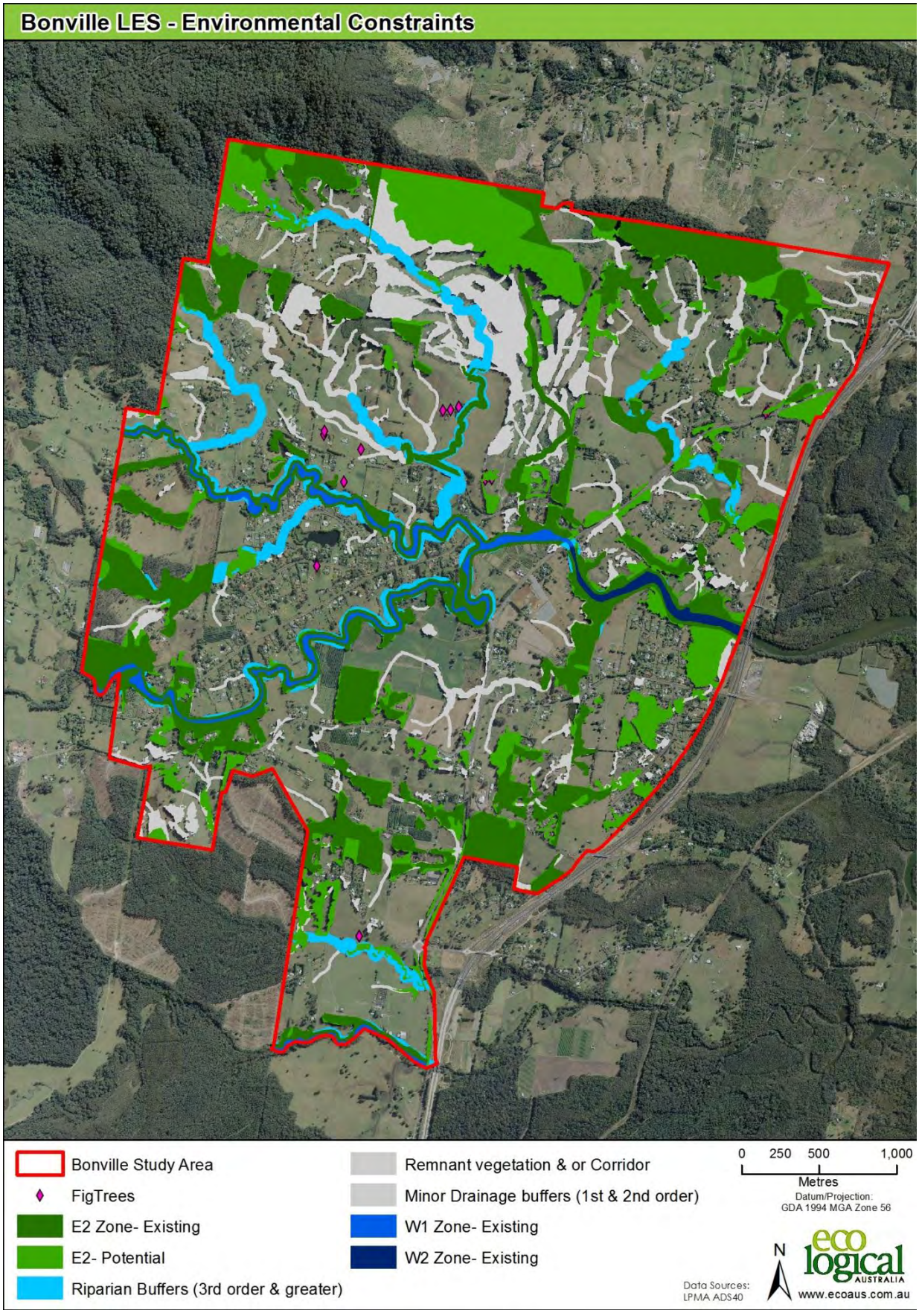

Figure 11: Environmental constraints

6.4 ENVIRONMENTAL CONSTRAINTS LAYER

The full extent of environmental constraints within the study area is depicted in Figure 11. A revision of the data layer was undertaken to remove slivers or edge effects from the GIS integration process. The final polygon layer has been reviewed and edited within each of the following categories to produce the final mapped output.

- E2 zone – Existing.
- E2 - Potential.
- Riparian buffers (3rd order and greater).
- Remnant vegetation and/or corridor.
- Minor drainage buffers (1st and 2nd order).
- W1 zone – Existing.
- W2 zone – Existing.

Table 9 shows the area covered by each environmental constraints category within the study area (Figure 11).

Table 9: Environmental constraints area

Environmental Constraint	Polygon Count	Area (ha)
E2 zone - existing	52	284.50
Minor drainage buffer (1st and 2nd order)	241	73.39
Remnant vegetation and/or corridor	130	98.52
Riparian buffers (3rd order and greater)	132	65.79
E2 - Potential	378	187.96
W1 zone - existing	2	24.11
W2 zone - existing	1	7.23
		741.50

The information provided in Figure 11 depicts the full extent of environmental variables for the Bonville study area, but is not intended as a recommendation for future environmental zones. This mapping layer will be provided to other consultants within the consortium to utilise during a full constraints analysis. This process may consider other potential constraints to land development (e.g. flooding and contaminated lands).

For inclusion to the planning process, the environmental constraints of the study area (Figure 11) will require logical assignment to relevant environmental zones. These existing categories (Table 9) have been assigned a zone (Figure 12) which could be applied to future rural or residential development areas.

It is likely that existing mapped environmental constraints (Figure 11) in areas deemed inappropriate for future development will retain their current zoning. Additional environmental zones are only likely to occur within areas identified for future development.

The Department of Planning and Infrastructure (DoPI) provided advice to CHCC regarding planning proposals using the new instrument zone categories. This advice suggested the 'E3 Environmental management' zone should not be used as part of any current planning processes.

'E2 Environmental conservation' provides a source zone to protect significant environmental values within the study area. Environmental constraints not considered for 'E2' zoning are displayed as a biodiversity overlay (Figure 12) for consideration during the full planning proposal process. These areas include minor drainage lines (e.g. stream orders 1 and 2) and some potential corridor areas for example through the BIG club lands.

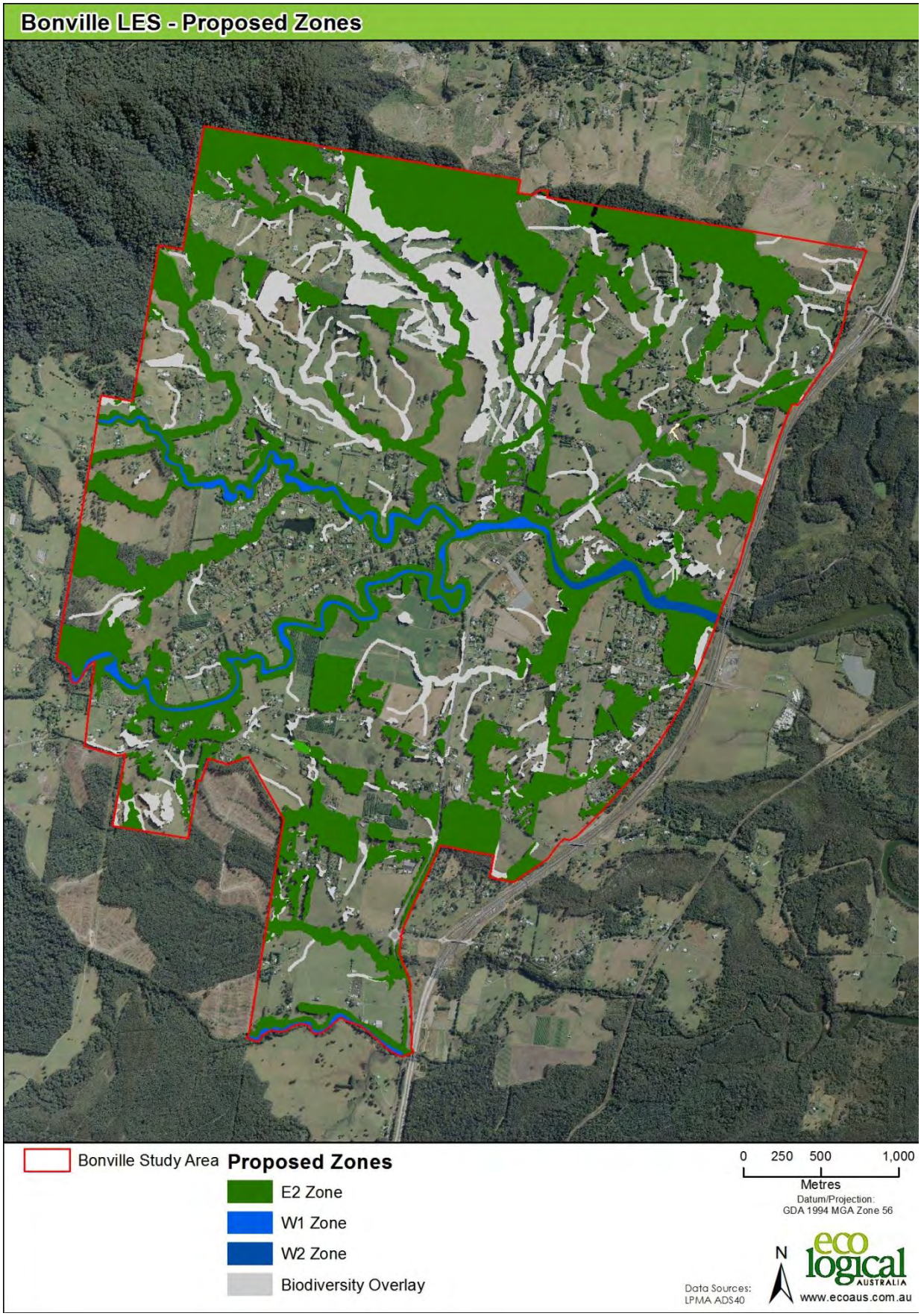

Figure 12: Proposed zones within potential development areas

7 Recommendations

For use during the full planning proposal process a workable constraints layer has been produced as part of this study (Figure 11). This layer was designed with the purpose of protecting and maintaining existing threatened species habitat, applying statutory requirements to riparian zones and applying the best available data when defining corridors. Figure 12 depicts likely allocations within the zoning scheme for any potential future rural or residential development area.

Recommendations for the Bonville study area developed during this study are as follows:

- Retain all high conservation habitats within E2 zoning (Figure 12).
- Absorb riparian buffer areas within E2 zoning as a statutory component (Figure 12).
- Remnant vegetation and / or corridor linkages should be retained as a biodiversity overlay (Figure 12).
- Provide 1st and 2nd order streams as a 'likely constraint' and displayed as a biodiversity overlay (Figure 12).
- Improve wildlife movement corridors under Pine Creek Way (formerly Old Pacific Highway) particularly at Reedy and Pine Creeks. This should allow a dry east – west access for fauna under the new Pacific Highway and Pine Creek Way road corridors.
- Encourage and establish a Bonville Landcare group to reduce NSW-listed weeds and environmental weed species, particularly along the Burgess, Crossmaglen and Bonville Creek drainage lines.
- Corridors within the BIG Club area must be maintained and improved to manage direct and indirect impacts of proposed development works.
- Encourage BIG club to develop a Flora and Fauna Plan of Management (PoM) for proposed housing development works and general management of environmentally significant lands under their control.

8 References

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Appendix A: Fauna species list

SPECIES NAME	COMMON NAME	Exotic	TSC Act	EPBC Act	Survey	
Amphibian					**LES**	**ATLAS**
Crinia signifera	Common Eastern Froglet				*	*
Limnodynastes peronii	Brown-striped Frog					*
Litoria fallax	Eastern Dwarf Tree Frog					*
Litoria tyleri	Tyler's Tree Frog					*
Pseudophryne coriacea	Red-backed Toadlet					*
Rhinella marina	Cane Toad	*				*
Reptiles						
Bellatorias major	Land Mullet					*
Cryptophis nigrescens	Eastern Small-eyed Snake					*
Demansia psammophis	Yellow-faced Whip Snake					*
Hemiaspis signata	Black-bellied Swamp Snake					*
Lampropholis delicata	Dark-flecked Garden Sunskink				*	*
Lialis burtonis	Burton's Snake-lizard					*
Ramphotyphlops nigrescens	Blackish Blind Snake					*
Ramphotyphlops sp.	Blind snake					*
Birds (Diurnal)						
Acanthiza lineata	Striated Thornbill					*
Acanthiza nana	Yellow Thornbill					*
Acanthiza pusilla	Brown Thornbill				*	*
Acanthorhynchus tenuirostris	Eastern Spinebill					*
Accipiter fasciatus	Brown Goshawk				*	
Accipiter novaehollandiae	Grey Goshawk				*	*
Acridotheres tristis	Indian Myna	*			*	
Ailuroedus crassirostris	Green Catbird				*	
Alisterus scapularis	Australian King-Parrot				*	*
Anas gracilis	Grey Teal				*	
Anas platyrhynchos	Mallard				*	
Anas superciliosa	Pacific Black Duck				*	*
Anthochaera chrysoptera	Little Wattlebird				*	*
Ardea ibis	Cattle Egret			Mi	*	*
Ardea intermedia	Intermediate Egret				*	
Ardea modesta	Great Egret				*	
Ardea pacifica	Pacific Heron				*	
Artamus leucorynchus	White-breasted Woodswallow					*
Aviceda subcristata	Pacific Baza				*	*
Aythya australis	Hardhead				*	

Cacatua galerita	Sulphur-crested Cockatoo				*	
Cacomantis flabelliformis	Fan-tailed Cuckoo				*	
Calyptorhynchus funereus	Yellow-tailed Black-Cockatoo				*	*
Calyptorhynchus lathami	Glossy Black-Cockatoo		V			*
Ceyx azureus	Azure Kingfisher				*	*
Chalcites basalis	Horsfield's Bronze-Cuckoo					*
Chenonetta jubata	Australian Wood Duck				*	*
Cisticola exilis	Golden Headed Cisticola				*	
Colluricincla harmonica	Grey Shrike-thrush				*	*
Columba leucomela	White-headed Pigeon				*	*
Coracina lineata	Barred Cuckoo-shrike		V			*
Coracina novaehollandiae	Black-faced Cuckoo-shrike				*	*
Coracina tenuirostris	Cicadabird					*
Corvus orru	Torresian Crow				*	*
Coturnix ypsilophora	Brown Quail				*	
Cracticus nigrogularis	Pied Butcherbird				*	*
Cracticus tibicen	Australian Magpie				*	*
Cracticus torquatus	Grey Butcherbird				*	*
Cygnus atratus	Black Swan					*
Dacelo novaeguineae	Laughing Kookaburra				*	*
Dicaeum hirundinaceum	Mistletoebird					*
Dicrurus bracteatus	Spangled Drongo					*
Egretta novaehollandiae	White-faced Heron				*	*
Elanus axillaris	Black-shouldered Kite				*	
Elseyornis melanops	Black-fronted Dotterel				*	
Entomyzon cyanotis	Blue-faced Honeyeater				*	*
Eolophus roseicapillus	Galah				*	*
Eopsaltria australis	Eastern Yellow Robin				*	*
Ephippiorhynchus asiaticus	Black-necked Stork		E			*
Eudynamys orientalis	Eastern Koel					*
Eurystomus orientalis	Dollarbird					*
Falco peregrinus	Peregrine Falcon					*
Fulica atra	Eurasian Coot				*	
Gallinula tenebrosa	Dusky Moorhen				*	
Gallirallus philippensis	Buff-banded Rail				*	*
Geopelia humeralis	Bar-shouldered Dove					*
Gerygone albogularis	White-throated Gerygone					*
Gerygone mouki	Brown Gerygone				*	*
Glossopsitta concinna	Musk Lorikeet				*	
Glossopsitta pusilla	Little Lorikeet		V			*
Grallina cyanoleuca	Magpie-lark				*	*
Haliaeetus leucogaster	White-bellied Sea Eagle			Mi	*	
Haliastur indus	Brahminy Kite				*	*
Haliastur sphenurus	Whistling Kite				*	

Hirundapus caudacutus	White-throated Needletail			Mi		*
Hirundo neoxena	Welcome Swallow			Mi	*	*
Ixobrychus flavicollis	Black Bittern		V			*
Lalage leucomela	Varied Triller				*	
Leucosarcia picata	Wonga Pigeon				*	*
Lonchura castaneothorax	Chestnut-breasted Mannikin					*
Lophoictinia isura	Square-tailed Kite		V		*	*
Lopholaimus antarcticus	Topknot Pigeon				*	*
Macropygia amboinensis	Brown Cuckoo-Dove				*	*
Malurus cyaneus	Superb Fairy-wren					*
Malurus lamberti	Variegated Fairy-wren					*
Manorina melanocephala	Noisy Miner				*	*
Megalurus gramineus	Little Grass Bird				*	
Meliphaga lewinii	Lewin's Honeyeater				*	*
Monarcha melanopsis	Black-faced Monarch					*
Myzomela sanguinolenta	Scarlet Honeyeater					
Neochmia temporalis	Red-browed Finch				*	*
Ocyphaps lophotes	Crested Pigeon				*	*
Oriolus sagittatus	Olive-backed Oriole				*	*
Orthonyx temminckii	Logrunner				*	*
Pachycephala pectoralis	Golden Whistler				*	*
Pachycephala rufiventris	Rufous Whistler					*
Pandion cristatus	Eastern Osprey		V		*	*
Pardalotus punctatus	Spotted Pardalote					*
Pardalotus striatus	Striated Pardalote				*	*
Petrochelidon ariel	Fairy Martin (nests)				*	
Petroica rosea	Rose Robin				*	
Phylidonyris niger	White-cheeked Honeyeater					*
Pitta versicolor	Noisy Pitta				*	
Platalea regia	Royal Spoonbill				*	
Platycercus eximius	Eastern Rosella				*	*
Porphyrio porphyrio	Purple Swamphen				*	*
Psophodes olivaceus	Eastern Whipbird				*	*
Ptilonorhynchus violaceus	Satin Bowerbird				*	*
Pycnonotus jocosus	Red-whiskered Bulbul	*				*
Rhipidura albiscapa	Grey Fantail				*	*
Rhipidura leucophrys	Willie Wagtail				*	*
Rhipidura rufifrons	Rufous Fantail					*
Sericornis citreogularis	Yellow-throated Scrubwren				*	
Sericornis frontalis	White-browed Scrubwren					*
Sericulus chrysocephalus	Regent Bowerbird				*	*
Sphecotheres vieilloti	Australasian Figbird				*	*
Strepera gaculina	Pied Currawong				*	
Streptopelia chinensis	Spotted Turtle Dove	*			*	

Symposiachrus trivirgatus	Spectacled Monarch					*
Tachybaptus novaehollandiae	Australasian Grebe				*	
Threskiornis molucca	Australian White Ibis				*	*
Threskiornis spinicollis	Straw-necked Ibis				*	
Todiramphus sanctus	Sacred Kingfisher					*
Trichoglossus chlorolepidotus	Scaly-breasted Lorikeet					*
Trichoglossus haematodus	Rainbow Lorikeet				*	*
Vanellus miles	Masked Lapwing				*	*
Zosterops lateralis	Silvereye				*	
Birds (Nocturnal)						
Podargus strigoides	Tawny Frogmouth				*	
Tyto alba delicatula	Eastern Barn Owl					*
Tyto novaehollandiae	Masked Owl		V			*
Tyto tenebricosa	Sooty Owl		V			*
Mammals (excluding bats)						
Acrobates pygmaeus	Feathertail Glider				*	
Antechinus stuartii	Brown Antechinus					*
Canis lupus	Dingo, domestic dog	*				*
Dasyurus maculatus	Spotted-tailed Quoll					*
Isoodon macrourus	Northern Brown Bandicoot					*
Lepus europaeus	Hare	*			*	*
Macropus rufogriseus	Red-necked Wallaby				*	
Ornithorhynchus anatinus	Platypus					*
Oryctolagus cuniculus	European rabbit	*			*	
Perameles nasuta	Long-nosed Bandicoot					*
Petaurus breviceps	Sugar Glider					*
Phascolarctos cinereus	Koala		V	V	*	*
Rattus fuscipes	Bush Rat					*
Rattus lutreolus	Swamp Rat					*
Tachyglossus aculeatus	Short-beaked Echidna					*
Trichosurus vulpecula	Brush-tailed Possum				*	*
Vulpes vulpes	Fox	*			*	*
Wallabia bicolor	Swamp Wallaby					*
Bats						
Chalinolobus gouldii	Gould's Wattled Bat				*	*
Chalinolobus morio	Chocolate Wattled Bat					*
Miniopterus australis	Little Bentwing-bat		V		*	*
Miniopterus schreibersii oceanensis	Eastern Bentwing-bat		V		*	*
Mormopterus norfolkensis	East-coast Freetail Bat		V		*	
Mormopterus species 2	Eastern Freetail Bat				*	*
Myotis macropus	Large-footed Myotis		V		*	

Nyctophilus spp.	a long eared bat				*	
Pteropus poliocephalus	Grey-headed Flying Fox		V	V	*	
Rhinolophus megaphyllus	Eastern Horseshoe Bat				*	
Saccolaimus flaviventris	Yellow-bellied Sheathtail Bat		V		*	
Scoteanax rueppellii	Greater Broad-nosed Bat					*
Tadarida australis	White-striped Freetail Bat				*	
Vespadelus darlingtoni	Large Forest Bat				*	
Vespadelus pumilus	Eastern Forest Bat				*	*
Vespadelus regulus	Southern Forest Bat				*	
Vespadelus vulturnus	Little Forest Bat					*
Invertebrates						
Ocybadistes knightorum	Black Grass-dart Butterfly		E			*
Petalura litorea	Coastal Petaltail		E			*

Mi = Migratory species (EPBC Act)

V = Vulnerable (TSC and EPBC Acts)

E = Endangered (TSC and EPBC Acts)

Appendix B: Flora species list

Family	Scientific Name	Common Name	Exotic	TSC	EPBC
Fabaceae (Mimosoideae)	*Acacia floribunda*	White Sally			
Fabaceae (Mimosoideae)	*Acacia melanoxylon*	Blackwood			
Euphorbiaceae	*Acalypha nemorum*				
Polygonaceae	*Acetosa sagittata*	Rambling Dock	*		
Myrtaceae	*Acmena smithii*	Lilly Pilly			
Rutaceae	*Acronychia oblongifolia*	White Aspen			
Adiantaceae	*Adiantum aethiopicum*	Common Maidenhair			
Adiantaceae	*Adiantum hispidulum*	Rough Maidenhair			
Adiantaceae	*Adiantum* spp.				
Asteraceae	*Ageratina adenophora*	Crofton Weed	*		
Asteraceae	*Ageratum houstonianum*		*		
Casuarinaceae	*Allocasuarina torulosa*	Forest Oak			
Rhamnaceae	*Alphitonia excelsa*	Red Ash			
Zingiberaceae	*Alpinia caerulea*	Native Ginger			
Poaceae	*Andropogon virginicus*	Whiskey Grass	*		
Myrtaceae	*Archirhodomyrtus beckleri*	Rose Myrtle			
Arecaceae	*Archontophoenix cunninghamiana*	Bangalow Palm			
Araliaceae	*Astrotricha latifolia*				
Poaceae	*Axonopus fissifolius*	Narrow-leafed Carpet Grass	*		

Asteraceae	*Baccharis halimifolia*	Groundsel Bush	*		
Myrtaceae	*Backhousia myrtifolia*	Grey Myrtle			
Asteraceae	*Bidens* spp.		*		
Pittosporaceae	*Billardiera scandens*	Hairy Apple Berry			
Blechnaceae	*Blechnum cartilagineum*	Gristle Fern			
Blechnaceae	*Blechnum indicum*	Swamp Water Fern			
Phyllanthaceae	*Breynia oblongifolia*	Coffee Bush			
Arecaceae	*Calamus muelleri*	Southern Lawyer Cane			
Cunoniaceae	*Callicoma serratifolia*	Black Wattle			
Myrtaceae	*Callistemon salignus*	Willow Bottlebrush			
Dicksoniaceae	*Calochlaena dubia*	Rainbow Fern			
Poaceae	*Capillipedium spicigerum*	Scented-top Grass			
Vitaceae	*Cayratia clematidea*	Native Grape			
Apiaceae	*Centella asiatica*	Indian Pennywort			
Orchidaceae	*Chiloglottis sylvestris*				
Poaceae	*Chloris gayana*	Rhodes Grass	*		
Lauraceae	*Cinnamomum camphora*	Camphor Laurel	*		
Vitaceae	*Cissus hypoglauca*	Giant Water Vine			
Ranunculaceae	*Clematis aristata*	Old Man's Beard			
Ranunculaceae	*Clematis glycinoides*	Headache Vine			
Lamiaceae	*Clerodendrum floribundum* var. *floribundum*				
Lamiaceae	*Clerodendrum tomentosum*	Hairy Clerodendrum			
Convolvulaceae	*Convolvulus erubescens*	Pink Bindweed			
Asteliaceae	*Cordyline petiolaris*	Broad-leaved Palm Lily			
Asteliaceae	*Cordyline stricta*	Narrow-leaved Palm Lily			
Asteraceae	*Coronidium elatum*				

Orchidaceae	*Corybas fimbriatus*	Fringed Helmet Orchid			
Myrtaceae	*Corymbia intermedia*	Pink Bloodwood			
Lauraceae	*Cryptocarya glaucescens*	Jackwood			
Lauraceae	*Cryptocarya microneura*	Murrogun			
Lauraceae	*Cryptocarya rigida*	Forest Maple			
Escalloniaceae	*Cuttsia viburnea*	Elderberry			
Cyatheaceae	*Cyathea australis*	Rough Treefern			
Rubiaceae	*Cyclophyllum longipetalum*	Coast Canthium			
Poaceae	*Cynodon dactylon*	Common Couch			
Cyperaceae	*Cyperus disjunctus*				
Davalliaceae	*Davallia solida* var. *pyxidata*	Hare's Foot Fern			
Orchidaceae	*Dendrobium aemulum*	Ironbark Orchid			
Urticaceae	*Dendrocnide excelsa*	Giant Stinging Tree			
Fabaceae (Faboideae)	*Desmodium gunnii*	Slender Tick-trefoil			
Fabaceae (Faboideae)	*Desmodium rhytidophyllum*				
Phormiaceae	*Dianella caerulea*	Blue Flax-lily			
Phormiaceae	*Dianella* spp.				
Dioscoreaceae	*Dioscorea transversa*	Native Yam			
Ebenaceae	*Diospyros fasciculosa*	Grey Ebony			
Sapindaceae	*Diploglottis australis*	Native Tamarind			
Blechnaceae	*Doodia aspera*	Prickly Rasp Fern			
Solanaceae	*Duboisia myoporoides*	corkwood			
Elaeocarpaceae	*Elaeocarpus reticulatus*	Blueberry Ash			
Myrsinaceae	*Embelia australiana*				
Lauraceae	*Endiandra sieberi*	Hard Corkwood			
Poaceae	*Entolasia marginata*	Bordered Panic			

Poaceae	*Entolasia stricta*	Wiry Panic			
Poaceae	*Eragrostis elongata*	Clustered Lovegrass			
Myrtaceae	*Eucalyptus acmenoides*	White Mahogany			
Myrtaceae	*Eucalyptus biturbinata*	Grey Gum			
Myrtaceae	*Eucalyptus grandis*	Flooded Gum			
Myrtaceae	*Eucalyptus microcorys*	Tallowwood			
Myrtaceae	*Eucalyptus pilularis*	Blackbutt			
Myrtaceae	*Eucalyptus propinqua*	Small-fruited Grey Gum			
Myrtaceae	*Eucalyptus resinifera*	Red Mahogany			
Myrtaceae	*Eucalyptus robusta*	Swamp Mahogany			
Myrtaceae	*Eucalyptus saligna*	Sydney Blue Gum			
Myrtaceae	*Eucalyptus siderophloia*	Grey Ironbark			
Eupomatiaceae	*Eupomatia bennettii*	Small Bolwarra			
Anacardiaceae	*Euroschinus falcatus*	Ribbonwood			
Luzuriagaceae	*Eustrephus latifolius*	Wombat Berry			
Moraceae	*Ficus coronata*	Creek Sandpaper Fig			
Cyperaceae	*Gahnia clarkei*	Tall Saw-sedge			
Cyperaceae	*Gahnia sieberiana*	Red-fruit Saw-sedge			
Luzuriagaceae	*Geitonoplesium cymosum*	Scrambling Lily			
Gleicheniaceae	*Gleichenia dicarpa*	Pouched Coral Fern			
Phyllanthaceae	*Glochidion ferdinandi*	Cheese Tree			
Fabaceae (Faboideae)	*Glycine clandestina*	Twining Glycine			
Sapindaceae	*Guioa semiglauca*	Guioa			
Araceae	*Gymnostachys anceps*	Settler's Twine			
Dilleniaceae	*Hibbertia aspera*	Rough Guinea Flower			
Dilleniaceae	*Hibbertia dentata*	Twining Guinea Flower			

Dilleniaceae	*Hibbertia scandens*	Climbing Guinea Flower			
Malvaceae	*Hibiscus splendens*	Pink Hibiscus			
Dennstaedtiaceae	*Histiopteris incisa*	Bat's Wing Fern			
Euphorbiaceae	*Homalanthus populifolius*	Bleeding Heart			
Violaceae	*Hybanthus stellarioides*				
Asteraceae	*Hypochaeris radicata*	Catsear	*		
Dennstaedtiaceae	*Hypolepis muelleri*	Harsh Ground Fern			
Poaceae	*Imperata cylindrica*	Blady Grass			
Fabaceae (Faboideae)	*Indigofera australis*	Australian Indigo			
Cyperaceae	*Isolepis inundata*	Club-rush			
Bignoniaceae	*Jacaranda mimosifolia*	Jacaranda	*		
Sapindaceae	*Jagera pseudorhus* var. *pseudorhus*	Foambark Tree			
Fabaceae (Faboideae)	*Kennedia rubicunda*	Dusky Coral Pea			
Verbenaceae	*Lantana camara*	Lantana	*		
Sterculiaceae	*Lasiopetalum spp.*				
Dryopteridaceae	*Lastreopsis microsora* subsp. *microsora*	Creeping Shield Fern			
Dryopteridaceae	*Lastreopsis* spp.				
Cyperaceae	*Lepidosperma laterale*	Variable Sword-sedge			
Fabaceae (Faboideae)	*Lespedeza striata*	Japanese Clover	*		
Ericaceae	*Leucopogon lanceolatus*				
Oleaceae	*Ligustrum* spp.		*		
Arecaceae	*Livistona australis*	Cabbage Palm			
Lobeliaceae	*Lobelia trigonocaulis*	Forest Lobelia			
Lomandraceae	*Lomandra filiformis*	Wattle Matt-rush			
Lomandraceae	*Lomandra longifolia*	Spiny-headed Mat-rush			
Proteaceae	*Lomatia silaifolia*	Crinkle Bush			

Myrtaceae	*Lophostemon confertus*	Brush Box			
Myrtaceae	*Lophostemon suaveolens*	Swamp Turpentine			
Apocynaceae	*Marsdenia longiloba*	Slender Marsdenia		E	V
Apocynaceae	*Marsdenia rostrata*	Milk Vine			
Myrtaceae	*Melaleuca alternifolia*				
Myrtaceae	*Melaleuca linariifolia*	Flax-leaved Paperbark			
Myrtaceae	*Melaleuca quinquenervia*	Broad-leaved Paperbark			
Rubiaceae	*Morinda jasminoides*	Sweet Morinda			
Myrsinaceae	*Myrsine variabilis*				
Oleaceae	*Notelaea venosa*	Veined Mock-olive			
Asteraceae	*Olearia nernstii*				
Poaceae	*Oplismenus aemulus*				
Poaceae	*Oplismenus imbecillis*				
Poaceae	*Ottochloa gracillima*				
Fabaceae (Faboideae)	*Oxylobium robustum*	Tree Shaggy Pea			
Asteraceae	*Ozothamnus diosmifolius*	White Dogwood			
Apocynaceae	*Parsonsia straminea*	Common Silkpod			
Poaceae	*Paspalum mandiocanum*	Broadleaf Paspalum	*		
Passifloraceae	*Passiflora* spp.		*		
Passifloraceae	*Passiflora subpeltata*	White Passionflower	*		
Proteaceae	*Persoonia stradbrokensis*				
Rutaceae	*Phebalium squamulosum*	Scaly Phebalium			
Phyllanthaceae	*Phyllanthus gunnii*				
Myrtaceae	*Pilidiostigma glabrum*				
Pinaceae	*Pinus* spp.		*		
Pittosporaceae	*Pittosporum revolutum*	Rough Fruit Pittosporum			

Pittosporaceae	*Pittosporum undulatum*	Sweet Pittosporum			
Polypodiaceae	*Platycerium bifurcatum*	Elkhorn Fern			
Poaceae	*Poa labillardierei* var. *labillardierei*	Tussock			
Araliaceae	*Polyscias murrayi*	Pencil Cedar			
Araliaceae	*Polyscias sambucifolia*	Elderberry Panax			
Rhamnaceae	*Pomaderris aspera*	Hazel Pomaderris			
Phyllanthaceae	*Poranthera microphylla*	Small Poranthera			
Lobeliaceae	*Pratia purpurascens*	Whiteroot			
Amygdalaceae	*Prunus* spp.		*		
Acanthaceae	*Pseuderanthemum variabile*	Pastel Flower			
Dennstaedtiaceae	*Pteridium esculentum*	Bracken			
Fabaceae (Faboideae)	*Pultenaea euchila*				
Myrtaceae	*Rhodamnia rubescens*	Scrub Turpentine			
Myrtaceae	*Rhodomyrtus psidioides*	Native Guava			
Ripogonaceae	*Ripogonum elseyanum*	Hairy Supplejack			
Ripogonaceae	*Ripogonum fawcettianum*	Small Supplejack			
Rosaceae	*Rubus moluccanus* var. *trilobus*	Molucca Bramble			
Rosaceae	*Rubus nebulosus*	Green-leaved Bramble			
Rosaceae	*Rubus parvifolius*	Native Raspberry			
Rosaceae	*Rubus* spp.		*		
Menispermaceae	*Sarcopetalum harveyanum*	Pearl Vine			
Araliaceae	*Schefflera actinophylla*	Umbrella Tree	*		
Cunoniaceae	*Schizomeria ovata*	Crabapple			
Cyperaceae	*Schoenus melanostachys*				
Fabaceae (Caesalpinioideae)	*Senna pendula* var. *glabrata*		*		
Sterculiaceae	*Seringia arborescens*				

Malvaceae	*Sida rhombifolia*	Paddy's Lucerne	*		
Elaeocarpaceae	*Sloanea australis*	Maiden's blush			
Smilacaceae	*Smilax australis*	Lawyer Vine			
Smilacaceae	*Smilax glyciphylla*	Sweet Sarsaparilla			
Solanaceae	*Solanum mauritianum*	Wild Tobacco Bush	*		
Menispermaceae	*Stephania japonica*	Snake vine			
Menispermaceae	*Stephania japonica* var. *discolor*	Snake Vine			
Myrtaceae	*Syncarpia glomulifera*	Turpentine			
Meliaceae	*Synoum glandulosum* subsp. *glandulosum*	Scentless Rosewood			
Myrtaceae	*Syzygium oleosum*	Blue Lilly Pilly			
Apocynaceae	*Tabernaemontana pandacaqui*	Banana Bush			
Poaceae	*Themeda australis*	Kangaroo Grass			
Melastomataceae	*Tibouchina granulosa*	Tibouchina	*		
Ulmaceae	*Trema tomentosa* var. *aspera*	Native Peach			
Uvulariaceae	*Tripladenia cunninghamii*				
Myrtaceae	*Tristaniopsis laurina*	Kanooka			
Ericaceae	*Trochocarpa laurina*	Tree Heath			
Asteraceae	*Vernonia cinerea*				
Violaceae	*Viola hederacea*	Ivy-leaved Violet			
Monimiaceae	*Wilkiea huegeliana*	Veiny Wilkiea			
Rutaceae	*Zieria smithii*	Sandfly Zieria			
Rutaceae	*Zieria* spp.				

Appendix C: Microbat (Anabat) results

Anabat Results – Bonville Rural Residential LES, 14 Anabat nights, 14 - 19 May 2013.

Bat calls were analysed using the program AnalookW (Version 3.8 25 October 2012, written by Chris Corben, www.hoarybat.com). Call identifications were made using regional based guides to the echolocation calls of microbats in New South Wales (Pennay et al. 2004); and south-east Queensland and north-east New South Wales (Reinhold et al. 2001) and the accompanying reference library of over 200 calls from north-eastern NSW. Available: (http://www.forest.nsw.gov.au/research/bats/default.asp).

Bat calls are analysed using species-specific parameters of the call profile such as call shape, characteristic frequency, initial slope and time between calls (Rinehold et al. 2001). To ensure reliable and accurate results the following protocols (adapted from Lloyd et. al. 2006) were followed:

- Search phase calls were used in the analysis, rather than cruise phase calls or feeding buzzes (McKenzie et al. 2002)
- Recordings containing less than three pulses were not analysed and these sequences were labelled as short (Law et al. 1999)
- Four categories of confidence in species identification were used (Mills et al. 1996):
    - definite – identity not in doubt
    - probable – low probability of confusion with species of similar calls
    - possible – medium to high probability of confusion with species with similar calls
    - unidentifiable – calls made by bats which cannot be identified to even a species group.
- Nyctophilus spp. are difficult to identify confidently from their calls and no attempt was made to identify this genus to species level (Pennay et al. 2004)
- Sequences not attributed to microbat echolocation calls were labelled as junk or non-bat calls and don't represent microbat activity at the site
- Sequences labelled as low were of poor quality and therefore not able to be identified to any microbat species, they can however be used as an indicator of microbat activity at the site

Over 5480 sequences were recorded from static Anabat detectors placed at four separate locations between 14 and 19 May 2013 within the Bonville study area. Approximately 79% of sequences submitted were able to be identified to species with the remainder being too short or of low quality preventing positive identification of species. General microbat activity was high at 2 locations on Bonville Creek; Pine Creek Way and at Crossmaglen Road with calls recorded more often than every two minutes throughout the evening. Activity was moderate at Burgess Creek at Crossmaglen, with calls recorded more often than every ten minutes but less often than every two minutes throughout the evening. Microbat activity on the northern Arm of Burgess Creek, North Bonville Rd was low with calls recorded less often than every ten minutes, perhaps reflecting the smaller order of stream and lower quality habitat surrounding the riparian area.

There were a minimum of 13 species identified including **five vulnerable** species listed under the NSW TSC Act 1987 (Tables 1 - 4). The most commonly recorded species were, Eastern Forest Bat (*Vespadelus pumilus*), **Little Bentwing Bat *(Miniopterus australis*) and Large-footed Myotis *(Myotis macropus*),** in that order which in total accounted for 63% of positively identified sequences. Eastern Forest Bat, Little Bentwing Bat and **Eastern Bentwing Bat (*Miniopterus schreibersii oceanensis*)** were found at every site surveyed. Feeding buzzes were often recorded.

Calls of the threatened **Eastern Bentwing Bat *(Miniopterus schreibersii oceanensis*)** overlap in frequency with those of the Large Forest Bat *(Vespadelus darlingtoni*) and Eastern Forest Bat (*V. regulus)*. Calls were identified as ***M.s.oceanensis*** when there was a down-sweeping tail, drop of more than 2 kHz in the pre-characteristic section, and the pulse shape and time between calls was variable.

Calls of the threatened **Large-footed Myotis** are very similar to all Nyctophilus species and it is often difficult to separate them. Calls were identified as *Nyctophilus spp*. when the time between calls (TBC) was higher than 95 ms and the initial slope (OPS) was lower than 300. Calls were identified as ***M. macropus*** when the TBC was lower than 75 ms and the OPS was greater than 400.

Calls of the **East-coast Freetail Bat (*Mormopterus norfolkensis*)** can be confused with those of the Eastern Freetail Bat (*Mormopterus species 2*). Positive identification of the East-coast Freetail Bat was assigned when there was alternation in frequency between pulses.

LOCATION	SPECIES NAME	COMMON NAME	NUMBER OF CALLS	DEFINITE	PROBABLE	POSSIBLE
Bonville Creek, Crossmaglen Rd	*Chalinolobus gouldii*	Gould's Wattled Bat	4	2		2
Bonville Creek, Crossmaglen Rd	*Miniopterus australis**	Little Bentwing Bat	48	48		
Bonville Creek, Crossmaglen Rd	*Miniopterus schreibersii oceanensis**	Eastern Bentwing Bat	86	81	4	1
Bonville Creek, Crossmaglen Rd	*Mormopterus* species 2	Eastern Freetail Bat	5	4	1	
Bonville Creek, Crossmaglen Rd	*Myotis macropus** / *Nyctophilus* spp.	Large-footed Myotis / a long eared bat	233			
Bonville Creek, Crossmaglen Rd	*Myotis macropus**	Large-footed Myotis	126	86	24	16
Bonville Creek, Crossmaglen Rd	*Nyctophilus* spp.	A long eared bat	16	16		
Bonville Creek, Crossmaglen Rd	*Saccolaimus flaviventris**	Yellow-bellied Sheathtail Bat	3	3		
Bonville Creek, Crossmaglen Rd	*Vespadelus darlingtoni*	Large Forest Bat	2	2		
Bonville Creek, Crossmaglen Rd	*Vespadelus pumilus*	Eastern Forest Bat	67	63	3	1
Bonville Creek, Crossmaglen Rd	*Vespadelus regulus*	Southern Forest Bat	1	1		
	Low		99			
	Short		182			
	Total sequences		872			

LOCATION	SPECIES NAME	COMMON NAME	NUMBER OF CALLS	DEFINITE	PROBABLE	POSSIBLE
Sth Trib. Burgess Ck	*Miniopterus australis**	Little Bentwing Bat	17	16		1
Sth Trib. Burgess Ck	*Miniopterus schreibersii oceanensis**	Eastern Bentwing Bat	47	47		
Sth Trib. Burgess Ck	*Mormopterus species 2*	Eastern Freetail Bat	3	3		
Sth Trib. Burgess Ck	*Myotis macropus* / Nyctophilus spp.*	Large-footed Myotis / a long eared bat	35			
Sth Trib. Burgess Ck	*Myotis macropus**	Large-footed Myotis	28	24	2	2
Sth Trib. Burgess Ck	*Rhinolophus megaphyllus*	Eastern Horseshoe Bat	1	1		
Sth Trib. Burgess Ck	*Vespadelus pumilus*	Eastern Forest Bat	815	814		1
	Low		4			
	Short		67			
	Total sequences		1017			

LOCATION	SPECIES NAME	COMMON NAME	NUMBER OF CALLS	DEFINITE	PROBABLE	POSSIBLE
Pine Creek, Pine Creek Way	*Chalinolobus gouldii*	Gould's Wattled Bat	5	4		1
Pine Creek, Pine Creek Way	*Miniopterus australis**	Little Bentwing Bat	764	763	1	
Pine Creek, Pine Creek Way	*Miniopterus schreibersii oceanensis**	Eastern Bentwing Bat	70	70		
Pine Creek, Pine Creek Way	*Mormopterus norfolkensis**	East-coast Freetail Bat	1	1		
Pine Creek, Pine Creek Way	*Mormopterus species 2*	Eastern Freetail Bat	12	11	1	
Pine Creek, Pine Creek Way	*Mormopterus species 2 / Mormopterus norfolkensis**	Eastern Freetail Bat / East-coast Freetail Bat	1			
Pine Creek, Pine Creek Way	*Myotis macropus* / Nyctophilus spp.*	Large-footed Myotis / a long eared bat	127			
Pine Creek, Pine Creek Way	*Myotis macropus**	Large-footed Myotis	118	75	33	10
Pine Creek, Pine Creek Way	*Nyctophilus spp.*	A long eared bat	7	5		2
Pine Creek, Pine Creek Way	*Rhinolophus megaphyllus*	Eastern Horseshoe Bat	1	1		
Pine Creek, Pine Creek Way	*Tadarida australis*	White-striped Freetail Bat	1	1		
Pine Creek, Pine Creek Way	*Vespadelus pumilus*	Eastern Forest Bat	971		3	
	Low		24			
	Short		337			
	Total sequences		2439			

LOCATION	SPECIES NAME	COMMON NAME	NUMBER OF CALLS	DEFINITE	PROBABLE	POSSIBLE
Bonville Creek, Pine Creek Way	*Chalinolobus gouldii*	Gould's Wattled Bat	7	4	1	2
Bonville Creek, Pine Creek Way	*Miniopterus australis**	Little Bentwing Bat	76	73		3
Bonville Creek, Pine Creek Way	*Miniopterus schreibersii oceanensis**	Eastern Bentwing Bat	64	60	3	1
Bonville Creek, Pine Creek Way	*Myotis macropus* / Nyctophilus spp.*	Large-footed Myotis / a long eared bat	117			
Bonville Creek, Pine Creek Way	*Myotis macropus**	Large-footed Myotis	82	61	15	6
Bonville Creek, Pine Creek Way	*Nyctophilus spp.*	a long eared bat	20	16	4	
Bonville Creek, Pine Creek Way	*Vespadelus pumilus*	Eastern Forest Bat	149	144	4	1
Bonville Creek, Pine Creek Way	*Vespadelus pumilus / Miniopterus australis*	Eastern Forest Bat / Little Bentwing Bat	1			
	Low		101			
	Short		242			
	Total sequences		859			

LOCATION	SPECIES NAME	COMMON NAME	NUMBER OF CALLS	DEFINITE	PROBABLE	POSSIBLE
Hand held - Spotlighting	*Miniopterus australis**	Little Bentwing Bat	1	1		
Hand held - Spotlighting	*Miniopterus schreibersii oceanensis**	Eastern Bentwing Bat	2	2		
Hand held - Spotlighting	*Vespadelus pumilus*	Eastern Forest Bat	1		1	
	Total sequences		4			

LOCATION	SPECIES NAME	COMMON NAME	NUMBER OF CALLS	DEFINITE	PROBABLE	POSSIBLE
Nth Trib. Burgess Ck	*Miniopterus australis**	Little Bentwing Bat	98	97		1
Nth Trib. Burgess Ck	*Miniopterus schreibersii oceanensis**	Eastern Bentwing Bat	7	7		
Nth Trib. Burgess Ck	*Myotis macropus**	Large-footed Myotis	1	1		
Nth Trib. Burgess Ck	*Vespadelus pumilus*	Eastern Forest Bat	70	69	1	
Nth Trib. Burgess Ck	*Vespadelus pumilus / Vespadelus vulturnus*	Eastern Forest Bat / Little Forest Bat	2			
	Low		15			
	Short		103			
	Total sequences		296			

* Listed threatened species

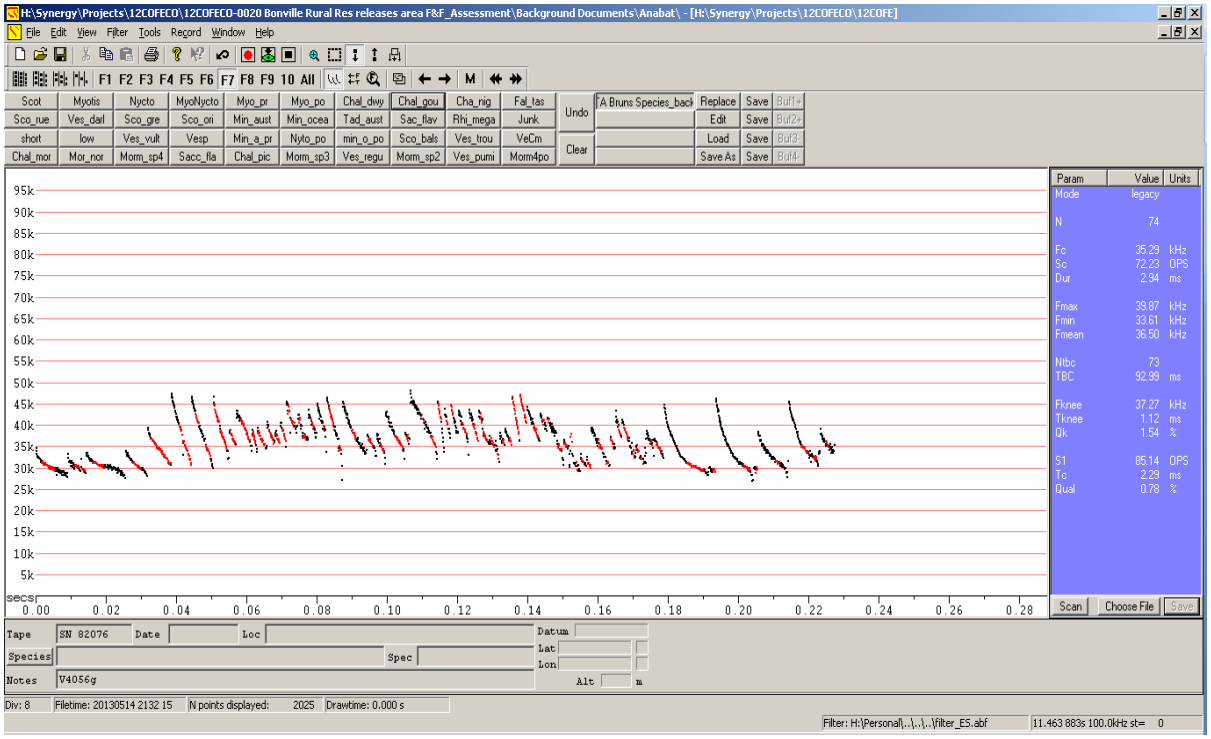

Figure 1: Call profile for *Chalinolobus gouldii* recorded along Bonville Creek, Pine Creek Way bridge at 21:32 on 14 May 2013.

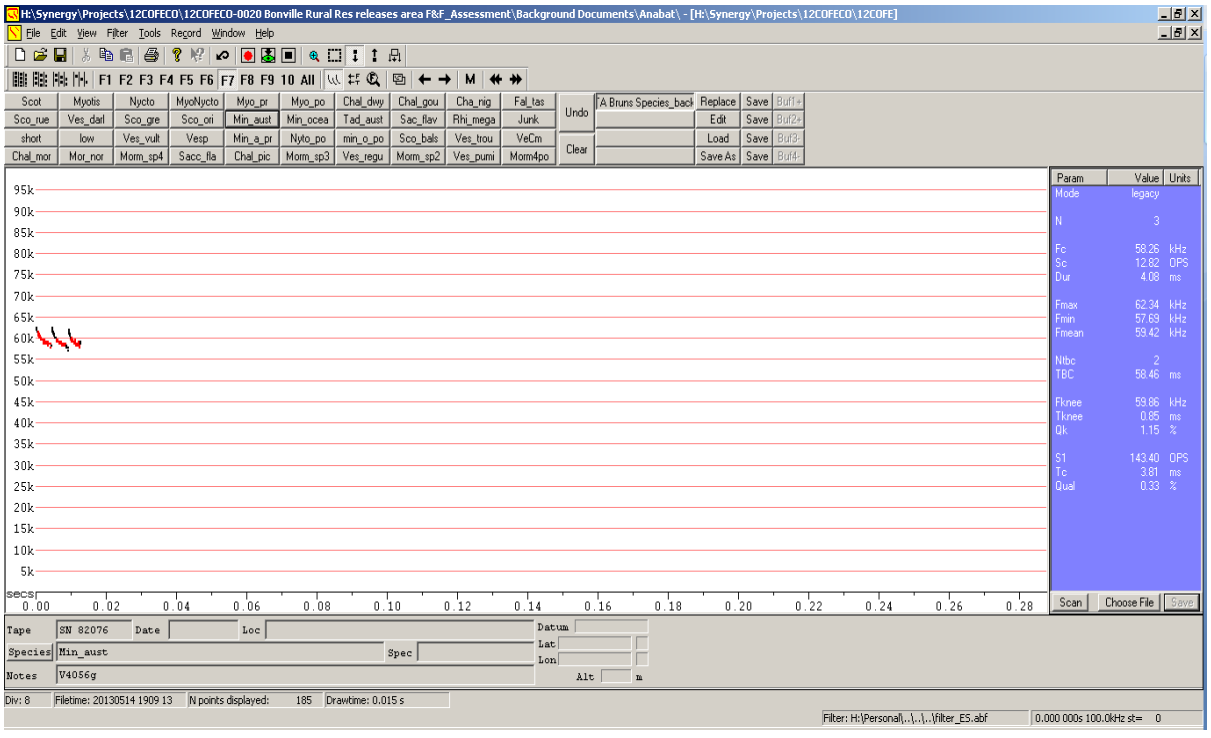

Figure 2: Call profile for *Miniopterus australis* recorded along Bonville Creek, Pine Creek Way bridge at 19:09 on 14 May 2013.

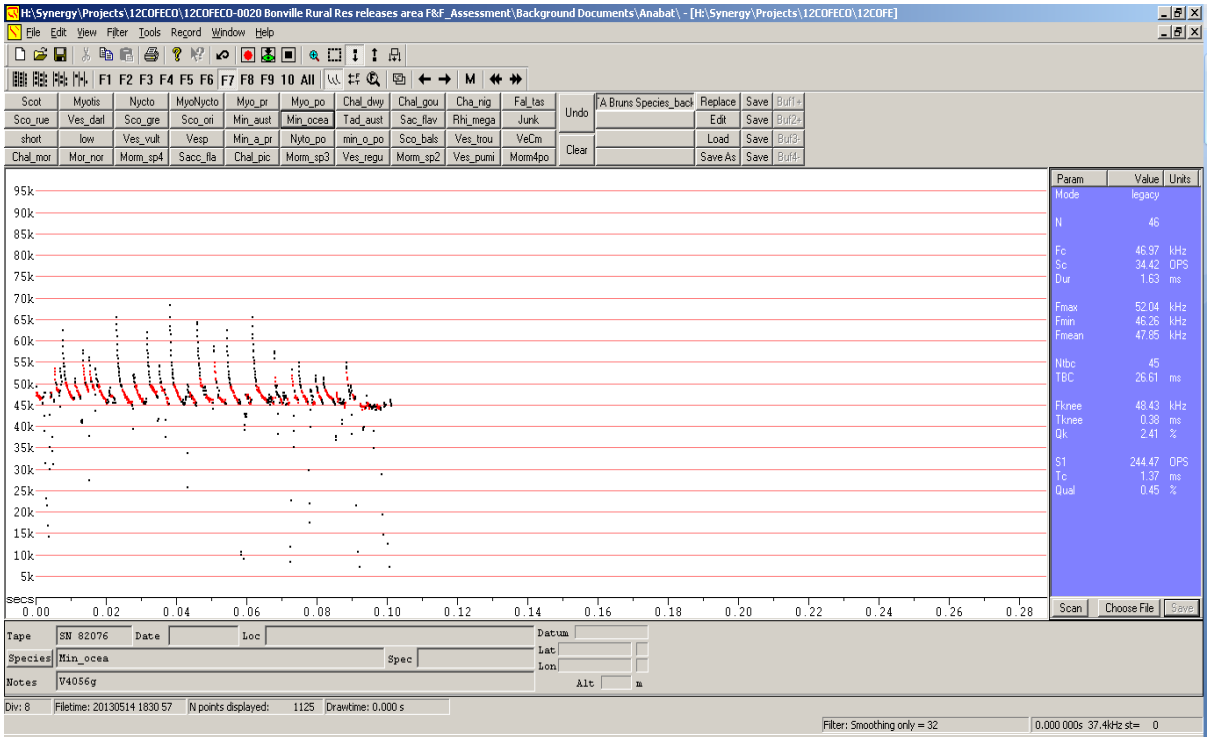

Figure 3: Call profile for *Miniopterus schreibersii oceanensis* recorded along Bonville Creek, Pine Creek Way Bridge at 18:30 on 14 May 2013.

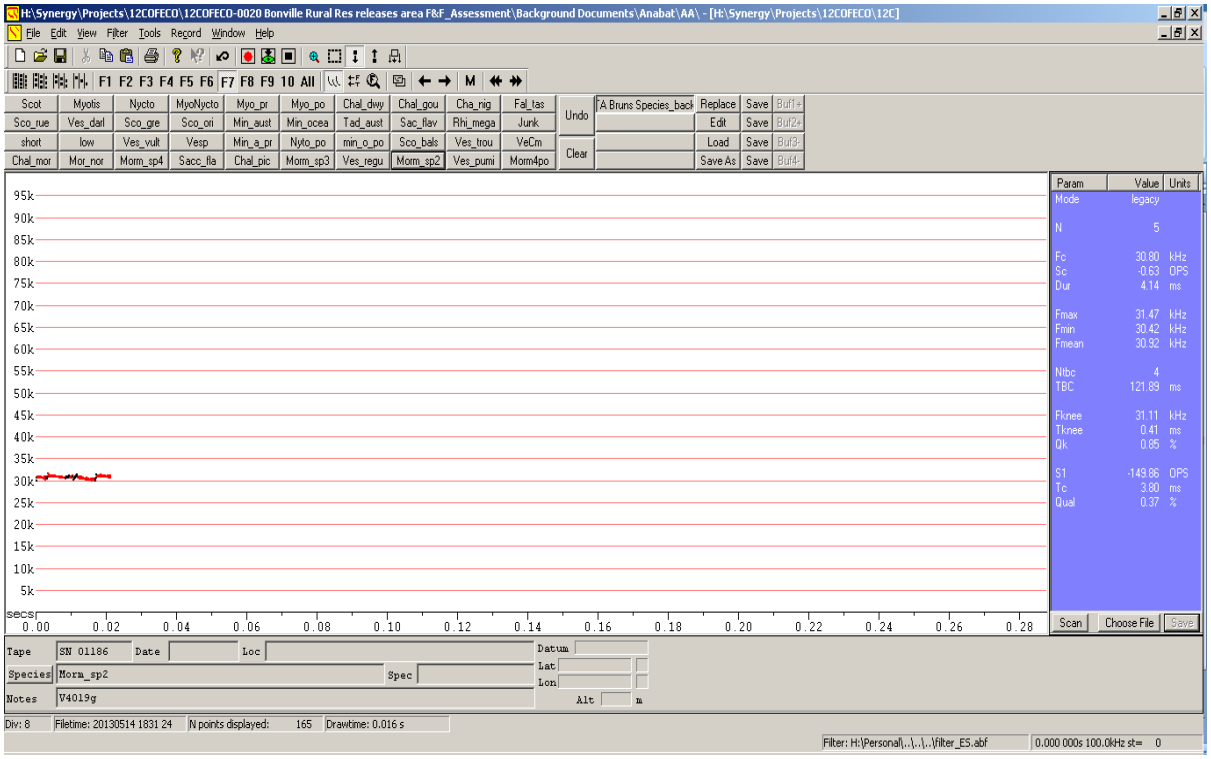

Figure 4: Call profile for *Mormopterus species 2* recorded at Bonville Creek at 21:39 on 14 May 2013.

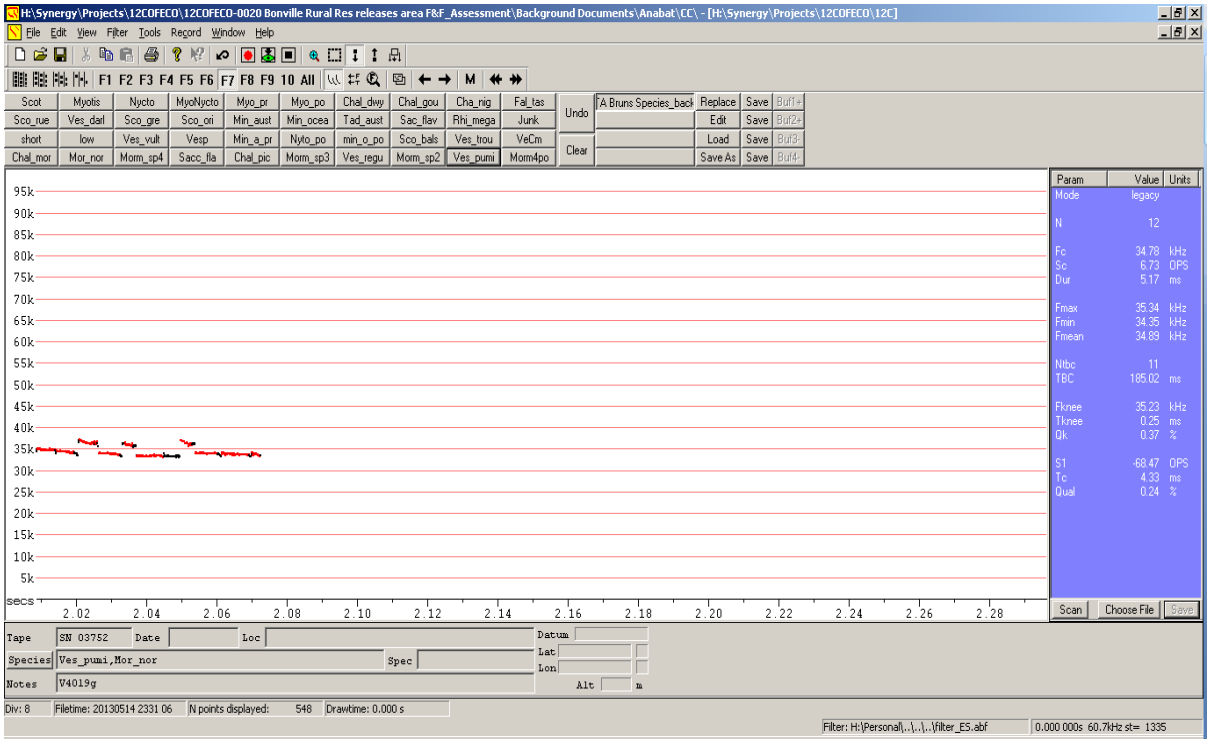

Figure 5: Call profile for *Mormopterus norfolkensis* recorded at Pine Creek, Bonville at 23:31 on 14 May 2013.

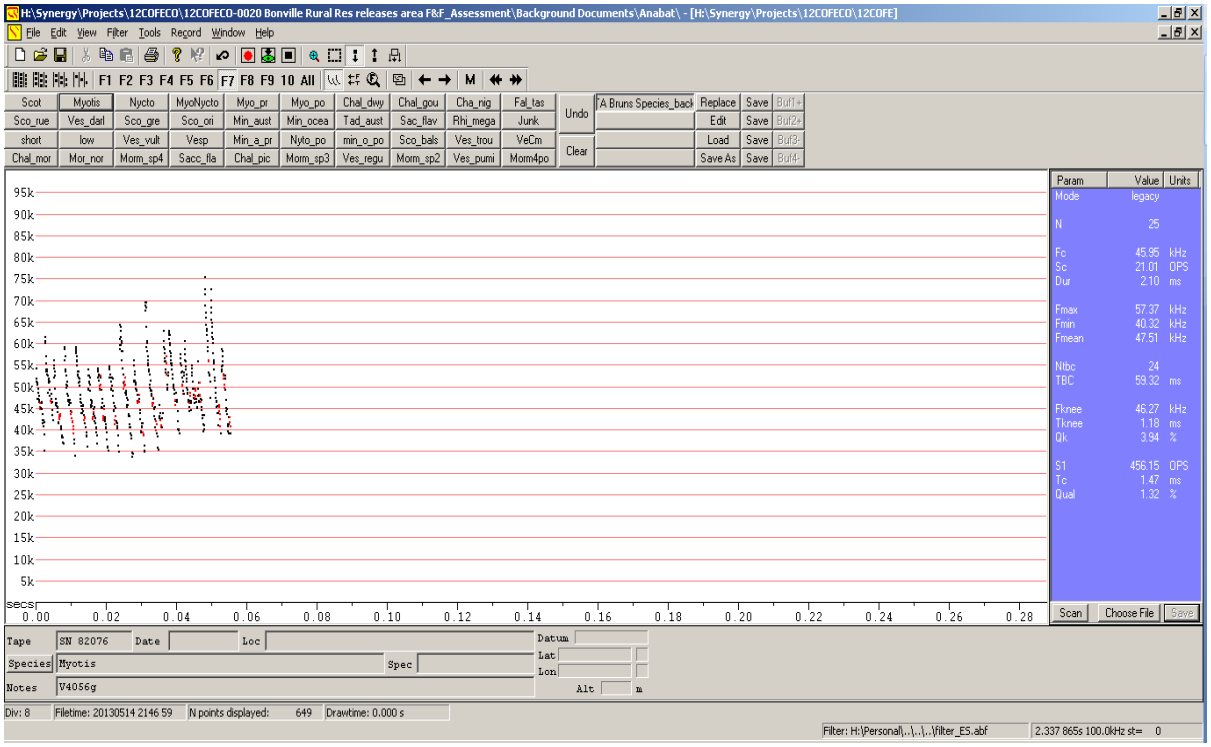

Figure 6: Call profile for *Myotis macropus* recorded along Bonville Creek, Pine Creek Way Bridge at 21:46 on 14 May 2013.

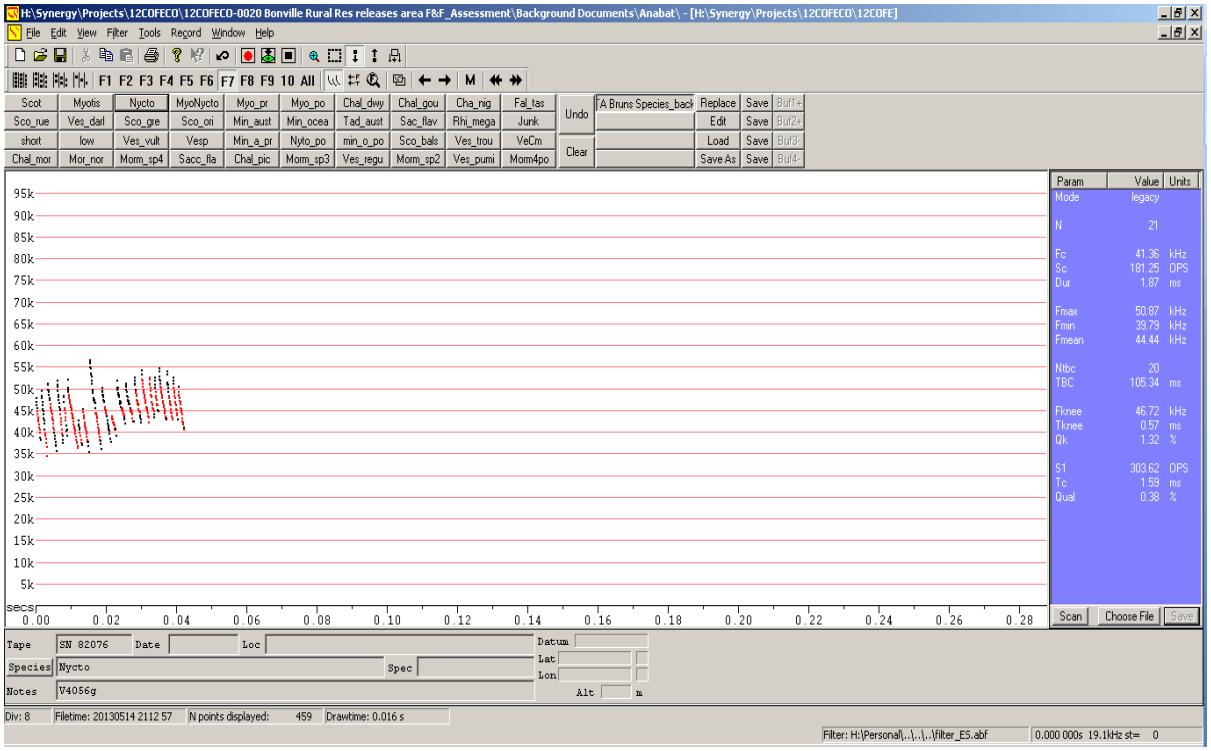

Figure 7: Call profile for *Nyctophilus sp.* recorded along Bonville Creek, Pine Creek Way Bridge at 21:12 on 14 May 2013.

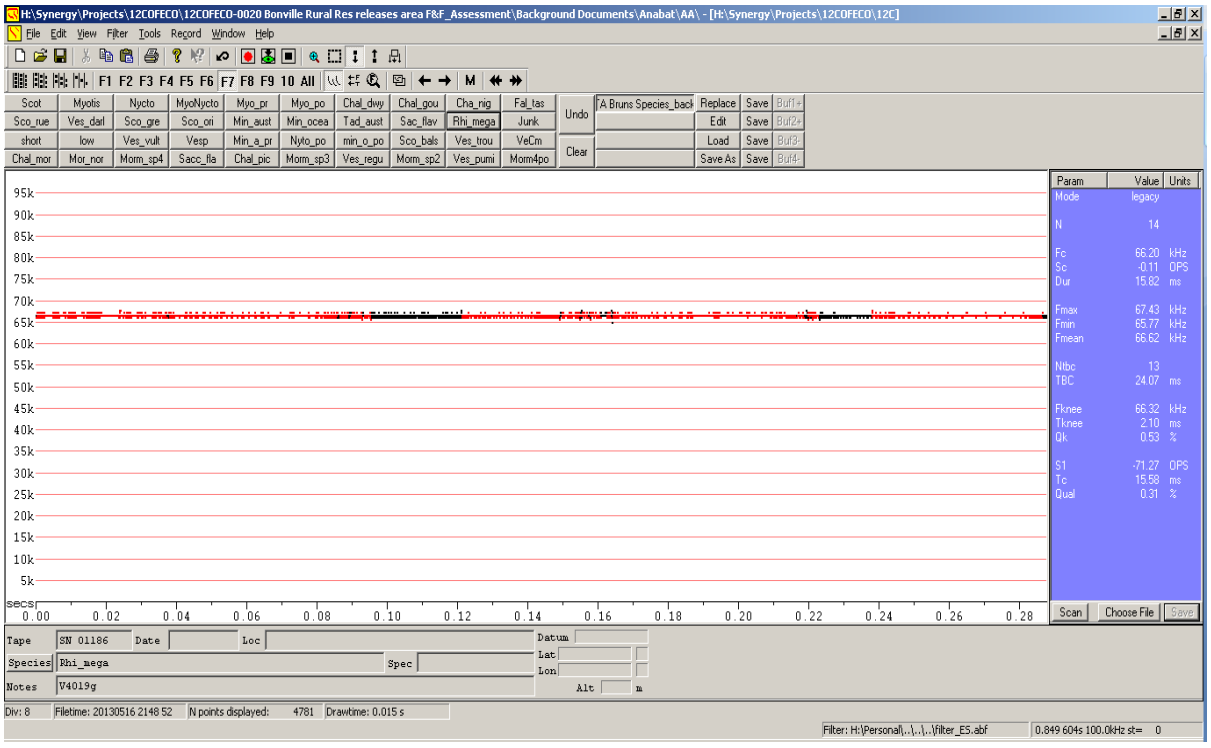

Figure 8: Call profile for *Rhinolophus megaphyllus* recorded at Crossmaglen at 21:48 on 16 May 2013.

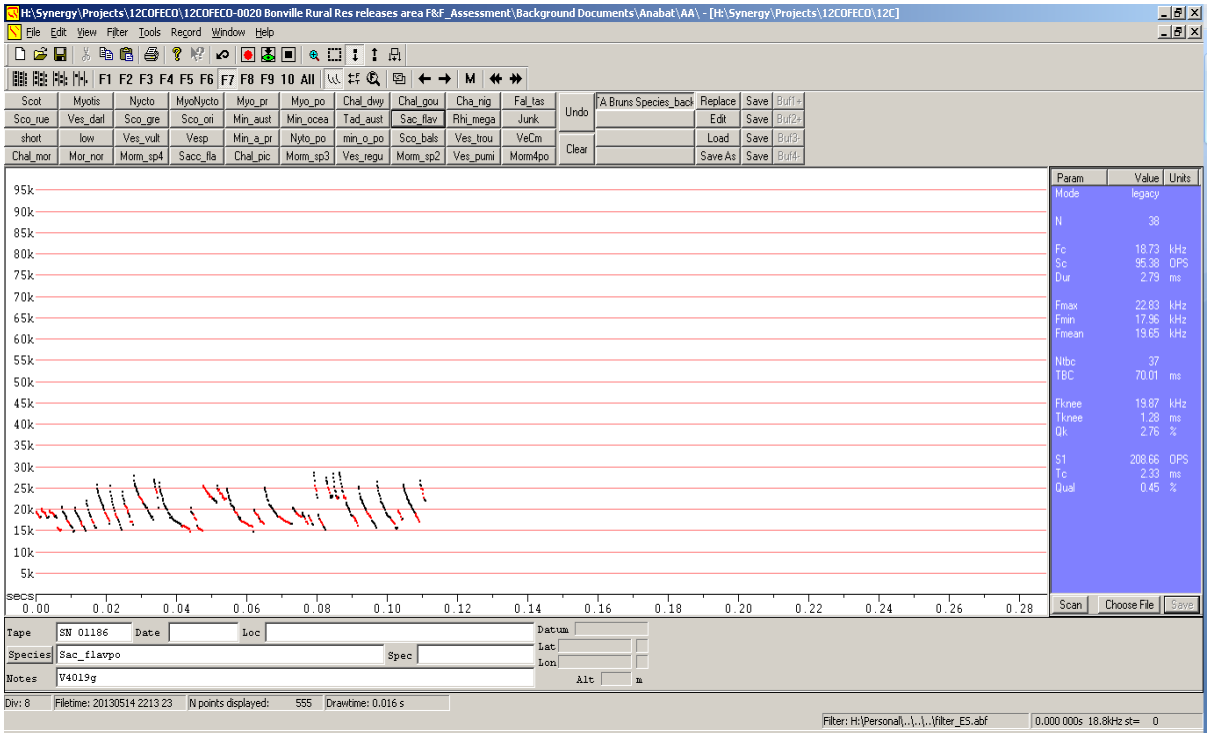

Figure 9: Call profile for *Saccolaimus flaviventris* recorded at Crossmaglen at 22:13 on 14 May 2013.

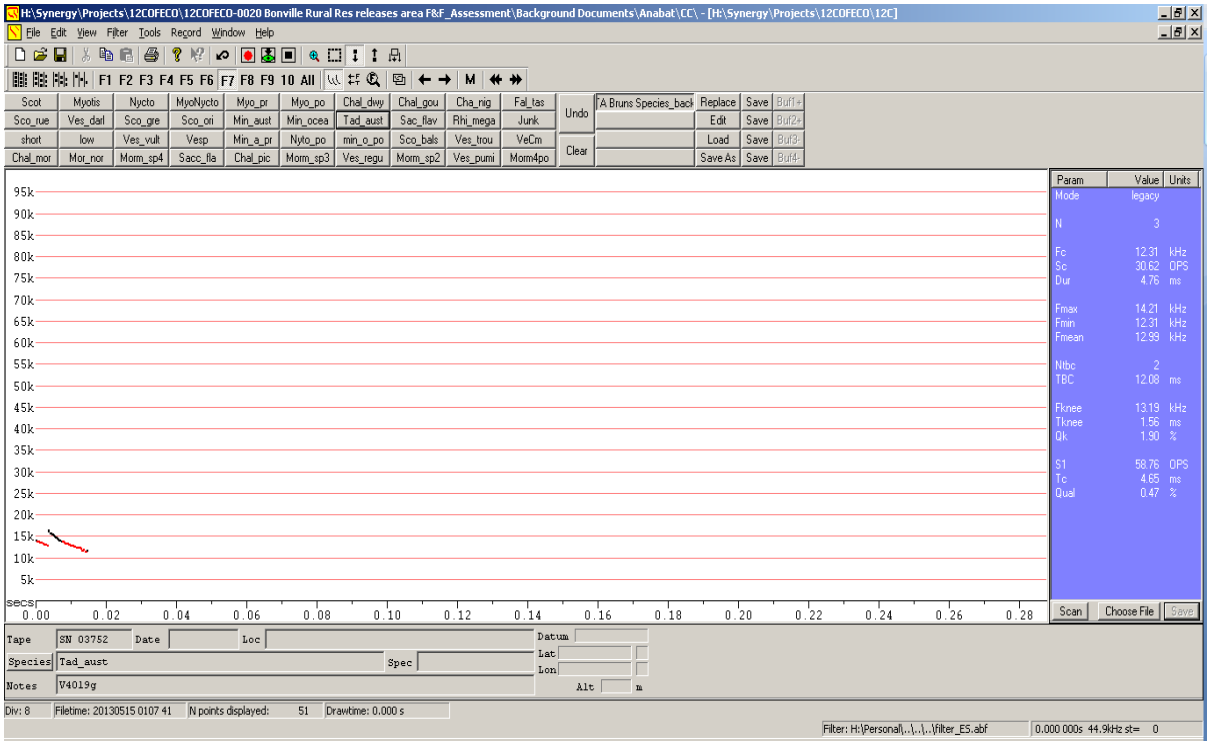

Figure 10: Call profile for *Tadarida australis* recorded at Pine Creek, Bonville at 01:07 on 15 May 2013.

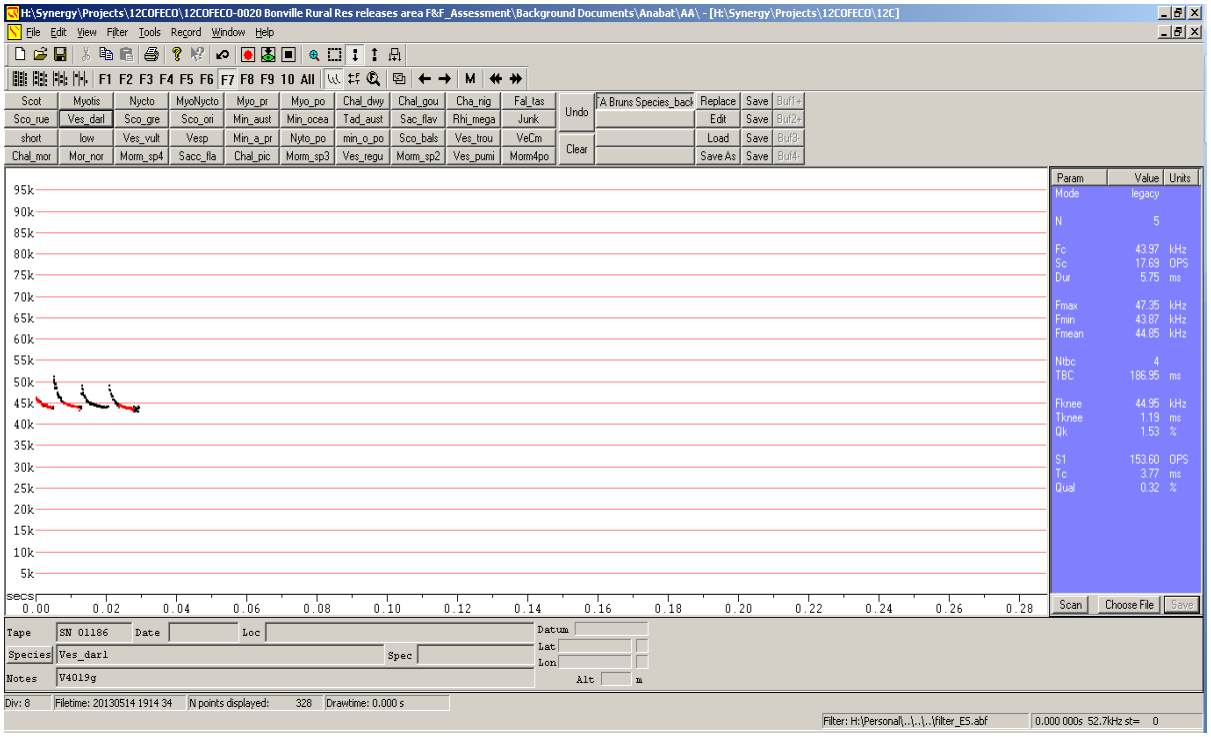

Figure 11: Call profile for *Vespadelus darlingtoni* recorded at Bonville Creek, Pine Creek Way Bridge at 19:14 on 14 May 2013.

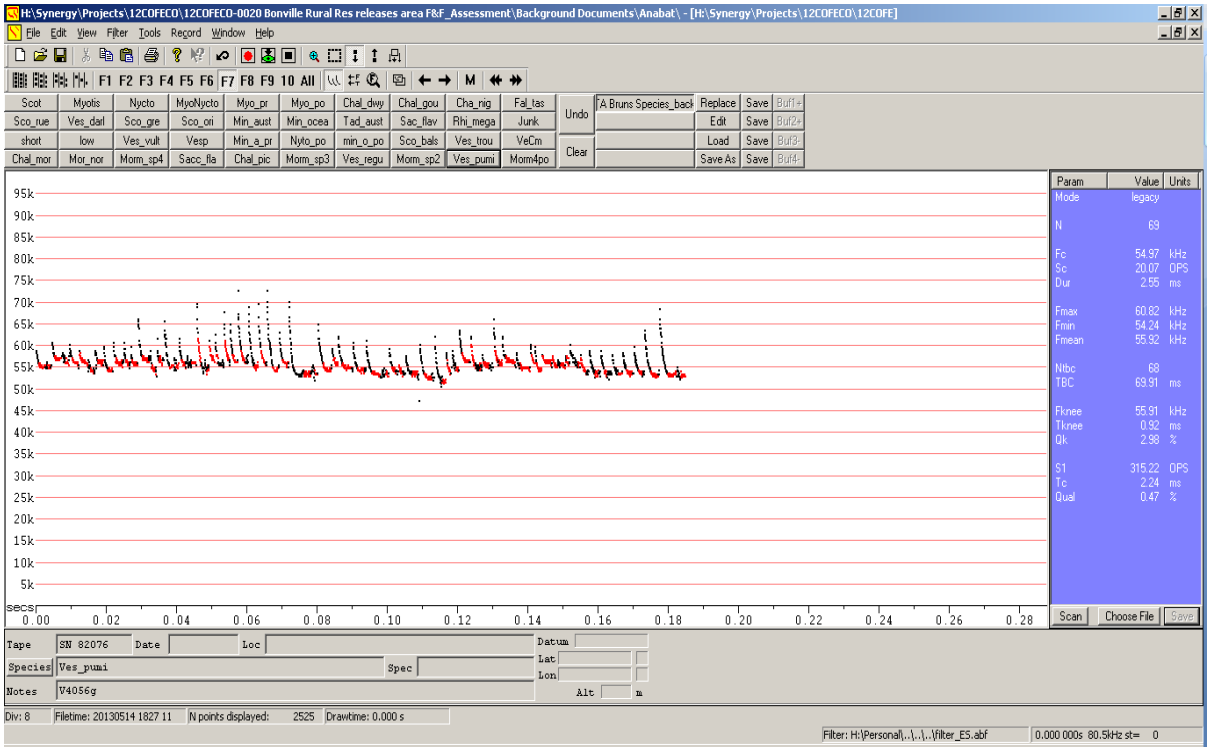

Figure 12: Call profile for *Vespadelus pumilus* recorded at Bonville Creek, Pine Creek Way Bridge at 18:27 on 14 May 2013.

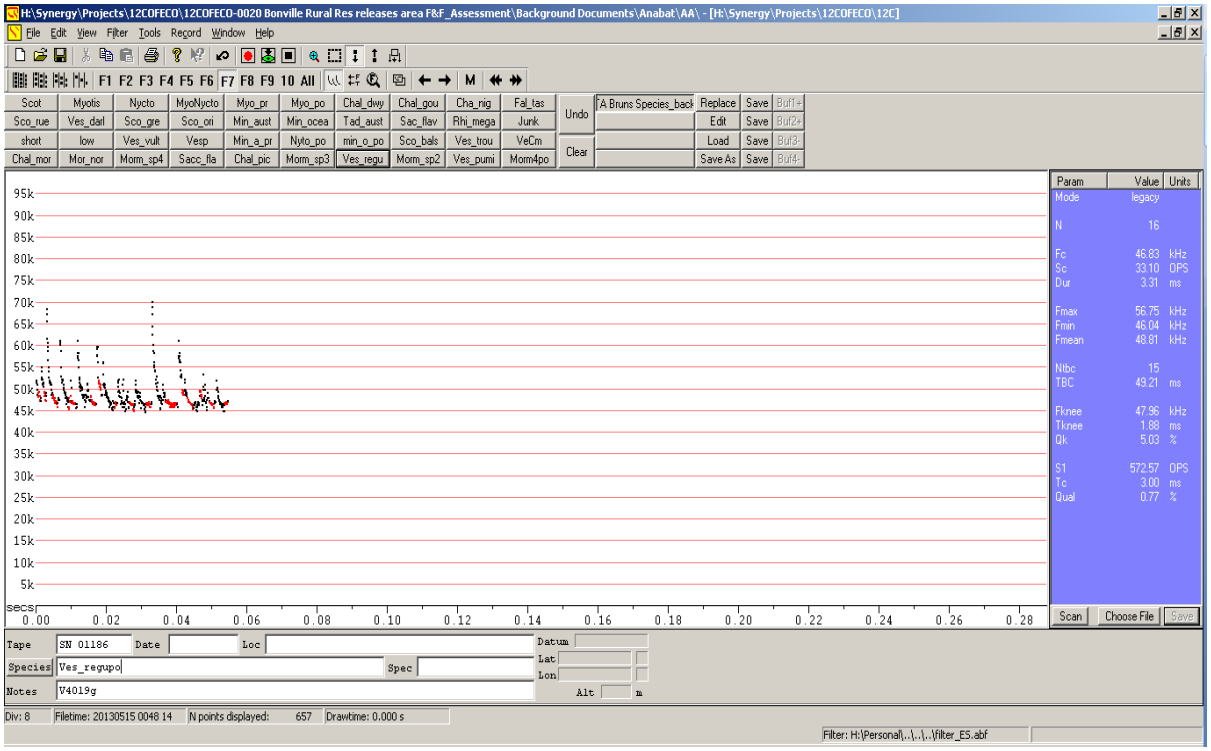

Figure 13: Possible call profile for *Vespadelus regulus* recorded at Crossmaglen at 00:48 on 15 May 2013.

Appendix D: Threatened fauna likelihood tables

SCIENTIFIC NAME	COMMON NAME	EPBC ACT	NSW TSC ACT	HABITAT ASSOCIATIONS	LIKELIHOOD OF OCCURRENCE
Amphibia					
Assa darlingtoni	Pouched Frog	—	V	Pouched Frog occurs mainly in the coolest, most moist sites within subtropical, warm temperate and cool temperate rainforests and wet sclerophyll forests (DECC 2009; Ehmann 1997). It favours the highlands and uplands of the eastern Great Dividing Range (300 to 1180 MASL) (Ehmann 1997).	Unlikely
Crinia tinnula	Wallum Froglet	—	V	The Wallum Frog is restricted to the Wallum swamps and associated low land meandering watercourses on coastal plains (Ehmann 1997). Occurs in elevations up to around 50m and is closely related to freshwater habitats in the coastal zone (DECC 2007). Found most commonly in wallum wetlands characterised by low nutrients, highly acidic, tannin-stained waters that are typically dominated by paperbarks and tea-trees. Also found in sedgeland and wet heathland (DECC 2007)	Potential

Litoria aurea	Green and Golden Bell Frog	V	E1	This species has been observed utilising a variety of natural and man-made waterbodies (Pyke & White 1996; Pyke and White 1996) such as coastal swamps, marshes, dune swales, lagoons, lakes, other estuary wetlands, riverine floodplain wetlands and billabongs, stormwater detention basins, farm dams, bunded areas, drains, ditches and any other structure capable of storing water (DECC 2009). Fast flowing streams are not utilised for breeding purposes by this species (Mahony 1999). Preferable habitat for this species includes attributes such as shallow, still or slow flowing, permanent and/or widely fluctuating water bodies that are unpolluted and without heavy shading (DEC 2005). Large permanent swamps and ponds exhibiting well-established fringing vegetation (especially bulrushes–*Typha* sp. and spikerushes–*Eleocharis* sp.) adjacent to open grassland areas for foraging are preferable (Ehmann 1997; Robinson 2004). Ponds that are typically inhabited tend to be free from predatory fish such as Mosquito Fish (*Gambusia holbrooki*) (DEC 2005; NPWS 2003). Formerly distributed from the NSW north coast near Brunswick Heads, southwards along the NSW coast to Victoria where it extends into east Gippsland. Records from west to Bathurst, Tumut and the ACT region. Since 1990 there have been approximately 50 recorded locations in NSW, most of which are small, coastal, or near coastal populations. These locations occur over the species' former range; however they are widely separated and isolated. Large populations in NSW are located around the metropolitan areas of Sydney, Shoalhaven and mid north coast (one an island population). There is only one known population on the NSW Southern Tablelands. Inhabits marshes, dams and stream-sides, particularly those containing bullrushes (*Typha* spp.) or spikerushes (*Eleocharis* spp.).	Potential
Litoria booroolongensis	Booroolong Frog	E1	E1	Typically inhabits rocky western-flowing creeks and their headwaters, although a small number of animals have also been recorded in eastern-flowing streams (NSW Scientific Committee 1998).	Unlikely

Litoria brevipalmata	Green Thighed Frog	—	V	Wet sclerophyll forest along the northern coast of NSW to Ourimbah (Anstis 2002). Also in a variety of habitats including dry to wet sclerophyll forest, rainforests and shrubland with a healthy understorey (DECC 2007). Breeding aggregations occur in still water habitats such as grassy temporary to semi-permanent ponds and flooded ditches in late spring and summer (Cogger 2000; Anstis 2002; DECC 2007).	Potential
Litoria olongburensis	Wallum Sedge Frog	V	V	Wallum, woodlands and sedgelands on coastal swamps dominated by *Melaleuca quinquenervia* with an understorey of the sedge Lepironia articulata are typical habitat (DECC 2007). Suitable wallum swamps are characterised by low nutrients, highly acidic, tannin-stained waters occurring on Pleistocene coastal sand deposits (DECC 2007).	Unlikely
Litoria subglandulosa	Glandular Frog	-	V	Predominately in the headwaters of coastal rivers in a narrow band along the eastern edge of the escarpment north from the Barrington Tops area to north of the Queensland border with occasional records just to the west of the Great Divide. Glandular Frogs may be found along streams in rainforest, moist and dry eucalypt forest or in subalpine swamps.	Unlikely
Mixophyes balbus	Stuttering Frog	V	E1	A variety of forest habitats from rainforest through wet and moist sclerophyll forest to riparian habitat in dry sclerophyll forest (DECC 2007) that are generally characterised by deep leaf litter or thick cover from understorey vegetation (Ehmann 1997). Breeding habitats are streams and occasionally springs. Not known from streams disturbed by humans (Ehmann 1997) or still water environments (NSW Scientific Committee 2002).	Unlikely
Mixophyes iteratus	Giant Barred Frog	E1	E1	Found on forested slopes of the escarpment and adjacent ranges in riparian vegetation, subtropical and dry rainforest, wet sclerophyll forests and swamp sclerophyll forest (DECC 2007; Ehmann 1997). This species is associated with flowing streams with high water quality, though habitats may contain weed species (Ehmann 1997). This species is not known from riparian vegetation disturbed by humans (NSW Scientific Committee 1999). During breeding eggs are kicked up onto an overhanging bank or the streams edge (DECC 2007).	Likely

Philoria sphagnicolus	Sphagnum Frog	—	V	Recorded between 640 to 1470 MASL in rainforest and wet sclerophyll forest with more than 1500mm annual rainfall (Ehmann 1997). Preferred habitat is sphagnum moss bogs in or adjacent to wet forest (DECC 2007). It occurs in the headwaters of small creeks and soaks associated with steep rocky cliffs or scree slopes (DECC 2007)	No
Reptilia					
Cacophis harriettae	White-crowned Snake	-	V	Typically found in coastal and near coastal areas (DECC 2007), usually in wet sclerophyll forests and rainforests (Swan 1999).	Potential
Hoplocephalus bitorquatus	Pale Headed Snake	—	V	Wide range of habitats from rain or wet sclerophyll forest to drier eucalypt forests (Cogger 1996).	Potential
Hoplocephalus stephensii	Stephen's Banded Snake	—	V	Found in a variety of habitats from rainforest through wet and moist sclerophyll forests to dry sclerophyll forests (DECC 2007). However it is most commonly found in wet to moist forests with rocky outcrops, cliffs or ridges and tends to favour ecotones between wet and dry forests (DECC 2007). It most frequently uses gaps in the peeling bark of large senescent or dead trees for daytime shelter (DECC 2007). However it can use hollow trunks, limbs, epiphytes, vine thickets, rock crevices or rock slabs (DECC 2007).	Potential
Aves (Diurnal Birds)					
Amaurornis moluccana	Pale-vented Bush-hen		V	Inhabits tall dense understorey or ground layer vegetation on the margins of freshwater streams and natural or artificial wetlands, usually within or bordering rainforest, rainforest remnants or forests. Also occurs in secondary forest growth, rank grass or reeds, thickets of weeds and pastures, crops or farmland where it borders forest, streams or wetlands. Requires dense undergrowth 2 to 4 m tall within 300m of water.	Potential

Anthochaera phrygia	Regent Honeyeater	E1, Mi	CE	Regent Honeyeaters mostly occur in dry box-ironbark eucalypt woodland and dry sclerophyll forest associations, wherein they prefer the most fertile sites available, e.g. along creek flats, or in broad river valleys and foothills. In NSW, riparian forests containing *Casuarina cunninghamiana* (River Oak), and with *Amyema cambagei* (Needle-leaf Mistletoe), are also important for feeding and breeding. At times of food shortage (e.g. when flowering fails in preferred habitats); Honeyeaters also use other woodland types and wet lowland coastal forest dominated by *Eucalyptus robusta* (Swamp Mahogany) or *E. maculata* (Spotted Gum) (Franklin et al. 1989; Geering & French 1998; Ley & Williams 1992; Oliver et al. 1999; Webster & Menkhorst 1992). Regent Honeyeaters sometimes occur in coastal forest, especially in stands dominated by Swamp Mahogany and Spotted Gum, but also in those with Southern Mahogany *E. botryoides*, and in those on sandstone ranges with banksias Banksia in the understorey (Franklin et al. 1989; Higgins et al. 2001; Menkhorst 1997c). They have been recorded in open forest including forest edges, wooded farmland and urban areas with mature eucalypts (Garnett 1993). The Regent Honeyeater primarily feeds on nectar from box and ironbark eucalypts and occasionally from banksias and mistletoes (NPWS 1995). As such it is reliant on locally abundant nectar sources with different flowering times to provide reliable supply of nectar (Environment Australia 2000).	Potential
Atrichornis rufescens	Rufous Scrub-bird		V	Rainforest and adjacent eucalypt forest where undergrowth is particularly thick (Blakers et al. 1984).	No
Botaurus poiciloptilus	Australasian Bittern	E1	E1	Terrestrial wetlands with tall dense vegetation, occasionally estuarine habitats (Marchant & Higgins 1990). Found along the east coast and in the Murray-Darling Basin, notably in floodplain wetlands of the Murrumbidgee, Lachlan, Macquarie and Gwydir Rivers (Marchant & Higgins 1990; NPWS 1990). Reedbeds, swamps, streams, estuaries (Simpson & Day 1999). Favours permanent shallow waters, edges of pools and waterways, with tall, dense vegetation such as sedges, rushes and reeds on muddy or peaty substrate. Also occurs in Lignum *Muehlenbeckia florulenta* and Canegrass *Eragrostis australasica* on inland wetlands (NSW Scientific Committee, 2010).	Potential

Burhinus grallarius	Bush Stone-curlew	—	E1	Associated with dry open woodland with grassy areas, dune scrubs, in savannah areas, the fringes of mangroves, golf courses and open forest / farmland (Pittwater Council 2000; Marchant & Higgins 1993). Forages in areas with fallen timber, leaf litter, little undergrowth and where the grass is short and patchy (Environment Australia 2000; Marchant & Higgins 1993). Is thought to require large tracts of habitat to support breeding, in which there is a preference for relatively undisturbed in lightly disturbed.	Unlikely
Calidris alba	Sanderling	—	V	Occur in coastal areas on low beaches, near reefs and inlets along tidal mudflats and bare open coastal lagoons (DECC 2007). Rarely seen in near-coastal wetlands such as lagoons, hypersaline lakes, saltponds and samphire flats (DECC 2007)	No
Calidris ferruginea	Curlew Sandpiper	Mi	E1	Intertidal mudflats of estuaries, lagoons, mangrove channels; around lakes, dams, floodwaters, flooded saltbush surrounds of inland lakes (Morcombe, 2004).	No
Calidris tenuirostris	Great Knot	—	V	Sheltered coastal habitats containing large intertidal mudflats or sandflats, including inlets, bays, harbours, estuaries and lagoons (DECC 2007). Often recorded on sandy beaches with mudflats nearby, sandy spits and inlets, or exposed reefs or rock platforms (Morris 1989; Higgins & Davies 1996).	No
Calyptorhynchus lathami	**Glossy Black-Cockatoo**	**—**	**V**	**Associated with a variety of forest types containing Allocasuarina species, usually reflecting the poor nutrient status of underlying soils (Environment Australia 2000; NPWS 1997; DECC 2007). Intact drier forest types with less rugged landscapes are preferred (DECC 2007). Nests in large trees with large hollows (Environment Australia 2000).**	**Yes**
Charadrius leschenaultii	Greater Sand Plover	—	V	Entirely coastal in NSW, foraging on intertidal sand and mudflats in estuaries, roosting during high tide on sandy beaches or rocky shores (DECC 2007)	No
Charadrius mongolus	Lesser Sand Plover	Ma	V	Favours coastal areas including beaches, mudflats and mangroves where they forage (DECC 2007). They may be seen roosting during high tide on sandy beaches or rocky shores (DECC 2007).	No

Circus assimilis	Spotted Harrier	—	V	The Spotted Harrier is found in mainland Australia and Indonesia. It is widespread but sparsely distributed. The Spotted Harrier is found in open wooded country in tropical and temperate Australia, particularly in arid and semi-arid areas (BIB, 2006).	Likely
Climacteris picumnus Climacteris picumnus victoriae	Brown Treecreeper (eastern subspecies)	—	V	Distributed through central NSW on the western side of the Great Dividing Range and sparsely scattered to the east of the Divide in drier areas such as the Cumberland Plain of Western Sydney, and in parts of the Hunter, Clarence, Richmond and Snowy River valleys. The Brown Treecreeper occupies eucalypt woodlands, particularly open woodland lacking a dense understorey. It is sedentary and nests in tree hollows within permanent territories. (NSW Scientific Committee 2001).	No
Coracina lineata	Barred Cuckoo-shrike	—	V	It is associated with subtropical, dry and littoral rainforests and is restricted to below 500m elevation (DECC 2007).	Potential
Daphoenositta chrysoptera	Varied Sittella	—	V	Varied Sittellas are endemic and widespread in mainland Australia. Varied Sittellas are found in eucalypt woodlands and forests throughout their range. They prefer rough-barked trees like stringybarks and ironbark's or mature trees with hollows or dead branches (BIB, 2006)	Potential
Dromaius novaehollandiae	Emu population of the NSW North Coast Bioregion and Port Stephens LGA	—	E2	Occupies a range of mainly open habitats including plains, grasslands, woodlands, shrubs and occasionally forest (NSW Scientific Committee 2002). Not found in rainforest (Simpson & Day 1999).	No
Ephippiorhynchus asiaticus	**Black-necked Stork**	**—**	**E1**	**Associated with tropical and warm temperate terrestrial wetlands, estuarine and littoral habitats, and occasionally woodlands and grasslands floodplains (Marchant & Higgins 1993). Forages in fresh or saline waters up to 0.5m deep, mainly in open fresh waters, extensive sheets of shallow water over grasslands or sedgeland, mangroves, mudflats, shallow swamps with short emergent vegetation and permanent billabongs and pools on floodplains (Marchant & Higgins 1993; DECC 2007).**	**Yes**

Esacus neglectus	Beach Stone-curlew	-	CE	Beaches, mudflats, reefs and especially islands (Blakers et al. 1984). Open undisturbed beaches, islands, reefs, intertidal sand and mudflats, preferably with estuaries or mangroves nearby (DECC 2007).	No
Glossopsitta pusilla	**Little Lorikeet**	**—**	**V**	**In New South Wales Little Lorikeets are distributed in forests and woodlands from the coast to the western slopes of the Great Dividing Range, extending westwards to the vicinity of Albury, Parkes, Dubbo and Narrabri. Little Lorikeets mostly occur in dry, open eucalypt forests and woodlands. They have been recorded from both old-growth and logged forests in the eastern part of their range, and in remnant woodland patches and roadside vegetation on the western slopes. They feed primarily on nectar and pollen in the tree canopy, particularly on profusely-flowering eucalypts, but also on a variety of other species including melaleucas and mistletoes.**	**Yes**
Grus rubicundus	Brolga	—	V	During breeding season mostly near shallow freshwater marshes or freshwater meadows (Marchant and Higgins 1993). During non-breeding seasons congregates near deep, permanent freshwater marshes, mostly foraging in nearby field, pastures and fallow fields and occasionally foraging in littoral zones of marshes (Marchant and Higgins 1993).	Potential
Haematopus fuliginosus	Sooty Oystercatcher	—	V	A coastal species that inhabits rock coastlines, coral cays, reefs and occasionally sandy beaches and Marchant & Higgins 1993; Simpson & Day 1999).	No
Haematopus longirostris	Pied Oystercatcher	—	E1	Roosts and forages on sandy beaches, sand banks, mudflats and estuaries (Marchant & Higgins 1993, Simpson & Day 1999).	No
Hieraaetus morphnoides	Little Eagle	—	V	The Little Eagle is widespread in mainland Australia, central and eastern New Guinea. The Little Eagle is seen over woodland, forested lands and open country, extending into the arid zone. It tends to avoid rainforest and heavy forest (BIB, 2006).The population of Little Eagle in NSW is considered to be a single population (DECCW 2010). This species was recently listed as vulnerable due to a moderate reduction in population size based on geographic distribution and habitat quality (NSWSC 2010).	Potential

Irediparra gallinacea	Comb-crested Jacana	—	V	Freshwater wetlands, such as lagoons, billabongs, swamps, lakes and reservoirs, generally with abundant floating aquatic vegetation (Marchant and Higgins 1999).	Potential
Ixobrychus flavicollis	**Black Bittern**	**—**	**V**	**Occurs in both terrestrial and estuarine wetlands generally in areas of permanent water and dense vegetation (DECC 2007). In areas with permanent water it may occur in flooded grassland, forest, woodland, rainforest and mangroves (DECC 2007)**	**Yes**
Lathamus discolor	Swift Parrot	E1, Ma	E	Breeds in Tasmania between September and January. Feeds mostly on nectar, mainly from eucalypts, but also eats psyllid insects and lerps, seeds and fruit. Migrates to mainland in autumn, where it forages on profuse flowering Eucalypts. Favoured feed trees include winter flowering species such as Swamp Mahogany (*Eucalyptus robusta*), Spotted Gum (*Corymbia maculata*), Red Bloodwood (*C. gummifera*), Mugga Ironbark (*E. sideroxylon*), White Box (*E. albens*) and Forest Red Gum (*E. tereticornis*) (DECC 2007). Box-ironbark habitat in drainage lines and coastal forest in NSW is thought to provide critical food resources during periods of drought or low food abundance elsewhere (MacNally et al. 2000).	Potential
Lichenostomus fasciogularis	Mangrove Honeyeater	—	V	Lives in mangroves, frequently visiting flowering shrubs in towns adjacent to mangroves. Spends some of its' time feeding close to the mud in mangroves (Blakers et al. 1984; DECC 2007).	No

Limicola falcinellus	Broad-billed Sandpiper	Mi	V	The eastern form of the Broad-billed Sandpiper breeds in northern Siberia before migrating southwards in winter to Australia (DECC 2007). In Australia, Broad-billed Sandpipers over-winter on the northern coast, particularly in the north-west, with birds located occasionally on the southern coast (DECC 2007). In NSW, the main site for the species is the Hunter River estuary, with birds occasionally reaching the Shoalhaven estuary (DECC 2007). There are few records for inland NSW (DECC 2007). Broad-billed Sandpipers favour sheltered parts of the coast such as estuarine sandflats and mudflats, harbours, embayment's, lagoons, saltmarshes and reefs as feeding and roosting habitat (DECC 2007). Occasionally, individuals may be recorded in sewage farms or within shallow freshwater lagoons (DECC 2007). Broad-billed Sandpipers roost on banks on sheltered sand, shell or shingle beaches.	No
Limosa limosa	Black-tailed Godwit	—	V	Primarily found along the coast on sandspits, lagoons and mudflats (DECC 2007). The species has also been found to occur inland on mudflats or shallow receding waters of portions of large muddy swamps or lakes (Pizzey and Knight 1997; Higgins & Davies 1996).	No
Lophoictinia isura	**Square-tailed Kite**	**—**	**V**	**In coastal areas associated tropical and temperate forests and woodlands on fertile soils with an abundance of passerine birds (Marchant & Higgins 1993, DECC 2007). May be recorded inland along timbered watercourses (DECC 2007). In NSW it is commonly associated with ridge or gully forests dominated by Woollybutt (*Eucalyptus longiflora*), Spotted Gum (*E. maculata*), or Peppermint Gum (*E. elata, E. smithii*) (DECC 2007).**	**Yes**

Oxyura australis	Blue-billed Duck	—	V	The Blue-billed Duck prefers deep water in large permanent wetlands and swamps with dense aquatic vegetation (DECC 2007). The species is completely aquatic, swimming low in the water along the edge of dense cover (DECC 2007). It will fly if disturbed, but prefers to dive if approached (DECC 2007). Blue-billed Ducks are partly migratory, with short-distance movements between breeding swamps and over-wintering lakes with some long-distance dispersal to breed during spring and early summer (DECC 2007). Young birds disperse in April-May from their breeding swamps in inland NSW to non-breeding areas on the Murray River system and coastal lakes (DECC 2007).	Potential
Pachycephala olivacea	Olive Whistler		V	Elevated (>500 MASL), cool temperate rainforest and moist eucalypt forest in the northern part of their range. This species appears to favour large tracts of undisturbed and densely vegetated forest (SFNSW 1995).	No
Pandion haliaetus	**Eastern Osprey**	**—**	**V**	**Associated with waterbodies including coastal waters, inlets, lakes, estuaries, beaches, offshore islands and sometimes along inland rivers (Schodde and Tidemann 1986; Clancy 1991; Olsen 1995). Osprey may nest on the ground, on sea cliffs or in trees (Olsen 1995). Osprey generally prefers emergent trees, often dead or partly dead with a broken off crown (Olsen 1995).**	**Yes**
Petroica boodang	Scarlet Robin	—	V	The Scarlet Robin is found in south-eastern and south-western Australia, as well as on Norfolk Island. In Australia, it is found south of latitude 25°S, from south-eastern Queensland along the coast of New South Wales (and inland to western slopes of Great Dividing Range) to Victoria and Tasmania, and west to Eyre Peninsula, South Australia; it is also found in south-west Western Australia. The Scarlet Robin lives in open forests and woodlands in Australia, while it prefers rainforest habitats on Norfolk Island. During winter, it will visit more open habitats such as grasslands and will be seen in farmland and urban parks and gardens at this time (BIB, 2006).	Potential

Petroica phoenicea	Flame Robin	—	V	Flame Robins are found in a broad coastal band around the south-east corner of the Australian mainland, from southern Queensland to just west of the South Australian border. The species is also found in Tasmania. Flame Robins prefer forests and woodlands up to about 1800 m above sea level.	Potential
Pomatostomus temporalis temporalis	Grey-crowned Babbler (eastern subspecies)	—	V	Open woodlands dominated by mature eucalypts with regenerating trees, tall shrubs, and an intact ground cover of grass and forbs (NSW Scientific Committee 2001). This species avoids very wet areas (Blakers et al. 1984).	Unlikely
Ptilinopus magnificus	Wompoo Fruit-Dove	—	V	Associated with large, undisturbed patches of tall tropical or subtropical rainforest, at all altitudes, preferably with a diversity of fruit (Marchant and Higgins 1999; DECC 2007). Occasionally located in patches of monsoon rainforest, closed gallery forest, wet sclerophyll forest, tall open forest, open woodland or vine thickets near rainforest (Marchant and Higgins 1999; DECC 2007).	Potential
Ptilinopus regina	Rose-crowned Fruit-Dove	—	V	Tall tropical and subtropical, evergreen or semi-deciduous rainforests, especially with a dense growth of vines trees (Marchant and Higgins 1999). Also located in closed wet sclerophyll forest, gallery forests or sclerophyll woodlands with abundant fruiting trees, near or next to rainforest (DECC 2007). Is thought to prefer large areas of vegetation, but has been located in patches and occasionally in parks and gardens with fruiting trees (Marchant and Higgins 1999).	Potential
Ptilinopus superbus	Superb Fruit-Dove	—	V	Inhabits rainforest and similar closed forests where it forages high in the canopy, eating the fruits of many tree species such as figs and palms (DECC 2007). It may also forage in eucalypt or acacia woodland where there are fruit-bearing trees (*ibid.*). Part of the population is migratory or nomadic (*ibid.*). At least some of the population, particularly young birds, moves south through Sydney, especially in autumn (*ibid.*). Breeding takes place from September to January (*ibid.*). Will feed in adjacent mangroves or eucalypt forests (Blakers et al. 1984).	Likely

Rostratula benghalensis australis	Painted Snipe (Australian subspecies)	E1	E1	Prefers fringes of swamps, dams and nearby marshy areas where there is a cover of grasses, lignum, low scrub or open timber (DECC 2007). Nests on the ground amongst tall vegetation, such as grasses, tussocks or reeds (*ibid.*). Breeding is often in response to local conditions; generally occurs from September to December (DECC 2007). Roosts during the day in dense vegetation (NSW Scientific Committee 2004). Forages nocturnally on mud-flats and in shallow water (DECC 2007). Feeds on worms, molluscs, insects and some plant-matter (*ibid.*).	Potential
Stagonopleura guttata	Diamond Firetail	—	V	Typically found in grassy eucalypt woodlands, but also occurs in open forest, mallee, Natural Temperate Grassland, and in secondary grassland derived from other communities (DECC 2007). It is often found in riparian areas and sometimes in lightly wooded farmland (DECC 2007). Appears to be sedentary, though some populations move locally, especially those in the south (DECC 2007).	Unlikely
Sterna albifrons	Little Tern	—	E	Almost exclusively coastal, preferring sheltered areas (DECC 2007), however may occur several kilometres inland in harbours, inlets and rivers (Smith 1990). Australian birds breed on sandy beaches and sand spits (Simpson & Day 1999).	No
Stictonetta naevosa	Freckled Duck	—	V	Associated with a variety of plankton-rich wetlands, such as heavily vegetated, large open lakes and their shores, creeks, farm dams, sewerage ponds and floodwaters (DECC 2007).	Potential
Xenus cinereus	Terek Sandpiper	Mi	V	A rare migrant to the eastern and southern Australian coasts, being most common in northern Australia, and extending its distribution south to the NSW coast in the east (DECC 2007). The two main sites for the species in NSW are the Richmond River estuary and the Hunter River estuary (DECC 2007). In Australia, has been recorded on coastal mudflats, lagoons, creeks and estuaries (DECC 2007). Favours mudbanks and sandbanks located near mangroves, but may also be observed on rocky pools and reefs, and occasionally up to 10 km inland around brackish pools (DECC 2007). Generally roosts communally amongst mangroves on dead trees, often with related wader species (DECC 2007).	No

Aves (Nocturnal birds)					
Ninox connivens	Barking Owl	—	V	Associated with a variety of habitats such as savannah woodland, open eucalypt forests, wetland and riverine forest. The habitat is typically dominated by Eucalypts (often Redgum species), however often dominated by Melaleuca species in the tropics (DECC 2007). It usually roosts in dense foliage in large trees such as River She-oak (*Allocasuarina cunninghamiana*), other Casuarina and Allocasuarina, eucalypts, Angophora, Acacia and rainforest species from streamside gallery forests (NPWS 2003). It usually nests near watercourses or wetlands (NPWS 2003) in large tree hollows with entrances averaging 2-29 metres above ground, depending on the forest or woodland structure and the canopy height (Debus 1997).	Potential
Ninox strenua	Powerful Owl		V	Powerful Owls are associated with a wide range of wet and dry forest types with a high density of prey, such as arboreal mammals, large birds and flying foxes (Environment Australia 2000, Debus & Chafer 1994). Large trees with hollows at least 0.5m deep are required for shelter and breeding (Environment Australia 2000).	Potential
Tyto capensis	Grass Owl	—	V	Reported habitats include tall grass, swampy, sometimes tidal areas, mangrove fringes, grassy plains, coastal heaths, grassy woodland, cane grass, lignum, sedges, cumbungi, cane fields and grain stubble (Pizzey and Knight, 1997). The Grass Owl nests on the ground within dense tall grass, sedges, reeds and even sugarcane plantations (Pizzey and Knight, 1997). The Grass Owl primarily feeds on rodents, hunting on the wing over heathland, grassland and sedgeland, as well as along the edge of sugar cane, crops and pastureland (Pizzey and Knight, 1997).	Potential
Tyto novaehollandiae	**Masked Owl**	**—**	**V**	**Associated with forest with sparse, open, understorey, typically dry sclerophyll forest and woodland (DECC 2007) and especially the ecotone between wet and dry forest, and non-forest habitat (Environment Australia 2000). Known to utilise forest margins and isolated stands of trees within agricultural land (Hyem 1979) and heavily disturbed forest where its prey of small and medium sized mammals can be readily obtained (Kavanagh & Peake 1993).**	**Yes**

Tyto tenebricosa	**Sooty Owl**	**—**	**V**	**Sooty Owls are associated with tall wet old growth forest on fertile soil with a dense understorey and emergent tall Eucalyptus species (Environment Australia 2000, Debus 1994). Pairs roost in the daytime amongst dense vegetation, in tree hollows and sometimes in caves. The Sooty Owl is typically associated with an abundant and diverse supply of prey items and a selection of large tree hollows (Debus 1994, Garnett 1993, Hyem 1979).**	**Yes**
Mammalia - terrestrial (excluding bats)					
Aepyprymnus rufescens	Rufous Bettong	—	V	The Rufous Bettong prefer forests with a grassy to sparse understorey including coastal forest, tall wet sclerophyll forest and dry forests west of GDR (DECC 2007). It is most commonly found on sites derived from sedimentary rock and in north eastern NSW in forests characterised by Spotted Gum (*Corymbia maculata and C. henryi)* (DECC 2007). It has been known to feed on introduced pasture species (DECC 2007).	No
Cercartetus nanus	Eastern Pygmy-possum	—	V	The Eastern Pygmy Possum occurs in wet and dry eucalypt forest, subalpine woodland, coastal banksia woodland and wet heath (Menkhorst & Knight 2004). Pygmy-Possums feed mostly on the pollen and nectar from banksias, eucalypts and understorey plants and will also eat insects, seeds and fruit (Turner & Ward 1995). The presence of *Banksia* sp. and *Leptospermum* sp. are an important habitat feature (DECC 2007). Small tree hollows are favoured as day nesting sites, but nests have also been found under bark, in old birds' nests and in the branch forks of tea-trees (Turner & Ward 1995).	Unlikely

***Dasyurus maculatus Dasyurus maculatus maculatus* (SE Mainland population)**	**Spotted-tailed Quoll**	**E1**	**V**	**The Spotted-tailed Quoll inhabits a range of forest communities including wet and dry sclerophyll forests, coastal heathlands and rainforests (Mansergh 1984; DECC 2007j), more frequently recorded near the ecotones of closed and open forest and in NSW within 200km of the coast. Preferred habitat is mature wet forest (Belcher 2000b; Green & Scarborough 1990; Watt 1993), especially in areas with rainfall 600 mm/year (Edgar & Belcher 2008; Mansergh 1984). Unlogged forest or forest that has been less disturbed by timber harvesting is also preferable (Catling et al. 1998, 2000). This species requires habitat features such as maternal den sites, an abundance of food (birds and small mammals) and large areas of relatively intact vegetation to forage in (DECC 2007). Maternal den sites are logs with cryptic entrances; rock outcrops; windrows; burrows (Environment Australia 2000).**	**Yes**
Macropus parma	Parma Wallaby	—	V	Preferred habitat is moist eucalypt forest with thick, shrubby understorey, often with nearby grassy areas, rainforest margins and occasionally drier eucalypt forest (DECC 2007).	Potential
Petaurus australis	Yellow-bellied Glider	—	V	This species is restricted to tall mature forests, preferring productive tall open sclerophyll forests with a mosaic of tree species including some that flower in winter (Environment Australia 2000, Braithwaite 1984, Davey 1984, Kavanagh 1984; DECC 2007). Large hollows within mature trees are required for shelter, nesting and breeding (Henry and Craig 1984; DECC 2007).	Potential
Petaurus norfolcensis	Squirrel Glider	—	V	Associated with dry hardwood forest and woodlands (Menkhorst et al. 1988; Quin 1995). Habitats typically include gum barked and high nectar producing species, including winter flower species (Menkhorst et al. 1988). The presence of hollow bearing eucalypts is a critical habitat value (Quin 1995).	Potential
Petrogale penicillata	Brush-tailed Rock-wallaby	V	E1	Rocky areas in a variety of habitats, typically north facing sites with numerous ledges, caves and crevices (Strahan 1995).	No
Phascogale tapoatafa	Brush-tailed Phascogale	—	V	The Brush-tailed Phascogale preferred habitat is Dry Open forest with a sparse open understorey, however, has been located in heath, swamps and rainforest and wet sclerophyll forest (DECC 2007).	Potential

***Phascolarctos cinereus Phascolarctos cinereus* (combined populations of Qld, NSW and ACT)**	**Koala**	**V**	**V**	**Associated with both wet and dry Eucalypt forest and woodland that contains a canopy cover of approximately 10 to 70% (Reed et al. 1990), with acceptable Eucalypt food trees. Some preferred Eucalyptus species are: *Eucalyptus tereticornis, E. punctata, E. cypellocarpa, E. viminalis***	**Yes**
Planigale maculata	Common Planigale	—	V	Subtropical to dry rainforest, dry sclerophyll forest, heathland and grassland up to 400m elevation (DECC 2007; Strahan 1998). Habitat selection is dependent on surface cover (DECC 2007).	Potential
Potorous tridactylus Potorous tridactylus tridactylus (SE Mainland)	Long-nosed Potoroo	V	V	Associated with dry coastal heath and dry and wet sclerophyll forests (Strahan 1998) with dense cover for shelter and adjacent more open areas for foraging (Menkhorst & Knight 2004).	Unlikely
Pseudomys gracilicaudatus	Eastern Chestnut Mouse		V	In NSW the Eastern Chestnut Mouse is mostly found, in low numbers, in heathland and is most common in dense, wet heath and swamps (DECC 2007). Optimal habitat appears to be in vigorously regenerating heathland burnt from 18 months to four years previously (DECC 2007). By the time the heath is mature, the larger Swamp Rat becomes dominant, and Eastern Chestnut Mouse numbers drop again (DECC 2007).	Unlikely
Pseudomys novaehollandiae	New Holland Mouse	V		This species has been recorded from Queensland to Tasmania, though with a sporadic and patchy distribution. Most records are coastal. However, populations have been recently recorded up to 400km inland. The species includes heathlands, woodands, open forest and paperbark swamps and on sandy, loamy or rocky soils (Kemper and Wilson 2008). In coastal populations the species seems to have a preference for sandy substrates, a heathy understorey of legumes less than one metre high and sparse ground litter. This species is generally recorded in regenerating burnt areas occurs that are one or two years post fire and rehabilitated sand-mined areas that are four to five years post-mining (Kemper and Wilson 2008).	Unlikely

Pseudomys oralis	Hastings River Mouse	E1	E1	The Hasting River Mouse prefers areas with an open canopy and shrub layer appear to be the major predictive habitat features of this species (Read & Tweedie 1996). Open forest or woodland with a grassy sedge rush or heath understorey that is about 10-75cm above the ground (DECC 2007). Ground cover may vary from almost no cover to a dense, rank cover of grasses, herbs and sedges (DECC 2007). Sedges, particularly *Carex, Juncus* and *Cyperus* spp. are common to most sites (DEH 2006a). This habitat occurs beside creeks (permanent and ephemeral) and soakages, but is also found on ridges and grassy Plains (DEH 2006a). Shelter areas such as rock piles, hollow logs, yabby burrows or cavities in the butts of large old trees are also required to be present (DECC 2007).	Potential
Thylogale stigmatica	Red-legged Pademelon		V	Predominantly a rainforest species, also in wet sclerophyll forest and deciduous vine thickets. Requires a dense understorey for cover (SFNSW 1995).	Unlikely
Mammalia - terrestrial (Bats)					
Chalinolobus dwyeri	Large-eared Pied Bat	V	V	The Large-eared Pied Bat has been recorded in a variety of habitats, including dry sclerophyll forests, woodland, sub-alpine woodland, edges of rainforests and wet sclerophyll forests (Churchill 1998; DECC 2007). This species roosts in caves, rock overhangs and disused mine shafts and as such is usually associated with rock outcrops and cliff faces (Churchill 1998; DECC 2007).	Potential
Chalinolobus nigrogriseus	Hoary Wattled Bat	—	V	The preferred habitat of this species appears to be variable, with dry open forest, woodland, vine thickets, coastal scrub, sand dunes, grasslands and floodplains recorded (Churchill 1998). This species often forages along watercourses, swampy areas and over farm dams. In NSW, this species has been recorded in Spotted Gum (*Corymbia maculata*), Grey Box (*Eucalyptus moluccana*) and Northern Ironbark (*E. siderophloia*) and woodland characterised by Scribbly Gums (*E. signata*) and Pink Bloodwood (*C. intermedia*) and sites dominated by the Blackbutt (*E. pilularis*) (Churchill 1998). Roost sites have been identified as tree hollows, rock crevices and the roofs of buildings (Churchill 1998).	Potential

Falsistrellus tasmaniensis	Eastern False Pipistrelle	—	V	Prefers moist habitats with trees taller than 20m (DECC 2007). Roosts in tree hollows but has also been found roosting in buildings or under loose bark (DECC 2007).	Likely
Kerivoula papuensis	Golden-tipped Bat	—	V	The most favoured habitat for this species is moist closed forests often with a rainforest influence; however, some captures have been made in dry forests some distance from any rainforest (Lunney et. al. 1986; Parnaby and Mills, 1994). It has been suggested that the amount of vines and complex tree layers allows for increased numbers of spiders and webs and such areas are sought by the Golden-tipped Bat (Schulz & Eyre 2000). Often caught over streams within rainforest. Known to frequently roost within the pendulous nests of Yellow-throated and Large-billed Scrub Wrens and Brown Gerygone in rainforest areas (Schulz & Eyre 2000).	Potential
Miniopterus australis	**Little Bent-wing Bat**	**—**	**V**	**Prefers well-timbered areas including rainforest, wet and dry sclerophyll forests, Melaleuca swamps and coastal forests (Churchill 1998). This species shelter in a range of structures including culverts, drains, mines and caves (Environment Australia 2000). Relatively large areas of dense vegetation of wet sclerophyll forest, rainforest or dense coastal Banksia scrub are usually found adjacent to caves in which this species is found (DECC 2007). Breeding occurs in caves, usually in association with M. schreibersii (Environment Australia 2000, DECC 2007).**	**Yes**
Miniopterus schreibersii oceanensis	**Eastern Bent-wing Bat**	**—**	**V**	**Associated with a range of habitats such as rainforest, wet and dry sclerophyll forest, monsoon forest, open woodland, paperbark forests and open grassland (Churchill 1998). It forages above and below the tree canopy on small insects (AMBS 1995, Dwyer 1995, Dwyer 1981). Will utilise caves, old mines, and stormwater channels, under bridges and occasionally buildings for shelter (Environment Australia 2000, Dwyer 1995).**	**Yes**

Mormopterus norfolkensis	**Eastern Freetail-bat**	**—**	**V**	**Most records of this species are from dry eucalypt forest and woodland east of the Great Dividing Range (Churchill 1998). Individuals have, however, been recorded flying low over a rocky river in rainforest and wet sclerophyll forest and foraging in clearings at forest edges (Environment Australia 2000; Allison & Hoye 1998). Primarily roosts in hollows or behind loose bark in mature eucalypts, but have been observed roosting in the roof of a hut (Environment Australia 2000; Allison & Hoye 1998).**	**Yes**
Myotis adversus	**Southern Myotis, Large-footed Myotis**	**—**	**V**	**Will occupy most habitat types such as mangroves, paperbark swamps, riverine monsoon forest, rainforest, wet and dry sclerophyll forest, open woodland and River Red Gum woodland, and as long as they are close to water (Churchill 1998). While roosting is most commonly associated with caves, this species has been observed to roost in tree hollows, amongst vegetation, in clumps of Pandanus, under bridges, in mines, tunnels and stormwater drains (Churchill 1998). However the species apparently has specific roost requirements, and only a small percentage of available caves, mines, tunnels and culverts are used (Richards 1998).**	**Yes**
Nyctophilus bifax	Eastern Long-eared Bat	—	V	This species prefers wetter habitats, ranging from rainforest and monsoon forest to riverine forests of paperbark, but may be found in open woodland, tall open forest and dry sclerophyll woodland (Churchill 1998).These forest bats have been recorded roosting under peeling bark, among epiphytes, in tree hollows and in foliage (Churchill 1998). Individuals are likely to change roost sites nightly (DECC 2007).	Potential
Pteropus poliocephalus	**Grey-headed Flying-Fox**	**V**	**V**	**Inhabits a wide range of habitats including rainforest, mangroves, paperbark forests, wet and dry sclerophyll forests and cultivated areas (Churchill 1998, Eby 1998). Camps are often located in gullies, typically close to water, in vegetation with a dense canopy (Churchill 1998).**	**Yes**

Saccolaimus flaviventris	**Yellow-bellied Sheathtail-bat**	**—**	**V**	**Found in almost all habitats, from wet and dry sclerophyll forest, open woodland (Churchill 1998), open country, mallee, rainforests, heathland and waterbodies (SFNSW 1995). Roosts in tree hollows; may also use caves; has also been recorded in a tree hollow in a paddock (Environment Australia 2000) and in abandoned sugar glider nests (Churchill 1998). The Yellow-bellied Sheathtail-bat is dependent on suitable hollow-bearing trees to provide roost sites, which may be a limiting factor on populations in cleared or fragmented habitats (Environment Australia 2000).**	**Yes**
Scoteanax rueppellii	Greater Broad-nosed Bat	—	V	Associated with moist gullies in mature coastal forest, or rainforest, east of the Great Dividing Range (Churchill, 1998), tending to be more frequently located in more productive forests (Hoye & Richards 1998). Within denser vegetation type's use is made of natural and manmade openings such as roads, creeks and small rivers, where it hawks backwards and forwards for prey (Hoye & Richards 1998).	Potential
Syconycteris australis	Common Blossom-bat	—	V	The combination of heathland and coastal rainforest is essential for this species (Churchill 1998). Breeding and sheltering habitats are in subtropical and littoral rainforests and a diverse range of nectar producing plant communities are required year round; it will occasionally eat some rainforest fruits (Churchill 1998; Environment Australia 2000).	Unlikely
Vespadelus troughtoni	Eastern Cave Bat	—	V	Inhabit tropical mixed woodland and wet sclerophyll forest on the coast and the dividing range but extend into the drier forest of the western slopes and inland areas (Churchill 1998). Has been found roosting in sandstone overhand caves, boulder piles, mine tunnels and occasionally in buildings (Churchill 1998).	Unlikely

Invertebrata					
Argyreus hyperbius	Laced Fritillary or Australian Fritillary	-	E1	Coastal areas of north-east NSW and south-east Queensland, and also New Guinea, south-east Asia and India. Australian population now restricted to a few widely separated localities from Port Macquarie north to Gympie. The Laced Fritillary has only been recorded from the Port Macquarie and Billinudgel/Byron Bay areas in NSW in recent times. Laced Fritillary is found in open swampy coastal habitat. Many former sites have been destroyed and records now only occur from a few widely separated sites.	Unlikely
Ocybadistes knightorum	**Black Grass-dart Butterfly**	**-**	**E1**	**The Black Grass-dart is found on the Mid North Coast between Digger's Headland and Warrell Creek (just south of Macksville). The main occurrence is just south of Coffs Harbour. It is restricted to areas where its sole food plant, Alexfloydia repens (Floyd's Grass), occurs. Floyd's Grass is also listed as an Endangered species in NSW.**	**Yes**
Petalura litorea	**Coastal Petaltail**	**-**	**E1**	**In NSW known populations are restricted to coastal and near coastal lowlands between Coffs Harbour and Ballina. Live in permanent swamps and bogs with some free water and open vegetation (DEC 2005).**	**Yes**
Phyllodes imperalis (Southern subspecies)	Pink Underwing Moth	E1	E1	Lower montane rainforests from QLD to NSW, where larvae appear to be dependent on the vine Carronia multisepalea (NSW Scientific Committee 2004). Breeding habitat is considered to be restricted to undisturbed old growth subtropical rainforest below 600m altitude (NSW Scientific Committee 2004)	Potential

Appendix E: Threatened flora likelihood table

SCIENTIFIC NAME	COMMON NAME	NSW TSC ACT	EPBC ACT	HABITAT ASSOCIATIONS	LIKELIHOOD OF OCCURRENCE
Acacia chrysotricha	Newry Golden Wattle	E1		*Acacia chrysotricha* occurs in a restricted area of the Kalang Valley south of Bellingen, on the NSW Mid North Coast. It is an understorey species on rainforest edges and in wet or dry eucalypt forest on quartzite soils. The round, yellow flower heads are present from July-August (DEC 2005).	No
Acronychia littoralis	Scented Acronychia	E1	E	Acronychia littoralis is found between Cooloola in south east Queensland and Port Macquarie on the North Coast of NSW. It occurs in littoral rainforest or in wet sclerophyll forest on the sandy coastal plain (Floyd 2008).	No
Aldrovanda vesiculosa	Waterwheel Plant	E1		Aldrovanda vesiculosa has only been recorded in NSW from lagoons in the Moruya area on the South Coast, from the Evans Head area on the North Coast and from north of Guyra on the New England Tablelands, where it is found free-floating in near-coastal shallow freshwater lagoons that are rich in organic matter (DEC 2005).	No

Alexfloydia repens	Floyd's Grass	E1		*Alexfloydia repens* is restricted to the area between Coffs Harbour and Macksville on the NSW Mid North Coast. It usually occurs in stands of Swamp Oak or paperbark in peat-like soil edging the upper tidal areas of mangroves and on the banks of estuarine creeks but has also been recorded in damp areas on headlands.	Potential
Allocasuarina defungens	Dwarf Heath Casuarina	E1	E	*Allocasuarina defungens* is found only in NSW from the Nabiac area, north-west of Forster, to Byron Bay on the North Coast. It is a straggly shrub about 2m high with blue-green foliage found in heath on sand (sometimes clay and sandstone soils), and swamp sclerophyll forest margins, and also extends onto exposed nearby-coastal hills or headlands adjacent to sandplains (DEC 2005).	Unlikely
Ancistrachne maidenii		V		*Ancistrachne maidenii* is known from two disjunct areas in NSW - northern Sydney (e.g. Berowra Waters, Brooklyn and Wisemans Ferry), and the Grafton district. Surveys have indicated that the species may have specific habitat requirements, with populations occurring in distinct bands in areas associated with a transitional geology between Hawkesbury and Watagan soil landscapes (NSW SC, 1999). The northern Grafton populations also occur on sandstone.	No
Arthraxon hispidus	Hairy Jointgrass	V	V	*Arthraxon hispidus* is known from a number of locations on the North Coast and Northern Tablelands. It is a moisture and shade-loving grass, found in or on the edges of rainforest, in wet eucalypt forest and in or near creeks or swamps.	Potential

Asperula asthenes	Trailing Woodruff	V	V	*Asperula asthenes* occurs only in NSW, in scattered locations from Bulahdelah north to near Kempsey, with several records from the Port Stephens/Wallis Lakes area (DEC 2005). It grows in damp sites often along river banks (Harden 1993).	No
Astrotricha cordata	Heart-leaved Star Hair	E1		*Astrotricha cordata* is known from Mt Belmore State Forest and Mount Neville Nature Reserve on the NSW North Coast. Grows in dry eucalypt forest on exposed rocky summits, cliff edges and rocky slopes (DEC 2005).	No
Bertya sp. (Chambigne NR, M. Fatemi 24)	Chambigne Bertya	E1		Currently known from a single population near Shannon Creek Dam south of Grafton. Plants grow in shrubby woodland and heath in shallow sandy soils over sandstone.	No
Boronia hapalophylla	Shannon Creek Boronia	E1		Known from a several areas in the Grafton district. Plants grow in shrubby woodland on sandstone.	No
Boronia umbellata	Orara Boronia	V	V	*Boronia umbellata* is found at only a few locations between Glenreagh and Lower Bucca, north of Coffs Harbour, but it is locally common in the restricted area where it occurs (DEC 2005). It grows as an understorey shrub in and around gullies in wet open forest (DEC 2005). It appears to regenerate well after disturbance, but it is not known whether prolonged or repeated disturbance affects long-term persistence (DEC 2005).	Unlikely
Chamaesyce psammogeton	Sand Spurge	E1		*Chamaesyce psammogeton* is known from coastal sites north from near Jervis Bay as well as on Lord Howe Island. It is a prostrate perennial herb, which grows on foredunes and exposed sites on headlands often with Spinifex (DEC 2005).	No

Cynanchum elegans	White-flowered Wax Plant	E1	E	*Cynanchum elegans* is a climber or twiner with a variable form, and flowers between August and May, peaking in November (DEC 2005). It occurs in dry rainforest gullies, scrub and scree slopes, and prefers the ecotone between dry subtropical rainforest and sclerophyll woodland/forest (NPWS 1997). The species has also been found in littoral rainforest; Leptospermum laevigatum – Banksia integrifolia subsp. integrifolia coastal scrub; Eucalyptus tereticornis open forest/ woodland; Corymbia maculata open forest/woodland; and Melaleuca armillaris scrub to open scrub (DEC 2005).	Potential
Cyperus aquatilis	Water Nutgrass	E1		In NSW, *Cyperus aquatilis* is known only from a few sites north from Grafton, where it grows in ephemerally wet sites, such as roadside ditches and seepage areas from small cliffs, in sandstone areas (DEC 2005).	No
Dendrobium melaleucaphilum	Spider orchid	E1		Occurs from the lower Blue Mountains north to the Queensland border. Mostly grows on the bark of *Melaleuca stypheliodes* in paperbark swamps but also occasionally on rainforest trees and rarely as a lithophyte on rocks.	Potential
Diuris venosa	Veined Doubletail	V	V	Widespread in sub-alpine areas on Barrington Tops, known from Nowendoc and Brackendale, possibly southern parts of New England Tableland. Grows in moist tussock grassland or open shrubland around margins of subalpine swamps.	No

Eleocharis tetraquetra	Square-stemmed Spike-rush	E1		*Eleocharis tetraquetra* was thought to be extinct in NSW until it was rediscovered in 1997 at Boambee near Coffs Harbour, and has since been found in other north coast localities near Grafton and Murwillumbah (DEC 2005). It is found in damp locations on stream edges and in and on the margins of freshwater swamps (DEC 2005).	Potential
Lindsaea incisa	Slender Screw Fern	E1		In NSW, *Lindsaea incisa* is known only from a few locations on the North Coast such as the Woombah, Coffs Harbour, Grafton and Bungawalbyn districts. It grows in a range of woodland and open forest types, usually in waterlogged or poorly drained sites along creeks, where ferns, sedges and shrubs grow thickly (DEC 2005).	Potential
Marsdenia longiloba	**Slender Marsdenia**	**E1**	**V**	***Marsdenia longiloba* occurs on the NSW North Coast north from Barrington Tops. It occurs in subtropical and warm temperate rainforest, lowland moist eucalypt forest adjoining rainforest and, sometimes, in areas with rock outcrops (DEC 2005). Preferred habitat seems to be moist open forest with a fern-grass understorey and occasional small rainforest trees, often on hillslopes adjacent to gully rainforest (Ecos Environmental Pty Ltd 2005).**	**Yes**
Neoastelia spectabilis	Silver Sword Lily	V	V	Known only from New England and Bellinger River National Parks where it is highly restricted and relatively uncommon. Grows in moist rocky areas near creeklines in rainforest and wet sclerophyll forest.	No

Niemeyera whitei	Rusty Plum, Plum Boxwood	V		*Niemeyera whitei* occurs north from the Macleay River in low to mid altitude coastal hills and ranges. It usually occurs in gully rainforest or wet sclerophyll forest with a well-developed rainforest understorey growing on medium fertility soils formed on metasediment or rhyolite (Floyd 2008).	Potential
Oberonia complanata	Yellow-flowered King of the Fairies	E1		Although historic records exist for this species from Coffs Harbour, Lismore and Byron Bay, Oberonia complanata is now known with certainty in NSW only from the Woodburn district. Plants grow as epiphytes on the bark of trees such as Prickly Paperbark (*Melaleuca styphelioides*) in moist swampy, areas at sea level.	Potential
Oberonia titania	Red-flowered King of the Fairies	V		Known from several populations on the North Coast north from the Port Macquarie district. Grows either as an epiphyte on rainforest trees (e.g. Grey Myrtle *Backhousia myrtifolia* and Bangalow Palm *Archontophoenix cunninghamiana*) or occasionally as a lithophyte on rocks.	
Parsonsia dorrigoensis	Milky Silkpod	V	E	*Parsonsia dorrigoensis* occurs as scattered populations in the Mid North Coast of NSW between Kendall and Woolgoolga (DEC 2005). Found in subtropical and warm-temperature rainforest, on rainforest margins, and in moist eucalypt forest up to 800 m, on brown clay soils. Flowers in summer (DEC 2005).	Potential
Peristeranthus hillii	Brown Fairy-chain Orchid	V		Known from coastal areas north from Port Macquarie. Grows as an epiphyte on rainforest trees and large climbers. Most records are from very close to the ocean in littoral rainforest.	No

Phaius australis	Southern Swamp Orchid	E1	E	Known from coastal areas north from about Port Macquarie with older records from as far south as Bulahdelah. Grows in moist swampy grassland and paperbark swamps and on the margins of rainforest.	Potential
Phaius tancarvilleae	Lady Tankerville's Swamp Orchid	E1	E	Found in swampy grassland or swampy forest, including rainforest, eucalypt and paperbark forest.	No
Pomaderris queenslandica	Scant Pomaderris	E1		Pomaderris queenslandica is widely scattered but not common in north-east NSW and in Queensland. It is only known from a few locations on the New England Tablelands and North Western Slopes, including near Torrington and Coolatai, and also from several locations on the NSW North Coast. It grows in moist eucalypt forest or sheltered woodlands with a shrubby understorey, occasionally along creeks (DEC 2005).	Potential
Pultenaea maritima	Coast Headland Pea	V		In NSW, *Pultenaea maritima* has been recorded from Newcastle north to Byron Bay on 16 headlands. It occurs in grasslands, shrublands and heath on exposed coastal headlands (DEC 2005).	No
Quassia sp. Moonee Creek	Moonee Quassia	E1	E	*Quassia sp. Moonee Creek* occurs between Moonee Creek near Coffs Harbour and the coast range north east of Grafton. It grows in either wet sclerophyll forest, dominated by species such as *Eucalyptus microcorys, Lophostemon confertus* and *Syncarpia glomulifera* or in dry open eucalypt forests with a well-developed shrub layer (DEC 2005).	No

Senna acclinis	Rainforest Cassia	E1		In NSW, *Senna acclinis* occurs in coastal districts and adjacent tablelands north from the Illawarra. It grows in or on the edges of subtropical, littoral and dry rainforest and in open eucalypt forest (DEC 2005).	Potential
Sophora tomentosa	Silverbush	E1		*Sophora tomentosa* occurs in coastal areas in Queensland and northern NSW. It was previously common north from Port Stephens but is now uncommon and found only north of Old Bar, near Taree. It grows on coastal dunes (DEC 2005).	No
Thesium australe	Austral Toadflax	V	V	Widespread throughout the eastern third of NSW but most common on the North Western Slopes, Northern Tablelands and North Coast. Occurs in grassland or grassy woodland. Often found in damp sites in association with Kangaroo Grass (*Themeda australis*) (DEC 2005). The preferred soil type is a fertile loam derived from basalt although it occasionally occurs on metasediments and granite.	Potential
Tinospora smilacina	Tinospora Vine	E1		North from the Coffs Harbour district on the North Coast of NSW, but chiefly further north again e.g. Lismore district. Mostly found in dry rainforest and in the ecotone between rainforest and dry eucalypt forest (DEC 2005).	Potential
Tylophora woollsii	Cryptic Forest Twiner	E1	E	Widespread but uncommon on the Northern Tablelands and North Coast of NSW. Known localities include the Ebor, Gibraltar Range, Nymboida and Tenterfield districts. Plants grow in moist eucalypt forest and on the margins of rainforest.	Unlikely

Typhonium sp. aff. brownii	Stinky Lily	E1		Only known from several locations in the ranges west of Coffs Harbour and Woolgoolga including Kangaroo River, Bruxner Park, Bindarri National Park and Upper Corindi (DEC 2005). Occurs on reasonably fertile soils, in moist eucalypt forest and the moist eucalypt forest-subtropical rainforest interface (DEC 2005).	Potential
Zieria prostrata	Headland Zieria	E1	E	*Zieria prostrata* is restricted to four coastal headlands in the Coffs Harbour area of north-east NSW. It grows in low grassy heath on exposed sites and wind-pruned open to sparse shrubland on more sheltered aspects (DEC 2005).	No

Appendix F: Threatened community likelihood table

ECOLOGICAL COMMUNITY	NSW TSC ACT	EPBC ACT	LIKELIHOOD OF OCCURRENCE
Coastal Saltmarsh in the New South Wales North Coast, Sydney Basin and South East Corner Bioregions	E3		No
Freshwater Wetlands on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions	**E3**		**Yes**
Littoral Rainforest in the New South Wales North Coast, Sydney Basin and South East Corner Bioregions	E3	CE	No
Lowland Rainforest in the NSW North Coast and Sydney Basin Bioregions	E3	CE	Potential
Lowland Rainforest on Floodplain in the New South Wales North Coast Bioregion	E3	CE	Unlikely
Montane Peatlands and Swamps of the New England Tableland, NSW North Coast, Sydney Basin, South East Corner, South Eastern Highlands and Australian Alps bioregions	E3	E	No
Sub-tropical Coastal Floodplain Forest of the NSW North Coast bioregion	E3		Unlikely
Swamp Oak Floodplain Forest of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions	E3		Potential
Swamp Sclerophyll Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions	**E3**		**Yes**
Themeda grassland on seacliffs and coastal headlands in the NSW North Coast, Sydney Basin and South East Corner Bioregions	E3		No

Appendix G - Riparian buffer guide

Department of Primary Industries
Office of Water

CONTROLLED ACTIVITIES ON WATERFRONT LAND

Guidelines for riparian corridors on waterfront land

Controlled activities carried out in, on or under waterfront land are regulated by the *Water Management Act 2000* (WM Act). The NSW Office of Water administers the WM Act and is required to assess the impact of any proposed controlled activity to ensure that no more than minimal harm will be done to waterfront land as a consequence of carrying out the controlled activity.

Waterfront land includes the bed and bank of any river, lake or estuary and all land within 40 metres of the highest bank of the river, lake or estuary.

This means that a controlled activity approval must be obtained from the Office of Water before commencing the controlled activity.

What is a riparian corridor?

A riparian corridor (RC) forms a transition zone between the land, also known as the terrestrial environment, and the river or watercourse or aquatic environment. Riparian corridors perform a range of important environmental functions such as:

- providing bed and bank stability and reducing bank and channel erosion
- protecting water quality by trapping sediment, nutrients and other contaminants
- providing diversity of habitat for terrestrial, riparian and aquatic plants (flora) and animals (fauna)
- providing connectivity between wildlife habitats
- conveying flood flows and controlling the direction of flood flows
- providing an interface or buffer between developments and waterways
- providing passive recreational uses.

The protection, restoration or rehabilitation of vegetated riparian corridors is important for maintaining or improving the shape, stability (or geomorphic form) and ecological functions of a watercourse.

Changes to controlled activities within riparian corridors

On 1 July 2012 new rules commenced regarding controlled activities within riparian corridors. The new rules amend the riparian corridor widths that apply to watercourses, providing more flexibility in how riparian corridors can be used and making it easier for applicants to determine the Office of Water controlled activity approval requirements. Key aspects of the changes include:

- Provision of greater flexibility in the allowable uses and works permitted within riparian corridors.
- The core riparian zone and vegetated buffer have been combined into a single vegetated riparian zone (VRZ).
- The width of the VRZ within the riparian corridor has been pre-determined and standardised for first, second, third and fourth order and greater watercourses.
- Where suitable, applicants may undertake non-riparian corridor works or development within the outer 50 per cent of a VRZ, as long as they offset this activity by connecting an equivalent area to the RC within the development site.
- A new 'riparian corridors matrix' enables applicants to determine what activities can be considered in riparian corridors.

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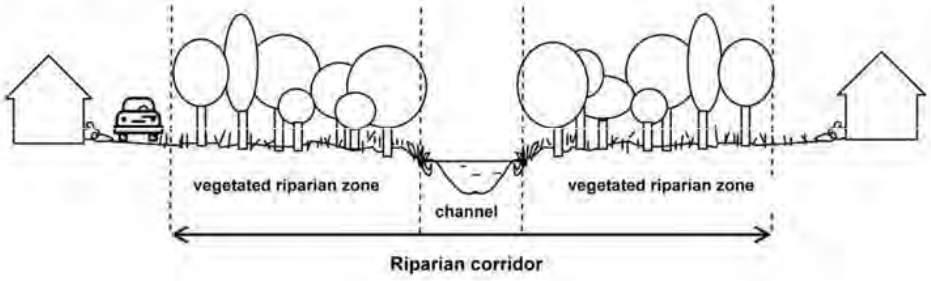
These changes will simplify the controlled activities application and assessment process, provide greater flexibility, help make more land available for housing, support floodplain, stormwater and bush fire management, and allow riparian corridors to be used for public amenity whilst continuing to deliver environmental outcomes required under the WM Act.

The riparian corridor consists of:

- the channel which comprises the bed and banks of the watercourse (to the highest bank) and
- the vegetated riparian zone (VRZ) adjoining the channel.

Figure 1. The riparian corridor



Riparian corridor widths

The Officer of Water recommends a VRZ width based on watercourse order as classified under the Strahler System of ordering watercourses and using current 1:25 000 topographic maps (see Figure 2 and Table 1). The width of the VRZ should be measured from the top of the highest bank on both sides of the watercourse.

Figure 2. The Strahler System

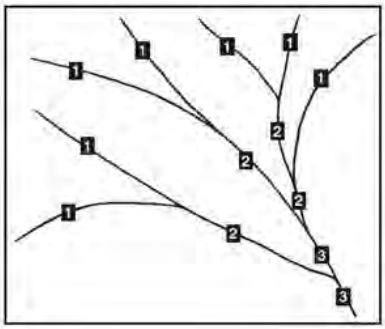


Table 1. Recommended riparian corridor (RC) widths

Watercourse type	VRZ width (each side of watercourse)	Total RC width
1st order	10 metres	20 m + channel width
2nd order	20 metres	40 m + channel width
3rd order	30 metres	60 m + channel width
4th order and greater (includes estuaries, wetlands and any parts of rivers influenced by tidal waters)	40 metres	80 m + channel width

Note: where a watercourse does not exhibit the features of a defined channel with bed and banks, the Office of Water may determine that the watercourse is not waterfront land for the purposes of the WM Act

Objectives for riparian corridor management

The overarching objective of the controlled activities provisions of the WM Act is to establish and preserve the integrity of riparian corridors.

Ideally the environmental functions of riparian corridors should be maintained or rehabilitated by applying the following principles:

- Identify whether or not there is a watercourse present and determine its order in accordance with the Strahler System.
- If a watercourse is present, define the RC/VRZ on a map in accordance with Table 1.
- Seek to maintain or rehabilitate a RC/VRZ with fully structured native vegetation in accordance with Table 1.
- Seek to minimise disturbance and harm to the recommended RC/VRZ.
- Minimise the number of creek crossings and provide perimeter road separating development from the RC/VRZ.
- Locate services and infrastructure outside of the RC/VRZ. Within the RC/VRZ provide multiple service easements and/or utilise road crossings where possible.
- Treat stormwater run-off before discharging into the RC/VRZ.

The Office of Water however, does allow for a range of works and activities on waterfront land and in riparian corridors to better meet the needs of the community, so long as they cause minimal harm as outlined in the riparian corridor matrix below.

Riparian corridor matrix

The riparian corridor matrix enables applicants to identify certain works and activities that can occur on waterfront land and in riparian corridors. Applicants should note that the matrix relates to controlled activity approvals under the WM Act only. They are still required to comply with other relevant government legislation, such as threatened species, flood planning levels and fisheries guidelines.

Table 2. Riparian corridor matrix

Stream order	Vegetated Riparian Zone (VRZ)	RC off-setting for non RC uses	Cycleways and paths	Detention basins		Stormwater outlet structures and essential services	Stream realignment	Road crossings		
				Only within 50% outer VRZ	Online			Any	Culvert	Bridge
1st	10m	•	•	•	•	•	•	•		
2nd	20m	•	•	•	•	•		•		
3rd	30m	•	•	•		•			•	•
4th +	40m	•	•	•		•			•	•

Key

Stream order: The watercourse order as classified under the Strahler System based on 1:25,000, 1:50,000 or 1:100,000 topographic maps whichever is the smallest scale available. A full list is provided at Part 2, Schedule 2 of the Water Management (General) Regulation 2011.

Vegetated riparian zone (VRZ): The required width of the VRZ measured from the top of the high bank on each side of the watercourse.

Riparian corridor (RC) off-setting for non RC uses: Non-riparian uses, such as Asset Protection Zones are allowed within the outer 50 per cent of the VRZ, so long as offsets are provided in accordance with the averaging rule as seen in Figure 3.

Cycleways and paths: Cycleways or paths no wider than four metres total disturbance footprint can be built in the outer 50 per cent of the VRZ.

Detention basins: Detention basins can be built in the outer 50 per cent of the VRZ or online where indicated. Refer to the Office of Water's *Controlled activities. Guidelines for outlet structures* and *Controlled activities. Guidelines for instream works*. Online basins must:

- be dry and vegetated
- be for temporary flood detention only with no permanent water holding
- have an equivalent VRZ for the corresponding watercourse order
- not be used for water quality treatment purposes.

Stormwater outlet structures and essential services: Stormwater outlets or essential services are allowed in the RC. Works for essential services on a fourth order or greater stream are to be undertaken by directional drilling or tied to existing crossings. Refer to the Office of Water's *Controlled activities. Guidelines for laying pipes and cables in watercourses* and *Controlled activities. Guidelines for outlet structures*.

Stream realignment: Indicates that a watercourse may be realigned. Refer to the Office of Water's *Controlled activities. Guidelines for instream works.*

Road crossings: Indicates permitted road crossing methods. Refer to the Office of Water's *Controlled activities. Guidelines for watercourse crossings* and NSW DPI policy and guidelines for fish friendly waterway crossings for Class 1 and 2 waterways.

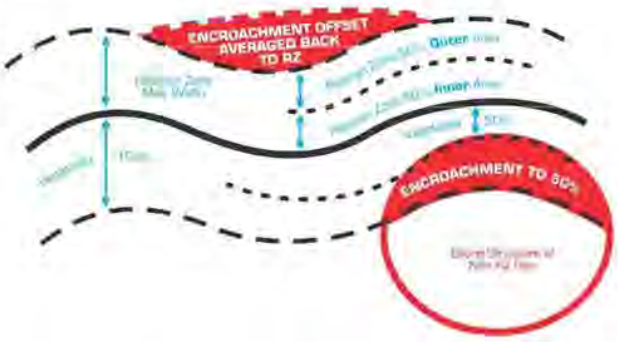
What is the averaging rule?

Non riparian corridor works and activities can be authorised within the outer riparian corridor, so long as the average width of the vegetated riparian zone can be achieved over the length of the watercourse within the development site. That is, where appropriate 50 per cent of the outer vegetated riparian zone width may be used for non-riparian uses including asset protection zones, recreational areas, roads, development lots and infrastructure. However, an equivalent area connected to the riparian corridor must be offset on the site (see Figure 3) and the inner 50 per cent of the vegetated riparian zone must be fully protected and vegetated with native endemic riparian plant species.

Bridges, cycleways, paths, stormwater oulets and other essential services do not need to be offset, but must comply with the requirements set out in the riparian corridor matrix (Table 2) and other relevant Office of Water controlled activities guidelines. Offline detention basins do not need to be offset so long as there is an equivalent VRZ for the corresponding watercourse and they are built in compliance with the Office of Water's *Controlled activities: Guidelines for watercourse crossings* and *Controlled activities: Guidelines for in-stream works*. If a proposed basin will not have an equivalent VRZ for the corresponding watercourse, it may still be built in the outer 50 per cent of the VRZ but must be offset.

The averaging rule should generally be applied to cleared waterfront land. Development proposals involving waterfront lands that contain existing native vegetation should seek to preserve that riparian vegetation in accordance with the minimum riparian corridor requirements outlined in Table 1.

Figure 3. Averaging rule



Applications for controlled activity approvals

Applications for controlled activities approvals should be informed by the riparian corridor matrix shown in Table 2 and prepared using the *Application for a Controlled Activity Approval for works on waterfront land* form and the *Guideline for completing an application for a Controlled Activity Approval*.

Other controlled activity guidelines are available on the Office of Water website and outline relevant considerations for applicants when proposing activities and works on waterfront lands.

Streamlined assessment

Where applications are presented in accordance with the riparian corridor matrix (Table 2) and other Office of Water controlled activity guidelines, they will be assessed under a streamlined process. This may decrease the amount of time it takes the Office of Water to make a determination, saving applicants time and money.

Applications that do not conform to the matrix and/or relevant Office of Water controlled activity guidelines will continue to be subject to merit assessment to ensure that the proposals meet the requirements of the WM Act. All applications will still need to demonstrate that minimal harm will occur to waterfront land before a controlled activity approval will be issued.

Where do I go for additional information?

Find out more about controlled activities at the Office of Water website www.water.nsw.gov.au.

Contact us

Contact a water regulatory officer as listed on the Office of Water website www.water.nsw.gov.au, free call the licensing information on 1800 353 104 or email information@water.nsw.gov.au.

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APPENDIX B – Engineering Issues

Bonville Rural Residential Area

Engineering Issues

September 2014

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1 INTRODUCTION

This report has been prepared as part of a Planning Proposal for the Bonville Rural Residential Area, and specifically to address the following major engineering issues relating to the proposed study area as defined in the original brief from Coffs Harbour City Council:

Description	Where details provided:
Acid Sulfate Soils (ASS)	Section 2 - ACID SULFATE SOILS
Geotechnical Assessment	Section 3 - GEOTECHNICAL ASSESSMENT
Topography	Section 4 - TOPOGRAPHY
Flood Liable Land	Separate Report
Contaminated Lands	Section 5 - CONTAMINATED LANDS
Water Services	Section 6 - WATER SERVICES
Sewerage Services	Section 7 - SEWERAGE SERVICES
Road Network	Section 8 - ROAD NETWORK
Infrastructure Costs and Staging	Section 9 - INFRASTRUCTURE COSTS AND STAGING

The Study Area is shown on **Figure 1 - Study Area**.

This report is based on the proposed Concept Master Plan for the Study area shown on **Figure 2 - Concept Master Plan**.

The proposed zonings in this Planning Proposal are shown on Figure LZN_001 in the Planning Proposal. The following development zoned areas result:

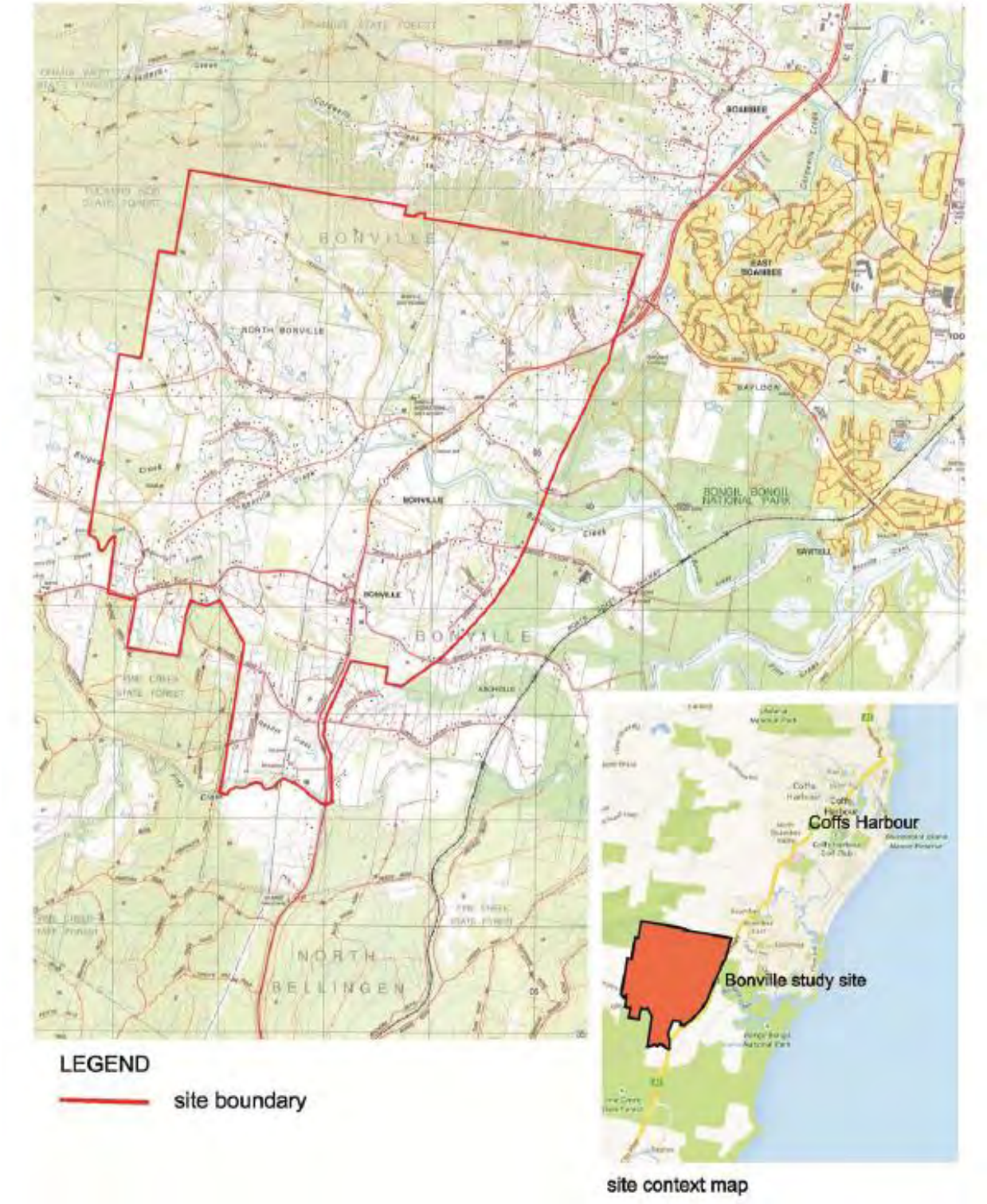
Zone	Area (ha)
Zone R5 - potential	462.3 ha

For the residential zones, we estimate the following lot yields:

Zone	Area (ha)	No of Tenements
Zone R5 (0.9 tenements /ha)	462	340

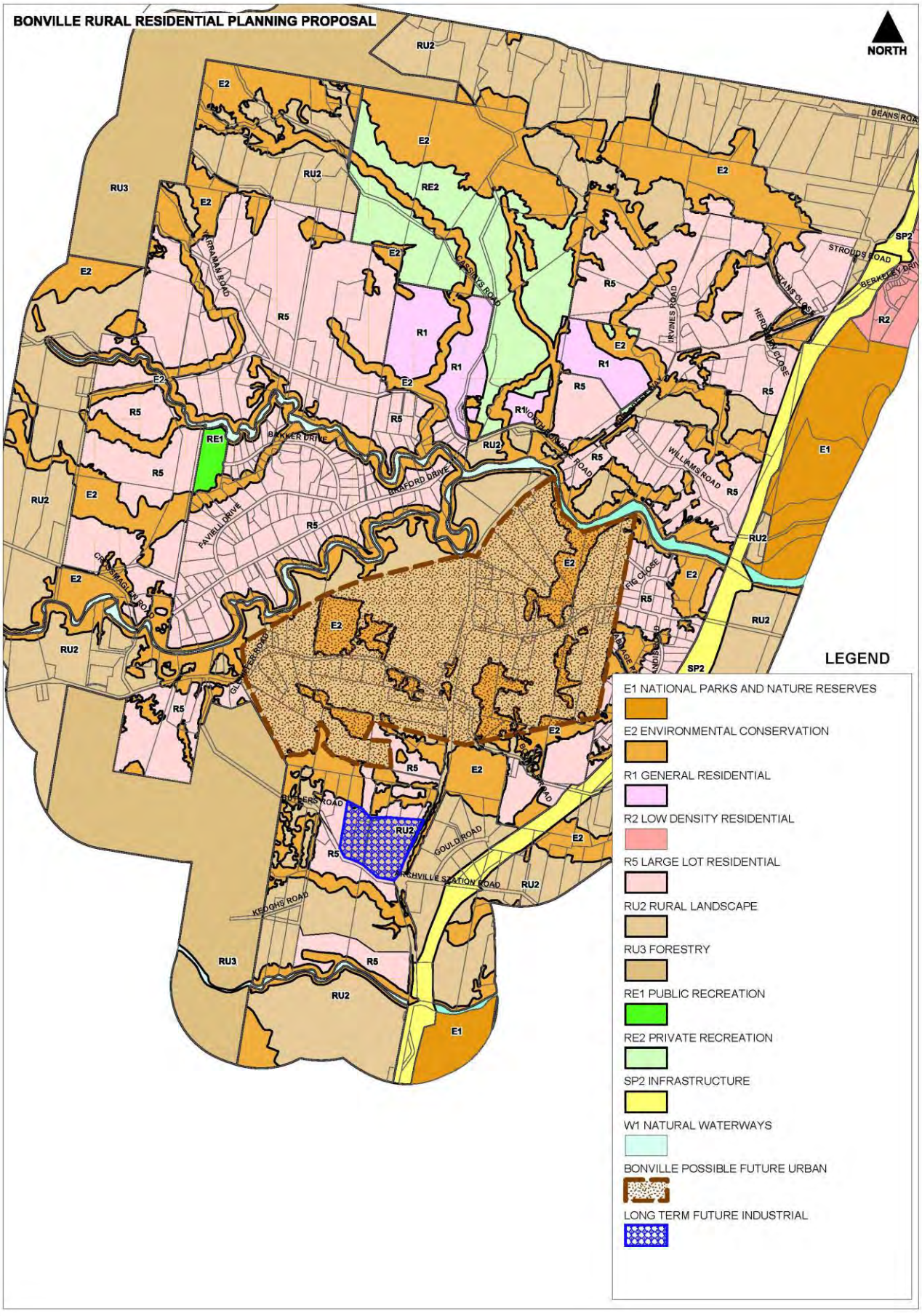
The existing development in the area comprises approximately 850 properties. As such when fully developed, the Study Area will comprise approximately 865 residential/rural properties.

Figure 1 - Study Area



Source: Jackie Amos Landscape Architect, September 2013

Figure 2 - Concept Master Plan



2 ACID SULFATE SOILS

2.1 Origins of Acid Sulfate Soils

Acid sulfate soils (ASS) are soils which contain significant concentrations of pyrite that, when exposed to oxygen in the presence of sufficient moisture, oxidize and generate sulfuric acids. Unoxidised pyritic soils are referred to as potential acid sulphate soils (PASS). When PASS are exposed the oxygen and the pyrite oxidises, they become actual ASS.

Pyritic soils typically form in waterlogged, saline sediments rich in iron and sulfate. The usual environment for the formation of acid sulphate soils are tidal flats, salt marshes and mangrove swamps below about RL 5m AHD. They can also form as bottom sediments in coastal rivers and creeks, ie as alluvial soils. Pyritic soils of concern on low lying coastal NSW and coastal lands have mostly formed in the Holocene period, (ie. 10,000 year ago to the present day) predominantly in the 7,000 years since the last rise in sea level. It is feasible that such conditions existed over the lower parts of the floodplains within the study area.

Disturbance of acid sulfate soils can generate substantial sulfuric acid, which can lower soil and water pH to levels below pH 4. Fish kills in coastal rivers are highly visible examples of consequences of acid sulphate generation. In addition, high salinity soils can adversely impact vegetation growth and can produce aggressive soil conditions detrimental to concrete and steel components of structures, foundations, pipelines and other engineering works.

2.2 Review of Available Mapping

Council's acid sulphate risk mapping has been extracted from their GIS system and is attached as Figure 3. This mapping was prepared by the Acid Sulfate Soils Advisory Committee, NSW Department of Land and Water Conservation, March 1998. It is predominantly based on surface elevation and landform. It is not known what, if any, actual field testing has been undertaken in the study area. The mapping provides:

Acid Sulfate Planning – Refer Figure 3 - Acid Sulfate Risk Mapping The mapping shows that the eastern portion of the site has Class 4 and 5 areas. These areas are defined as:

- Class 4 – Works beyond 2m below natural ground surface; works by which the water table may be lowered beyond 2m below natural ground level;
- Class 5 – Works within 500m of the above Classes of land which are likely to lower the water level by 1m on the adjacent Class of land.

The mapping does not anticipate acid sulfate soils to be present in the class 5 land. The class 5 land is rather a buffer and is included as major works, particularly drainage works, could conceivably impact on the water table in the adjacent class 4 or higher lands.

Where significant earthworks or drainage works are proposed within the classified lands, Council requires an acid sulphate assessment, and where present, a management plan.

2.3 Limited Field Investigations

Because the acid sulfate mapped areas have little impact on the candidate areas, the location and number of sampling points was significantly constrained. Two boreholes were excavated and three samples were collected from each, ranging from 0.5 to 2.0 metres deep. The samples where then

tested by Coffs Harbour Laboratory. The borehole locations are shown on Figure 4. The full test results are contained in APPENDIX A – Acid Sulfate Test Results and are summarised in table 2.1.

The samples were recovered from fine grained soils (silty clays). The action criteria for which acid sulfate management is required was taken from Table 4.4 of the Acid Sulfate Soil Manual (Ref 1).

Table 2.1 – Acid Sulfate Test Summary

Bore Hole	Action Criteria (1-1000 tonnes disturbed)	AS 1	AS 2
0.5 – 1.0m			
Equivalent Sulfur (%S)	>0.1	**0.14**	0.09
Equivalent Acidity (moles+/t)	>62	**90**	56
Lime requirement (kg/tonne)		9.5	4.2
1.0 – 1.5m			
Equivalent Sulfur (%S)	>0.1	**0.24**	**0.10**
Equivalent Acidity (moles+/t)	>62	**148**	**65**
Lime requirement (kg/tonne)		15.8	5.1
1.5 – 2.0m			
Equivalent Sulfur (%S)	>0.1	**0.19**	**0.16**
Equivalent Acidity (moles+/t)	>62	**117**	**100**
Lime requirement (kg/tonne)		12.5	7.6

2.4 Conclusions and Recommendations

Some of the land in the candidate areas lies across area identified as class 4 and 5 under Council's acid sulfate soil mapping. This land being the lower floodplain of Bonville / Pine Creeks, and along the eastern portion of the study area. Class 4 lands may contain acid sulfate soils and, depending on the depth and extent of any proposed earthworks and drainage works, further investigation and possible management is required.

Limited fieldwork was undertaken to gauge if acid sulfate soils are present. These however did find mild acid sulfate, sufficient to require management.

Due to flood constraints, any proposed development in these areas will generally involve filling the land. Filling the land is unlikely to expose any potential acid sulfate soils to oxidation.

It is recommended that Council's existing policies of requiring acid sulfate assessment and, where present, management, be retained for the class 4 and 5 lands in Bonville Candidate Areas.

As is generally found along the lower creek lines around Coffs Harbour, mild acid sulfate soils will be found in places. Management practices will be required such as treatment with lime. The investigations and management will add to the cost of development. However, as the extent of deep excavation will be limited and the likelihood of high acid sulfate soils is low, it is not expected that managing acid sulfate soils will be a significant constraint. Testing and management of acid sulfate soils will not significantly impact on the viability of development.

3 GEOTECHNICAL ASSESSMENT

3.1 Investigation

The geotechnical investigation was limited to the areas identified as potentially developable once environmental and riparian buffer constraints were applied. Within these areas the investigation was general or 'broad brushed' in nature. It comprised limited walk over and very limited sub-surface investigations. Figure 4 shows the location of bore holes.

3.2 Geotechnical Description

Across the investigation area the topography is that of moderate to steep slopes falling to gentle limited floodplains adjacent several creek lines. The general profile of soils underlying the site is:

- Under the sloping terrain – residual, having weathered from the underlying rock which, according to the 1:250,000 Geological Series Mapping (Ref 2), Sheet SH 56 – 10 & 11, is siliceous argillite, slate, rare siliceous greywacke from the Brooklana Formation of the Carboniferous period. The slopes are dominated by residual soils, that is, soils that have formed in their current location by the weathering of the underlying rock. Some slopewash may be present in isolated areas below steep slopes. Slopewash is soil that has been washed down from up-slope and deposited.

- Under the flood plains, either residual as above, or alluvial, having formed through deposition from the creeks.

The natural residual soil on the slopes is cohesive (silty clay) in nature and is generally fairly shallow. Weathered rock can be expected within several metres depth. On the steeper slopes where erosion is typically acting faster, weathered rock can be at quite shallow depths. Topsoil on the slopes is typically 100-200mm in depth. Across the floodplain the soil profile is more variable and can be significantly deeper in alluvial areas.

The hydrology of the site is that of steep sided valleys with hydraulically steep creeks. The major stream lines, including Newports Creek, flow west to east. There are many smaller ephemeral water courses feeding these streams. The overall catchment extends beyond the study area, but not substantially so. Rainfall is high and frequent with only moderate seasonal variation. Drier times are late winter & early spring.

The depth to bedrock also varies significantly. Across the higher and steeper slopes, where erosion is greater, the soil profile is quite shallow. Extremely weathered rock is typically found at 0.5 to 2.0 metres deep, firming to weathered then had rock within a few metres. Across the floodplains the range of soil depth will be greater. Deep soil depths of over 6 metres are likely, particularly near the creeks and through alluvial soils.

The residual soils are typically silty clays of medium plasticity and range in colour from browns, reds and greys. On the steeper slopes significant gravel and cobbles are often present in the soil. The borehole logs can be found in APPENDIX B – Bore Hole Logs.

The soils and geology is typical for Coffs Harbour and its valleys. They are not prone to slope instability, although the steep slope in places do pose a hazard, refer to the following section.

3.3 Suitability of Development

Notwithstanding slope hazard in limited areas, as discussed in section 4, the soils and underlying geology are generally not expected to significantly constrain development potential. The relatively shallow residual soils on the slopes are not expansive. Coupled with fairly consistent climate, they generate only low to moderate shrink/swell potential. The residual soils, and ancient alluvial soils will generally provide adequate bearing capacity for conventional low rise building construction. Younger alluvial soils may pose bearing capacity constrains although these are likely to be fairly limited in area adjacent the creek lines.

Shallow hard rock is likely to be present under some of the steeper land. In such locations excavations of over a few metres depth may be hindered by hard rock.

Acid sulphate soils may be present in very limited areas of the lower floodplains, refer to Section 2.

3.4 Site Classification for Residential Slabs and Footings.

The residual soils underlying much of the proposed residential land will generally warrant an 'M' classification in accordance with AS2870. Class 'M' is for moderately reactive sites. Such a classification calls for raft slabs stiffened with edge and internal beams and for slightly stiffer strip footings than the minimum. Based on local performance, some class 'S' sites, for slightly reactive, may be suitable. Class 'A' for negligible reactivity and class 'H' for highly reactive, will be rarely, if at all, warranted.

Class M sites are the norm for Coffs Harbour and do not pose a significant development cost over the lesser classifications, typically only a few percent of the construction cost.

A greater constraint to footing and slab design will be slope. Slab on a cut to fill earthworks pad is the most economical flooring system for residential construction. However, on slopes of over about 15% such construction generally leads to fill depth in excess of that allowed in AS2870, resulting in a 'P' classification. 'P' refers to problem sites where footings and slabs need to be designed by engineering principals. On slopes with fill, this generally results in class M slabs with additional reinforcement and supported on bored piers. The greater the slope, the deeper the fill and the greater the number and depth of piering. Regardless, slab on ground construction, possibly with steps and retaining elements, remains competitive with strip footings and suspended floors until slopes of about 20 – 25%. The cost of residential construction significantly increases on slopes of over about 25%. **Error! Reference source not found.** shows the distribution of slope classes across the evelopment areas. There are significant areas where slope is greater than 15% although minimal above 28%.

Areas of poor founding soils may be present across the floodplains where soft alluvial soils have accumulated during past creek meandering. The locations of such have not been identified in this study. If and where present they may add to development costs, but overall, are not anticipated to present a significant development constraint.

With respect to bulk earthworks during subdivision, such work should be undertaken in accordance with AS3798. All fill under buildings and roadways should be placed with compact control, testing and reporting. Fill plans, reports and provisional site classifications should be a council requirement, as is current practice.

Slab and footings across the proposed industrial land will depend on loads and be a mixture of shallow footings founding in filled or natural soils and deeper piered/piled footings to rock. The proposed industrial areas, generally across the floodplains, pose similar ground conditions to the adjacent Isle Industrial Estate. The placement of fill and subsequent development through the Isle estate has proved entirely viable.

3.5 Recommendations

The geotechnical conditions across the proposed development areas do not pose a major constraint. Slope, as discussed in Section 4, will have the greatest effect of development. The residual soils will typically yield an M classification in accordance with AS2870 although this will give way to a P classification on the steeper slopes.

This investigation is general in nature and, apart from limited field work, relies on local experience in the design and construction of residential footings throughout the Coffs Harbour region over the Brooklana Formation. This investigation does not obviate the need for site specific investigations as part of individual development.

It is recommended that Council retain existing policies that require individual site classifications and the engineering design of slabs and footings, plus compaction control of subdivision earthworks. Notwithstanding the recommendations of section 4, no additional planning and policy requirements are recommended.

4 TOPOGRAPHY

4.1 Topographical Description

The topography of the study area is that of moderately steep sided valleys and ridgelines with incised gullies draining to two main creek lines. These flow west to east within limited floodplains. The ground level within the study area varies from 5 to 170 mAHD, although not far beyond the study boundary the land continues to rise to ridgelines that in places exceed 300 m in elevation. Figure 5 provides contour mapping of the study area.

4.2 Slope Hazard

Within the study area the topographical characteristic of most importance to development potential is slope, and specifically, steep slopes. The steeper the slope the greater the erosion potential and risk of instability (land slips, slumps & soil creep). Steep slopes also increase bush fire hazard. These issues can be managed to an extent although only at increasing costs. As slopes increase beyond about 25%, the costs of constructing roads, infrastructure, building footings and retaining structures increases significantly and is generally uneconomic by about 40%. Industrial developments generally require even gentler slopes due to their larger building footprints.

The risk of slope instability is not solely a function of slope gradient, but is also influenced by the composition and depth of the soil, underlying geology and climate, specifically rainfall. The geology underlying the study area is that of the Brooklana Formation, refer to Section 3 – Geotechnical Assessment. The soil profiles across the study area vary and are somewhat related to slope:

Across the gentle floodplains the soil origin is either residual soils (soils that have formed in their current location by the weathering of the underlying rock) or alluvial (soils that have formed by deposition, in this case by action of the creeks). The depth to bedrock is likely to vary from several metres to many metres. Due to its inherent gentle slope, the floodplains are at very low risk of instability. However, due to flooding, they are at risk of erosion.

The soils of the valley sides are nearly exclusively residual in origin and are generally fairly shallow. There may be some locations, particularly below very steep areas, where slope wash will be present. Slope wash is akin to alluvial, in that it has been deposited rather than forming in place. The soil has either slipped or has been washed down from above. Slope wash is more likely to be found in and adjacent the steep incised gullies.

The physical properties and mineralogy of the Brooklana formation and its residual soils is not specifically prone to erosion or instability. The residual silty clay soils typically have an undrained internal angle of friction of between 20 & 25° (36 – 47%). The underlying rock is not known for steeply angled clay seams. Well vegetated and drained slopes of well in excess of 50% gradient prove to be stable throughout the region.

Based on local experience in similar topography and geology, and with reference to the Australian Geomechanics Society (Ref 3 & Ref 4), the study area was divided into four geotechnical hazard classes based on a qualitative risk assessment. The classes are summarised in Table 4.1 below.

Table 4.1 – Geotechnical Hazard Classes

Class	**A**
Gradient	0 – 15% (<9°)
AGS Hazard	Very low to low.
Possible Hazard	Land slip, flow.
Likelihood	Minimal
Consequence	Minor
Further investigation	Nil
Management	Conventional road and subdivision design and construction. Seepage and springs may be present at the base of steeper slopes.
Comments	Suitable for development, cost of slope and erosion management will be relatively low. Road construction can generally be on grade. Significant earthworks are unlikely to be warranted. Economic residential slab on ground construction will generally be suitable, possibly with low retaining walls.
Class	**B**
Gradient	15% – 30% (9 – 16°)
AGS Hazard	Moderate risk.
Possible Hazard	Land slip, flow.
Likelihood	Possible, increased in extreme weather.
Consequence	Medium.
Further investigation	Limited – desktop and walkover slope stability investigation.
Management	Exceeds maximum gradient limits for some road classes. May require significant earthworks and possible retaining structures for road construction. Slope assessment of significant cut and fill batters required. Footing and drainage design to consider slope hazard.
Comments	Suitable for development, but at greater cost. Road and lot layout may be partly constrained. Larger residential lots (>600 sq.m) preferred to provide greater room for batters and retaining. Not suitable for large slab on ground construction unless narrow and shaped along the contour. More expensive suspended floors likely. Access and driveway gradients need to be considered. Deeper piered footing more likely required. Drainage design important.
Class	**C**
Gradient	30% – 40% (16 – 22°)
AGS Hazard	High risk.
Possible Hazard	Land slip, flow, creep.
Likelihood	High, increased in extreme weather.
Consequence	Medium.
Further investigation	Desktop, walkover and limited sub-surface investigation recommended.
Management	All aspects of design need to consider the slope hazard. Deep fills to be avoided unless engineered to ameliorating the slope. Significant retaining structures will be required. Deep piered footings required.
Comments	Expensive to develop, may be uneconomic. Access driveways & roads will generally be in concrete and will have to cut across the slope as too steep otherwise. Earthworks to be generally limited. Larger lots preferred, Light weight building construction with suspended floors and piered footings required. Drainage design important.
Class	**D**

Table 4.1 – Geotechnical Hazard Classes

Gradient	>40% (>22°)
AGS Hazard	Very High risk.
Possible Hazard	Land slip, flow, creep, rock topple.
Likelihood	High, increased in extreme weather.
Consequence	Major.
Further investigation	Detailed desktop, walkover, sub-surface and slope analysis required.
Management	All aspects of design needs to address slope hazard. Substantial retaining and stabilising structures will be required.
Comments	Generally uneconomic to develop and manage risk. Specialist design and construction needed.

4.3 Hazard Mapping

Figure 6 shows the slope hazard classes across the proposed development areas. These figures are based on the existing ground slope average across 10 by 10 m grid cells. The slope being derived from Council's aerial laser survey data. The following is noted:

- The majority of proposed residential land, zoned R1 & R2 lies within class A, although a significant portion lies within class B. There are a few small areas of class C.

- The vast majority of proposed industrial land lies within class A, with only a small fraction within class B (excluding lot 1 DP 129036). This was the intent in assigning the proposed zoning as slope is a greater constraint to industrial developments than residential. Note, Lot 1 DP 129036 is currently used as storage and maintenance yards for Peter Ryan Earthmoving and its rezoning as industrial is a logical step to better reflect is current use.

- The proposed large lot residential, zoned R5, is approximately evenly split between class A and B plus some areas of class C.

4.4 Recommendations

There are several options available to developers and Council to manage the risk posed by the steeper land. The following is recommended:

Class A Land:

No specific planning controls are warranted. Conventional engineering design and construction practices are acceptable.

Class B Land:

No specific planning controls are recommended. The risk can be managed through good hillside engineering practice at both the subdivision and individual development stages. As part of any development or construction application, council should review and be satisfied that such practice is implemented. A summary of good hillside design is given in APPENDIX C – Slope Hazard.

Class C Land, all zones other than R5:

Much of the class C land is relatively small in size and width. At subdivision stage it could be ameliorated through bulk earthworks to reduce gradients. Alternatively, the locating of roads and individual lots can be adjusted to accommodate the steeper land. The indicative road layout in **Error! eference source not found.** is an example. Residential lots containing Class C land can be expanded and adjusted to provide sufficient area of Class A or B land within the lot for dwelling construction.

No specific planning controls are recommended at subdivision stage other than to ensure good hillside engineering design and construction practice.

At the individual development stage, it is recommended that a stability assessment be undertaken for any significant building works on or immediately up/downslope (within 10m) of class C land.

Class C Land zoned R5

Within the proposed R5 lands the extent of Class 'C' land is larger and it will not be economic to address through earthworks. It is recommend that:

- At subdivision stage, a stability assessment be undertaken for any road or services infrastructure proposed across or immediately up/downslope (within 10m) of class C land.
- At subdivision stage, lots be sized to ensure sufficient area for dwelling construction (say 750 m^2) is available within class A or B land.
- At the individual development stage, a stability assessment be undertaken for any significant building works on or immediately up/downslope (within 10m) of class C land.

Class D Land, all zoning.

There is very little class D land within the proposed areas. At both subdivision and individual development stage, a detailed slope assessment will be required for any works in or within 10 metres of class D land.

5 CONTAMINATED LANDS

5.1 Site History

Prior to European settlement, the site would have been heavily vegetated in native forest with only rare impact from fire. Clearing and agriculture commenced in the 19th century, expanding roughly to its current extents by the mid 20th. Significant areas of land were cultivated. Most notably bananas were cultivated over the east, north and west facing slopes. The flatter floodplains were also cleared and mainly used for stock grazing. In addition to clearing and agriculture, development of roads, dwellings, storage sheds, yards and small on-stream dams have occurred over the years.

Council's mapping identifies areas that have been subject to cultivation in the past, as shown on Figure 7. Possible soil contamination exists through these areas and through areas of current cultivation due to the use of pesticides and herbicides. The use of arsenic in pesticides and herbicides during the 1940s to 1960s is considered a definite possibility, if not likely, source of soil contamination.

5.2 Previous Investigations

Many of the existing residential sites within the study are have had building envelopes tested by de Groot & Benson for possible chemical contamination. The location of these sites is shown on Figure 4 - Geotechnical and Chemical Test Locations.

5.3 Fieldwork and Sampling

Pesticide and herbicide practices in areas of present and past banana cultivation was identified as the most likely source of any wide spread soil contamination. A soil sampling regime was prepared with reference to Ref 8 and Ref 9. It was beyond the scope of this investigation to undertake the sampling and testing in full accordance with Ref 8 which requires a 25 x 25 m grid. This would have resulted in approximately 1,000 sampling points and excessive laboratory costs.

No specific field testing was undertaken for this study; rather the results of the previous investigation reference in Section 5.2 were examined. Copies of the results are contained in Appendix D.

5.4 Assessment and Results

The soil investigation levels (SILs) for urban development sites in NSW found in column 1 of Appendix II of "*Contaminated Sites, Guidelines for the NSW Site Auditor Scheme (2nd Edition)*" (Ref 7) were adopted for this assessment as the concentrations defining site contamination.

For all parcels, except C19, the anticipated source of contamination is that of widespread application of pesticides/herbicides to the land. In these circumstances no reduction to the SILs to account for the composite nature of the sample is appropriate, as per method 2 section 6 of "*Contaminated Sites, Sampling Design Guidelines*" (Ref 8).

For parcel C19, where hot spots may be present, the SILs were divided by the number of sampling points as per method 1 from Ref 9.

The full laboratory test results can be found in APPENDIX D – Contamination Testing .

The results are varied. Some building envelopes had chemical levels below threshold and some had levels above threshold.

All sites with high levels were able to be successfully remediated to comply with EPA guidelines.

5.5 Conclusions and Recommendations

This preliminary investigation has concentrated on possible soil contamination from pesticide and herbicide use within past and present areas of cultivation. It has found:

- In many locations the arsenic concentration is well above what can be expected for the naturally occurring or background levels of arsenic, which is typically less than about 10 mg/kg. This signifies that arsenic has been applied to the land. .

- Some envelopes had low concentrations, consistent with background levels. This suggests that arsenic may not have been used over these parcels. This implies recent cultivation only, well after the use of arsenic.

- The remaining envelopes had elevated arsenic levels, but below the SIL.

  The concentrations of lead were all comfortably below the SIL.

- Traces of Dieldrin, DDE, DDD & DDT were also found in some envelopes although all were well below their SILs. All other organochlorines tested for were not found within the detection limits of the laboratory equipment.

- No organphosphates tested for were found in any parcel within the detection limits of the laboratory equipment.

It can be concluded that arsenic contamination is present across past banana land in the Bonville area. This finding is entirely consistent with past banana land across the Coffs Harbour region.

Council's existing land contamination policies should be applied to any proposed development within the Bonville region. This assessment has not been prepared in sufficient detail, in terms of sampling density, to satisfy Council's policy requirements. All proposed development within present and past cultivated areas should be subject to soil contamination assessments and where contamination is identified a remediation plan be prepared for Council's consideration.

As has been found in other areas, it is anticipated that the arsenic contamination can be readily remediated, generally through on-site vertical mixing. The cost of further investigation, and remediation if required, will fall to the developer. While an additional burden, it is not expected to significantly constrain the land's development potential.

6 WATER SERVICES

6.1 Current Strategy Study

No reticulated water supply is available in the Study Area.

Council have indicated that properties in the Study Area will need to install water tanks for their potable water supply.

7 SEWERAGE SERVICES

7.1 Current Strategy Study

The Coffs Harbour Sewerage Strategy Study, 1998 (Ref 10) (CHSSS) developed a sewerage strategy for the City. It does not extend to the Study Area.

It is noted that the recently rezoned areas around the Bonville International Golf Course will be provided with reticulated sewerage services. However, this is solely for this developments use.

The balance of the Study Area will need to rely on on-site effluent disposal. This has been investigated in a separate report.

8 ROAD NETWORK

8.1 Existing Road Hierarchy

At present, the two main roads serving the study area are Pine Creek Way and the Pacific Highway

- Pine Creek Way was formerly the Pacific Highway and became a Council road several years ago
- Pacific Highway. This is a dual lane divided carriageway. There is limited access to the highway. Interchanges are provided at Lyons Road / Pine Creek Way in the north and Archville Station Road located approximately mid Study Area

The various properties are accessed off a rural class roads which connect to Pine Creek Way which runs as a spine, north /south through the Study Area.

8.2 Traffic Generation from the Study Area

The average daily traffic generation from the Study Area after full development is summarised below in Table 8.1

Table 8.1 – Study Area Traffic Generation

Development Type	Traffic Generating parameter	AADT (veh/day)
Existing Development	850ET @ 10vpd / ET	8,500 veh/day

Possible Development (460 ha)	415 ET @ 10vpd / ET	4,150 veh/day
Total	**1,000 ET**	**12,650 veh / day**

In terms of assignment to the two main roads leaving the Study Area, our expectation is as follows:

- Pine Creek Way (at Lyons Road) – 6,800 veh /day
- Pine Creek Way (at Archville Station Road) – 4,600 veh /day
- Pine Creek Way (south to Mailmans Track Road) – 1,250 veh /day

Under Clause 2.9 of Section 041 Geometric Road Layout of Council's AUS-SPEC guidelines, both road would be classed as Local Sub-Arterial Roads as their daily traffic is above 6,000 veh/day.

8.3 Existing Road Network Audit.

An audit was carried out of the existing road network. The results are contained in APPENDIX E – Road Audit.

8.4 Proposed Road Upgrading.

In accordance with the study objectives, road upgradings is proposed to bring the local road network up to AUS-SPEC standards. These are detailed in Appendix E and shown on Figure 8.

8.5 External Impacts

The major external impacts of the proposed development are on the roundabout at the intersection of Pine Creek Way / Pacific Highway off ramp and Lyons Road.

It is our understanding that this intersection was designed for the development of the Bonville area

8.6 Proposed Footpath and Cycleway Routes

Because of the rural nature of the Study Area, no footpaths or cycleways are proposed

9 INFRASTRUCTURE COSTS AND STAGING

9.1 Scope

Based on the nexus of location and required works, the various upgrading works were divided into 4 catchment Areas. The areas are shown on Figure 8. The various candidate areas in each catchment is shown below:

Catchment	Candidate Areas	Works Required
Catchment 1	Candidate Areas 13, 14,1 5, 16	• Road upgradings to Williams Road, Herdegen Close, Titans Close, Irvines Road • Bus Shelter
Catchment 2	Candidate Areas 2, 3, 4, 5 and 6	• Road upgradings to Yarraman Road, North Bonville Road, Crossmaglen Road • Bus Shelter • New Bridges on Nth Bonville Road and Crossmaglen Road
Catchment 3	Candidate Areas 8 and 9	• Road upgradings to Butlers Road (part), Keoghs Road (part) • Bus Shelter
Catchment 4	Candidate Areas 10 and 11	• Road upgradings to East Bonville road (part)

Figure 8– Section 94 Contributions – Designated Works shows the main infrastructure to be included in a Section 94 contributions plan.

The costing of these items is detailed in Appendix E and summarised below in Table 9.1– Section 94 Cost Estimates.

Table 9.1– Section 94 Contribution Cost Estimates – Traffic Management

Catchment 1	Candidate areas		No of Lots	Contribution	Other Plans	TOTAL
	13,14,15,16					
Total Road Costs	$787,020					
Other Costs						
- Bridge						
- Bus Shelter	$20,000					
SubTotal	$807,020					
Survey Investigation and Design (15%)	$121,053					
Contingency (15%)	$139,211					
TOTAL	**$1,067,283.95**		**124**	**$8,607.13**	**$4,779.00**	**$13,386.13**

Catchment 2	Candidate areas		No of Lots	Contribution	Other Plans	TOTAL
	2,3,4,5 & 6					
Total Road Costs	$1,465,683					
Other Costs						
- Bridges (Nth Bonville Rd & Crossmaglen Rd)	$900,000					
- Bus Shelter	$40,000					
SubTotal	$2,405,683					
Survey Investigation and Design (15%)	$360,852					
Contingency (15%)	$414,980					
TOTAL	**$3,181,515.77**		**175**	**$18,180.09**	**$4,779.00**	**$22,959.09**

Catchment 3	Candidate areas		No of Lots	Contribution	Other Plans	TOTAL
	8 & 9					
Total Road Costs	$556,225					
Other Costs						
- Bus Shelter	$20,000					
SubTotal	$576,225					
Survey Investigation and Design (12.5%)	$72,028					
Contingency (15%)	$81,031.64					
TOTAL	**$729,284.77**		**30**	**$24,309.49**	**$4,779.00**	**$29,088.49**

Catchment 4	Candidate areas		No of Lots	Contribution	Other Plans	TOTAL
	10 & 11					
Total Road Costs	$174,640					
Other Costs						
- Bridge						
- Bus Shelter	$0					
SubTotal	$174,640					
Survey Investigation and Design (15%)	$26,196					
Contingency (15%)	$30,125.40					
TOTAL	**$230,961.40**		**11**	**$20,996.49**	**$4,779.00**	**$25,775.49**

10 REFERENCES

Ref 1 – Acid Sulfate Soil Manual, (Acid Sulfate Soil Management Advisory Committee, August 1998).

Ref 2 - Dorrigo – Coffs Harbour, 1:250,000 Geological Series Sheet SH 56 – 10 & 11, (Geological Survey of NSW & University of New England, 1966)

Ref 3 - Guideline for Landslide Susceptibility, Hazard and Risk Zoning for Land Use Planning, (Journal and News of the Australian Geomechanics Society Volume 42 No 1 March 2007)

Ref 4 - Landside Risk Management Concepts and Guidelines, (Australian Geomechanics Society, Sub-Committee on Landslide Risk Management, March 2000)

Ref 5 - Contaminated Sites, Guidelines for Consultants Reporting on Contaminated Sites (NSW Government, Office of Environment & Heritage, 2011, ISBN 0 7310 3892 4).

Ref 6 - Soil Pesticides Residue Survey North Boambee Valley Coffs Harbour, August 1991 (NSW Agriculture).

Ref 7 - Contaminated Sites, Guidelines for the NSW Site Auditor Scheme (2nd Edition). (Department of Environment and Conservation, April 2006, ISBN 1 74137 859 1

Ref 8 - Contaminated Sites, Sampling Design Guidelines. EPA NSW.

Ref 9 - Guidelines for Assessing Banana Plantation Sites (EPA NSW 1997)

Ref 10 - Coffs Harbour Water Supply Strategy Study - Final Report, February 1999, de Groot & Benson Pty Ltd

Ref 11 - Section 041 Geometric Road Layout of Development Specification – Design by Coffs Harbour City Council, January 2009.

Ref 12 – Traffic Assessment for "Elements" Subdivision, Stadium Drive, Coffs Harbour, for Plantations CHS Pty Ltd, May 2013; prepared by de Groot & Benson Pty Ltd

FIGURES