



Benchmark
Environmental Management

Devil's Pulpit Pacific Highway Upgrade Compensatory Habitat Assessment


Lot 21 DP 755601 and Lot 2 DP 1112483, 1457 Myall Creek Road Bungawalbin



19 December 2012

LOT 21 DP 755601 and Lot 2 DP 1112483, 1457 MYALL
CREEK ROAD BUNGAWALBIN
COMPENSATORY HABITAT ASSESSMENT

19 December 2012

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EXECUTIVE SUMMARY

BEM was contracted by RMS to undertake a compensatory habitat assessment of Lot 21 DP 755601 and Lot 2 DP 1112483, 1457 Myall Creek Road Bungawalbin to enable consideration of the subject land for inclusion in a Biodiversity Offset Package for the Devil's Pulpit Pacific Highway Upgrade.

A detailed flora survey and habitat assessment of the subject land was undertaken over three days on 2, 5 and 6 November 2012.

Vegetation Communities

Six native vegetation types were identified on the subject land. They comprise:

- Forest Red Gum-Swamp Box of the Clarence Valley Lowlands of the North Coast;
- Narrow-leaved Red Gum Woodlands of the Lowlands of the North Coast
- Paperbark Swamp Forest of the Coastal Lowlands of the North Coast;
- Grey Gum-Grey Ironbark Open Forest of the Clarence Lowlands of the North Coast;
- Flooded Gum - Tallowood - Brush Box Moist Open Forest of the Coastal Ranges of the North Coast;
and
- Freshwater Wetland Lagoons.

Four of these vegetation types are representative of Endangered Ecological Communities (EECs) as listed on the *Threatened Species Conservation Act 1995* (TSC Act). All of the native vegetation present on the subject land is in benchmark condition which equates to the vegetation community having an intact structure and all vegetation layers being dominated by native species.

Threatened Flora Species

No threatened flora species were recorded on site during the field surveys. However, the subject land contains potential habitat for 30 threatened plant species.

Habitat Types

The subject land contains a mosaic of five habitat types:

1. Grassy Dry Open Forest (includes grassy and shrub elements);
2. Swamp Sclerophyll Forest;
3. Moist Open Forest;
4. Riparian Forest; and
5. Cleared land.

The conservation value of habitat types on the subject land ranges from high in the dry open forest and riparian habitats to low in the cleared land habitat.

Threatened and Migratory Fauna

The subject land provides known habitat for two threatened species, black bittern and giant barred frog. The site also provides potential habitat for an additional 31 threatened fauna species. Of these, the subject land provides sufficient habitat resources to support the complete lifecycles of 20 threatened fauna species.

The subject land provides known habitat for four migratory fauna species and potential habitat for an additional four migratory species.

Habitat Connectivity

The subject land provides important local and regional habitat connectivity functions. The subject land connects Bungawalbin NR with extensive floodplain forest and riparian habitats retained on private land. The site also provides an important riparian corridor, linking most of the lowland dry sclerophyll forest in the Bungawalbin Catchment including several conservation reserves. The subject land is also recognized as a regional wildlife corridor.

Conclusions

The subject land compares favourably with the selection criteria for offset lands as stipulated in the Pacific Highway Upgrade Devil's Pulpit Biodiversity Offset Strategy. The subject land has many features that make it suitable for acquisition as part of a compensatory habitat package for the upgrade project or other RMS projects in the Northern NSW Bioregion, including:

- close proximity to the upgrade project;
- it adjoins existing conservation reserves and other large tracts of native vegetation;
- it contains a diverse range of habitat types that provide suitable habitat resources for 33 threatened fauna species and 30 threatened flora species;
- it contains a wide range of key habitat components for threatened fauna;
- it contains three EECs covering a total of 271.32 hectares; and
- it provides important local and regional wildlife corridor functions.

In conclusion, the subject land would be a worthy acquisition either as part compensation for the upgrade project or as compensatory habitat for other RMS projects in the North Coast Bioregion.

1. INTRODUCTION

1.1 Background

Roads and Maritime Services (RMS) is in the process of upgrading the 7.3 kilometre section of the Pacific Highway commencing approximately 65 kilometres north of Grafton and extending to approximately 73 kilometres north of Grafton (*Figure 1.1*). The upgrade forms part of the Pacific Highway Upgrade Program, a joint commitment by the NSW State Government and the Federal Government to upgrade the Pacific Highway between Hexham and the Queensland border. The project involves upgrading the existing highway to dual carriageways with the introduction of local service roads, generally within or adjacent to the existing road reserve.

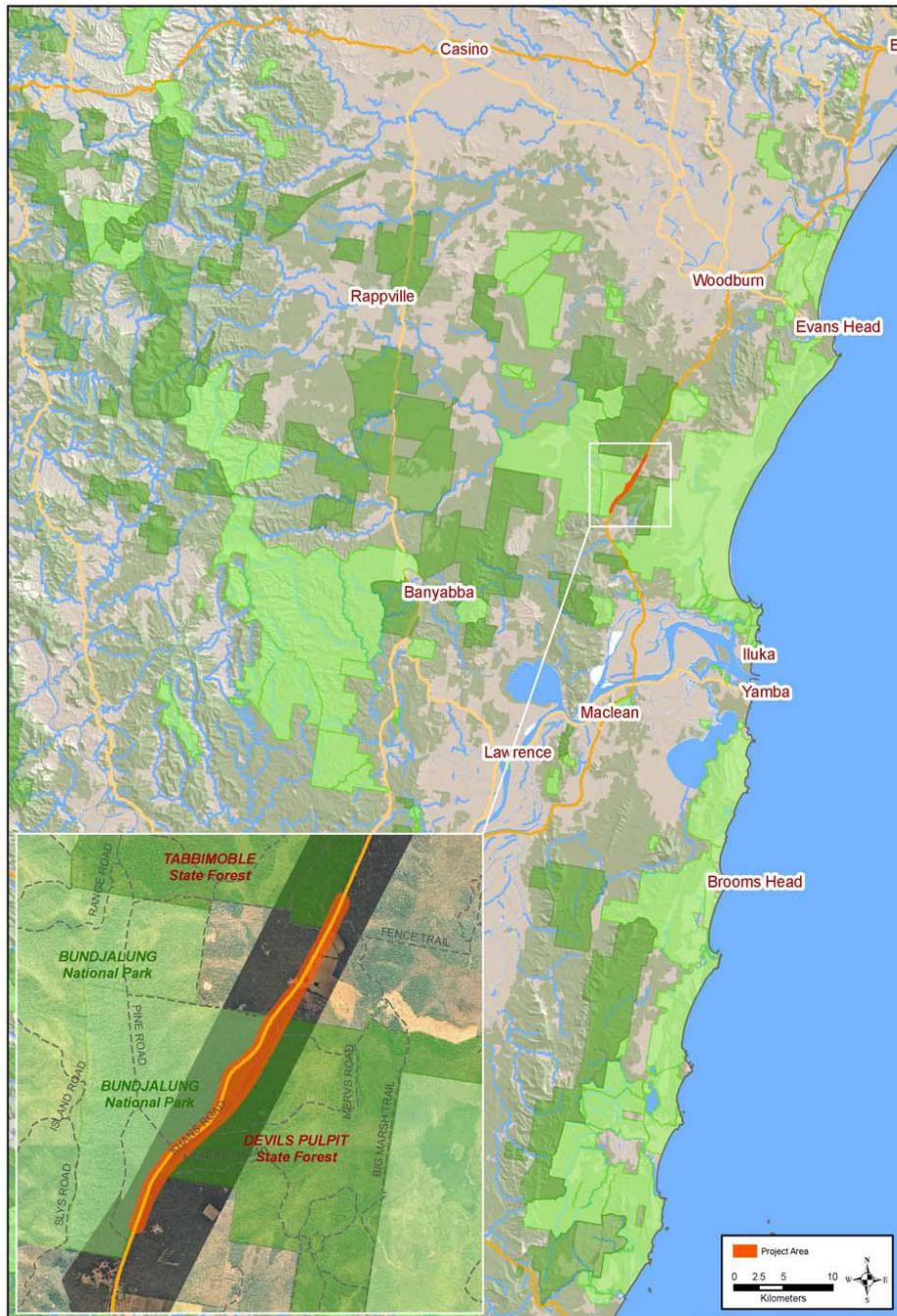


Figure 1.1: Location and extent of the Devil's Pulpit Pacific Highway upgrade.

Construction of the project commenced in February 2012. Planning for the Devil's Pulpit upgrade has generally accorded with the following hierarchy of principles in regard to biodiversity values along the road corridor:

1. avoid impact;
2. minimise impact; and
3. mitigate impacts.

Where impacts are unavoidable, mitigation and management measures are incorporated into the project to reduce impacts. In some instances there are residual impacts that cannot be adequately mitigated. Residual impacts identified for the Devil's Pulpit upgrade include:

- a loss of native vegetation, including Subtropical Coastal Floodplain Forest of the NSW North Coast Bioregion EEC; and
- a loss of habitat for a variety of protected and threatened native fauna species.

RMS has developed a biodiversity offset and mitigation strategy, which includes mitigation measures such as avoiding areas of high biodiversity value, constructing fauna crossings, providing artificial habitat and revegetating areas. In addition, biodiversity offsets will ensure that additional native vegetation is protected and managed for conservation.

The objective of the Biodiversity Offset Strategy is to deliver a Biodiversity Offset Package that aims to achieve a beneficial biodiversity outcome for the region as a result of the upgrade project. The measures used to gauge success of this objective will be:

- successfully securing the long-term (in perpetuity) protection and management of lands containing Endangered Ecological Communities (EECs) and habitat for threatened species (key habitat);
- the total area of lands used to offset the biodiversity impacts shall exceed the direct and indirect (edge effects) impacts; and
- the process for setting the scope and quantum of the biodiversity offsets is transparent and justifiable on environmental, social and economic grounds.

RMS has identified the extent of habitat types and vegetation communities that would be lost or degraded as a result of the upgrade project (*Table 1.1*).

Table 1.1: Indicative biodiversity offset areas required as a result of clearing impacts from the upgrade project.

Vegetation Community	OEH Biometric Vegetation Type	Broad Vegetation Type	Habitat Type	Area Impacted	Offset Ratio Applied	Offset Area Required
Blackbutt Dry Sclerophyll Forest	Blackbutt - Spotted Gum shrubby open forest on sandstones of the lower Clarence Valley of the North Coast	Dry Open Sclerophyll Forest (Non-EEC)	Dry Sclerophyll Forest	56	2:1	112
Scribbly Gum Dry Sclerophyll Forest	Scribbly Gum - Red Bloodwood heathy open forest of the coastal lowlands of the North Coast					
Spotted Gum Dry Sclerophyll Forest	Spotted Gum - Grey Ironbark - Pink Bloodwood open forest of the Clarence Valley lowlands of the North Coast					

Vegetation Community	OEI Biometric Vegetation Type	Broad Vegetation Type	Habitat Type	Area Impacted	Offset Ratio Applied	Offset Area Required
Eastern Red Gum Floodplain Forest	Narrow-leaved Red Gum woodlands of the lowlands of the North Coast	Subtropical Coastal Floodplain Forest (EEC)	Forested Wetlands	18.6	4:1	74.4
Forest Red Gum Floodplain Forest	Forest Red Gum - Swamp Box of the Clarence Valley lowlands of the North Coast					
TOTAL				74.6		186.4

1.2 Purpose of the Report

BEM was contracted by RMS to undertake a compensatory habitat assessment of Lot 21 DP 755601 and Lot 2 DP 1112483, 1457 Myall Creek Road Bungawalbin, to enable consideration of the subject land for inclusion in a Biodiversity Offset Package for the Devil’s Pulpit Pacific Highway Upgrade. The reporting aims are based on the required outcomes stated by RMS in the project brief, which are to:

- assess the condition of the identified habitat/vegetation communities of the proposed offset land to ensure they consist of appropriate vegetation types and are of adequate condition to meet the criteria for offset land; and
- provide an assessment of the proposed compensatory habitat to include in the Biodiversity Offset Package.

1.2.2 Objectives

The reporting objectives are based on assessment criteria specified within *Section 3.4* of the Pacific Highway Upgrade Devil’s Pulpit Biodiversity Offset Strategy, which include:

- properties to be located within a 30 kilometre radius of the project, extending to 100 kilometres with the agreement of the Department of Planning and EPA where it can be demonstrated that a suitable offset could not be found;
- offset land are to contain vegetation communities consistent with those affected by the project upgrade (refer to *Table 1.1*);
- land would be assessed as to its suitability as habitat for the threatened species impacted by the project (including patch sizes) based on OEI threatened species profiles databases;
- offset land would comprise vegetation of at least moderate to good condition (according to OEI native vegetation benchmarks database);
- offset land would comprise land that enables connectivity between adjacent areas of vegetation; and
- offset land must be suitable for ongoing management for conservation through an appropriate legal instrument.

2 ASSESSMENT METHODS

2.1 Desktop Assessment

A search was undertaken of the NSW Office of Environment and Heritage Wildlife Atlas database to obtain historical and recent flora and fauna species records for the locality, which is defined as 'the area within a 10 kilometre radius of the study area'.

The EPBC Act internet-based database was searched (e.g. point search using latitude and longitude coordinates) to identify any nationally listed threatened species and ecological communities likely to occur within a five kilometre radius of the study area.

In addition, the following references were also reviewed to obtain information relevant to the assessment:

- Hyder Consulting 2010a, *Devil's Pulpit Pacific Highway Upgrade Environment Assessment – Appendix D*, Technical Working Paper: Ecology (Part 1);
- Hyder Consulting 2010b, *Devil's Pulpit Pacific Highway Upgrade Environment Assessment – Appendix E*, Technical Working Paper: Ecology (Part 2); and
- Rodd, J. 2012, *Roads and Maritime Services Pacific Highway Upgrade – Devil's Pulpit Biodiversity Offset Strategy*, unpublished report prepared by Hyder Consulting for RMS;

2.2 Flora Survey

Flora survey of the subject land was undertaken over three days on 2, 5 and 6 November 2012. The surveys were carried out over 26 hours and involved a combination of plot-based and random meander sampling techniques.

2.2.1 Random Meander Sampling

A random meander flora survey was initially conducted to assess the distribution and extent of vegetation communities present. The random meander survey technique involves walking in a random manner throughout the subject land, visiting the full range of potential habitats and recording every plant species observed (Cropper 1993).

2.2.2 Plot-based Sampling

Plot sampling was undertaken to enable a quantitative assessment of vegetation structure, species distribution and abundance. Information recorded during plot sampling included:

- sampling date;
- quadrat size;
- locality description and location coordinates (WGS84);
- landform type;
- soil type;
- slope;
- aspect;
- dominant species, foliage cover and height range for each vegetative stratum;
- other flora species present;

- disturbance history; and
- successional stage;

A minimum of one sampling plot was established within each vegetation type. Additional plots were established to sample variations in microclimate, topographic position, aspect and past land management practices. A total of ten sampling plots were completed on the subject land (*Figure 3.1*).

2.2.3 Taxonomy

The naming of plants follows Harden (1990-93, 2000, 2002), with subsequent updates as provided by 'PlantNet', the online version of the Flora of NSW (Royal Botanic Gardens and Domain Trust, Sydney 2012). Plant communities are described and identified by reference to the dominant canopy trees, vegetation structure and floristic composition. Vegetation formations and classes are based on Keith (2004).

2.2.4 Conservation Significance of Plant Species and Communities

The conservation significance of plant species and vegetation types was determined with reference to the following:

- Schedules of the NSW *Threatened Species Conservation Act 1995* (TSC Act);
- Schedules of the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act);
- ROTAP (Briggs and Leigh 1996) for nationally rare species; and
- Biometric Vegetation Types for Northern Rivers CMA – percentage cleared estimates.

2.2.5 Condition Assessment

The condition rating used in this study for woody native vegetation is based on that used in the Biometric (Gibbons *et al.* 2005) or BioBanking methodology and comprises two classes, 1) moderate to good or 2) low. Vegetation assigned as having a low condition met the following criteria:

- native overstorey percent foliage cover <25% of the lower value of the overstorey percent foliage cover benchmark for that vegetation type, and
- <50% of groundcover vegetation is indigenous species, or
- >90% of groundcover vegetation is cleared.

If these criteria were not met then the vegetation is not considered to be in low condition and must be assigned as having a moderate to good condition.

2.3 Habitat Assessment

2.3.1 Site Traverse

The subject land was initially traversed on-foot and by vehicle to gain an understanding of the floristic and structural diversity of vegetation thereby ensuring that sampling targeted all habitat types present. The traverse also provided the opportunity to search for evidence of threatened fauna, such as feeding signs, nests, scats, tracks, important Hollow-bearing Trees (HBT) and obtain records of threatened species. The location of important fauna features was determined using a Garmin GPS 62s.

2.3.2 Plot-based Sampling

Fauna habitat was assessed in combined 25 x 25m plots and 250m x 20m transects. Replicate quadrats and transects were sampled in each habitat type with quadrats (& transects) allocated proportionally to each habitat based on the predicted area of that habitat. The number and location of habitat assessment plots were the same as vegetation sample plots (see *Section 2.2.2*). Information collected in each plot was based on a standardized habitat assessment proforma and included:

- Disturbance history;
- Vegetation structure (height & cover) and dominant species in each strata;
- Topographic position and vegetation age class;
- Occurrence (percentage of overstorey and midstorey vegetation within a one hectare area surrounding the plot) of key habitat resources (i.e. mistletoe, epiphytes, fleshy fruits, blossom, winter flowering eucalypts, acacia, banksia, Allocasuarina, figs, melaleuca, decortivating bark);
- Number of logs >150mm diameter and number of hollow logs;
- Presence and type of waterbodies and type of frog habitat;
- Occurrence of caves, rock overhangs, scree slopes, nest trees and flying fox camps; and
- Predicted occurrence of threatened fauna.

A 250m x 20m transect was established at each quadrat to assess the type and abundance of habitat resources. All tree hollows observed within 10 metres of the transect centre-line were recorded. Information recorded for each hollow-bearing tree included species, hollow type (i.e. trunk, branch, spout) and estimated entrance size (i.e. 10-50mm, 50-150mm, 150-300mm >300mm). Signs of fauna such as diggings, scats, tracks and feeding signs were also sampled along each transect. The ground layer beneath each she-oak (*Allocasuarina* spp) was checked for evidence of recent feeding activity by glossy black-cockatoos (i.e. chewed cones).

2.3.3 Opportunistic Fauna Records

A list of vertebrate fauna recorded on the subject land was compiled during the field survey. The list was compiled by diurnal observations only during a dry period and is intended to provide basic information on vertebrate fauna within the subject land.

2.4 Survey Limitations

There are several limitations that apply to the flora survey undertaken on the subject land:

- lack of existing vegetation mapping for the site;
- relatively homogenous canopy colours and textures throughout the site limiting ability to accurately identify vegetation types from aerial photography;
- large sampling area;
- very limited vehicle access; and limited available sampling time.

Consequently, the resulting vegetation mapping presents only approximate vegetation boundaries and extents. Improved accuracy will require verification through additional field sampling. Furthermore, the flora survey was conducted over three days during late spring, hence some flora species could not be identified to species level due to a lack of suitable flowering or fruiting material.

3 FLORA ASSESSMENT RESULTS

3.1 Vegetation Types

The subject land contains approximately 386.28 hectares of intact or regenerating native vegetation and 1.42 hectares of cleared land. Six native vegetation types and one derived vegetation type were identified:

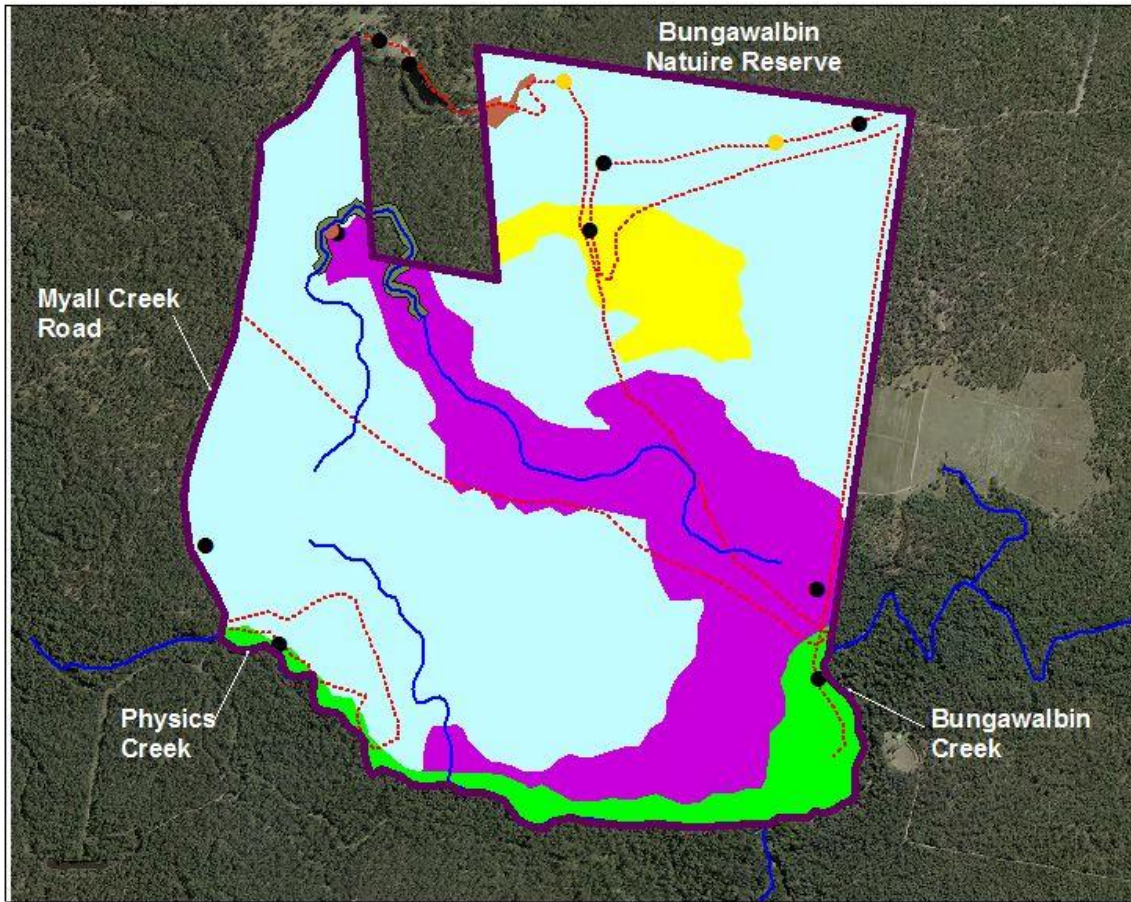
- Forest Red Gum-Swamp Box of the Clarence Valley Lowlands of the North Coast;
- Narrow-leaved Red Gum Woodlands of the Lowlands of the North Coast
- Paperbark Swamp Forest of the Coastal Lowlands of the North Coast;
- Grey Gum-Grey Ironbark Open Forest of the Clarence Lowlands of the North Coast;
- Flooded Gum - Tallowwood - Brush Box Moist Open Forest of the Coastal Ranges of the North Coast;
- Freshwater Wetland Lagoons (billabongs); and
- Cleared land.

The approximate distribution and extent of each vegetation type is illustrated in *Figure 3.1*. A description of each vegetation type and its extent on the subject land is provided below and listed in *Table 3.1*.

Table 3.1: Biometric vegetation types identified on the subject land.

Keith (2004) Formation-Vegetation Class	Biometric Vegetation Type	Area (ha)	EEC¹
Forested Wetlands – Coastal Floodplain Wetlands	Forest Red Gum-Swamp Box of the Clarence Valley Lowlands of the North Coast	237.7	Yes
Forested Wetlands – Coastal Floodplain Wetlands	Narrow-leaved Red Gum Woodlands of the Lowlands of the North Coast		Yes
Forested Wetlands - Coastal Swamp Forests	Paperbark Swamp Forest of the Coastal Lowlands of the North Coast	22.3	Yes
Dry Sclerophyll Forests - Clarence Dry Sclerophyll Forest	Grey Gum-Grey Ironbark Open Forest of the Clarence Lowlands of the North Coast	71.5	No
North Coast Wet Sclerophyll Forests	Flooded Gum - Tallowwood - Brush Box Moist Open Forest of the Coastal Ranges of the North Coast	19.6	No
Freshwater Wetlands - Coastal Freshwater Lagoons	Freshwater Wetland Lagoons	n/a	Yes

¹ Endangered Ecological Community



800 0 800 1600 Meters

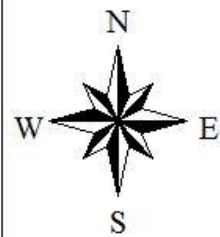


Figure 3.1: Distribution of sample sites, vegetation communities and threatened species records in the subject site. NB - Vegetation community boundaries require verification.

3.1.1 Forest Red Gum-Swamp Box of the Clarence Valley Lowlands of the North Coast

Approximate extent: 249.11 hectares

Landform, substrate and soils: Occurs on poorly drained, alluvial clays and sands, on periodically inundated flats.

Structure: Tall to very tall open forest with a mid-dense to dense shrub and small tree layer and a mid-dense ground layer of grasses and forbs (*Plate 1*).



Plate 1: Forest Red Gum-Swamp Box of the Clarence Valley Lowlands of the North Coast

Frequent Native Species:

- Trees: *Eucalyptus tereticornis*, *Corymbia intermedia*, *Eucalyptus siderophloia*, *Eucalyptus propinqua* and *Eucalyptus robusta*.
- Small Tree layer: *Lophostemon suaveolens*, *Alphitonia excelsa*, *Acacia melanoxylon* and *Allocasuarina torulosa*.
- Shrubs: *Lophostemon suaveolens*, *Alphitonia excelsa*, *Trochocarpa laurina*, *Notelaea longifolia*, *Melaleuca sieberi*, *Exocarpus cupressiformis*, *Glochidion ferdinandi*, *Myrsine howittiana*, *Diospyros fasciculosa* and *Persoonia stradbokensis*.
- Groundcover: *Imperata cylindrica*, *Themeda australis*, *Cymbopogon refractus*, *Entolasia stricta*, *Aristida vagans*, *Lomandra longifolia*, *Pratia purpurascens*, *Entolasia stricta*, *Eragrostis* sp., *Pimelea linifolia*, *Hibbertia vestita*, *Hibbertia diffusa* and *Microlaena stipoides*.

- Vines, climbers, twiners: *Geitenoplesium cymosum*, *Eustrephus latifolius*, *Trophis scandens* and *Morinda jasminoides*.

Exotic Species: *Lantana camara*

Condition: This vegetation type has been subject to heavy logging in the past as evidenced by a paucity of large mature trees and presence of old sawn stumps. However, there is very little evidence of recent fire activity or weed infestation in this vegetation type. In terms of the biobanking criteria for assessing vegetation condition, this vegetation type is in moderate to good condition, with canopy cover exceeding 60 percent, indigenous plant species comprising over 90 percent of flora species present and native groundcover vegetation ranging from 36 to 52 percent.

3.1.2 Narrow-leaved Red Gum Woodlands of the Lowlands of the North Coast

Approximate Extent: Occurs as small stands within the Forest Red Gum-Swamp Box vegetation type.

Landform, substrate and soils: Occurs on poorly drained, alluvial clays and sands, on periodically inundated flats.

Structure: Tall to very tall open forest with a mid-dense to dense shrub and small tree layer and a mid-dense ground layer of grasses and forbs (*Plate 2*).



Plate 2: Narrow-leaved Red Gum Woodlands of the Lowlands of the North Coast

Frequent Native Species:

- Trees: *Eucalyptus seeana*, *Eucalyptus tereticornis*, *Corymbia. intermedia*, *Eucalyptus siderophloia* and *Eucalyptus propinqua*.

- Small Tree layer: *Lophostemon suaveolens*, *Angophora subvelutina*, *Alphitonia excelsa* and *Acacia melanoxylon*.
- Shrubs: *Lophostemon suaveolens*, *Alphitonia excelsa*, *Trochocarpa laurina*, *Notelaea longifolia*, *Glochidion ferdinandi* and *Persoonia stradbokensis*.
- Groundcover: *Imperata cylindrica*, *Themeda australis*, *Lomandra longifolia*, *Gahnia aspera*, *Cymbopogon refractus*, *Entolasia stricta*, *Adiantum aethiopicum* and *Microlaena stipoides*.
- Vines, climbers, twiners: *Geitenoplesium cymosum*, *Eustrephus latifolius* and *Morinda jasminoides*.

Exotic Species: *Lantana camara*

Condition: This vegetation type has been subject to heavy logging in the past as evidenced by a paucity of large mature trees and presence of old sawn stumps. However, there is very little evidence of recent fire activity or weed infestation in this vegetation type. In terms of the biobanking criteria for assessing vegetation condition, this vegetation type is in moderate to good condition, with canopy cover exceeding 60 percent, indigenous plant species comprising over 90 percent of flora species present and native groundcover vegetation ranging from 28 to 42 percent.

3.1.3 Grey Gum-Grey Ironbark Open Forest of the Clarence Lowlands of the North Coast

Approximate extent: 92.35 hectares

Landform, substrate and soils: Occurs on slightly elevated alluvial clays and clay loams adjacent to drainage lines and creeks.

Structure: Tall to very tall open forest with a mid-dense to dense shrub and small tree layer and a sparse ground layer of grasses and ferns (*Plate 3*).



Plate 3: Grey Gum-Grey Ironbark Open Forest of the Clarence Lowlands of the North Coast

Frequent Native Species:

- Trees: *Eucalyptus siderophloia* and *Eucalyptus propinqua*.
- Small Tree layer: *Acacia melanoxylon*, *Callistemon salignus* and *Endiandra muelleri*.
- Shrubs: *Lantana camara*, *Notelaea longifolia*, *Endiandra muelleri*, *Dodonaea triquetra*, *Alphitonia excelsa*, *Trema aspera*, *Myrsine variabilis*, *Psychotria loniceroides* and *Acacia longissima*.
- Groundcover: *Gahnia aspera* and *Hypolepis muelleri*.
- Vines, climbers, twiners: *Smilax australis*.

Exotic Species: *Lantana camara*

Condition: This vegetation type has been subject to heavy logging in the past as evidenced by a paucity of large mature trees and presence of old sawn stumps. There is no evidence of recent or regular fire activity. However, there are moderate infestations of lantana that may be impacting on the species abundance and diversity of native plants in the understorey stratum. In terms of the biobanking criteria for assessing vegetation condition, this vegetation type is in moderate to good condition, with canopy cover exceeding 60 percent, indigenous plant species comprising over 90 percent of flora species present and naturally sparse groundcover vegetation.

3.1.4 Flooded Gum/Brushbox Moist Forest of the Coastal Ranges of the North Coast

Approximate extent: 22.61 hectares

Landform, substrate and soils: Occurs along the banks of Physics Creek and Bungawalbin Creek, which traverse the southern boundary of the subject land.

Structure: Extremely tall closed forest with a dense midstorey stratum of small tree species and sparse groundcover of rainforest seedlings and scramblers (*Plates 4 and 5*). Climbers are very common throughout.



Plate 4: Flooded Gum/Brushbox Moist Forest of the Coastal Ranges of the North Coast



Plate 5: Riparian vegetation on Bungawalbin Creek

Frequent Native Species:

- Trees: *Eucalyptus grandis*, *Corymbia intermedia* and *Lophostemon confertus*.
- Small Tree layer: *Ficus coronata*, *Waterhousia floribunda*, *Guoia semiglauca*, *Neolitsea dealbata* and *Endiandra muelleri* var. *muelleri*.
- Shrubs: *Wilkiea huegeliana*, *Cordyline stricta*, *Guoia semiglauca*, *Neolitsea dealbata*, *Endiandra muelleri*, *Cryptocarya triplinervis* var. *pubens*, *Deeringia amaranthoides* and *Jagera pseudorhus*.
- Groundcover: rainforest seedlings.
- Vines, climbers, twiners: *Cissus antarctica*, *Ripogonum album*, *Dioscorea transversa*, *Morinda jasminoides* and *Smilax australis*.

Exotic Species: None recorded.

Condition: This vegetation type has been subject to very light logging in the distant past as evidenced by the occurrence of very large mature trees and absence sawn stumps. This vegetation type is weed free and doesn't appear to have been burnt in the last 20 years. In terms of the biobanking criteria for assessing vegetation condition, this vegetation type is in moderate to good condition, with canopy cover exceeding 85 percent, indigenous plant species comprising 100 percent of flora species present and naturally sparse groundcover vegetation.

3.1.5 Paperbark Swamp Forest of the Coastal Lowlands of the North Coast

Approximate extent: 22.21 hectares

Landform, substrate and soils: Occurs on waterlogged or seasonally inundated lower-lying sites on peaty sands or loams.

Structure: Mid-high open forest with a sparse to dense shrub mid-stratum and a dense ground layer of sedges, forbs and ferns (*Plate 6*).



Plate 6: Paperbark Swamp Forest of the Coastal Lowlands of the North Coast

Frequent Native Species:

- Trees: *Melaleuca quinquenervia*, *Lophostemon suaveolens*, *Eucalyptus tereticornis*.
- Small Tree layer: *Melaleuca quinquenervia*, *Lophostemon suaveolens*, *Eucalyptus tereticornis*.
- Shrubs: *Melaleuca alternifolia*, *Lophostemon suaveolens*.
- Groundcover: *Baumea articulata*, *Eleocharis sphacelata*, *Baumea juncea*, *Blechnum indicum*, *Philydrum lanuginosum*, *Triglochin procerum* and *Cynodon dactylon*.
- Vines, climbers, twiners: *Parsonsia straminea*.

Exotic Species: *Lantana camara* and *Baccharis halimifolia*.

Condition: This vegetation type is in moderate to good condition, with low levels of weed infestation, no discernable impacts from fire and good recovery from moderate intensity logging 20 to 30 years ago.

In terms of the biobanking criteria for assessing vegetation condition, this vegetation type is in moderate to good condition, with canopy cover of 30 percent, indigenous plant species comprising over 90 percent of flora species present and native groundcover vegetation of 46 percent.

3.1.6 Freshwater Wetlands - Coastal Lagoons (Billabongs)

Approximate extent: Extent too small to accurately estimate.

Landform, substrate and soils: Occurs on alluvial silt, mud or loam of drainage lines and backswamps.

Structure: Billabongs (*Plate 7*).



Plate 7: Natural billabong along ephemeral drainage line situated in the central part of the subject land.

Frequent Native Species:

- Trees: absent.
- Groundcover: *Lepironia articulata*, *Nymphaea caerulea* subsp. *zanzibarensis*, *Nymphoides indica*, *Ottelia ovalifoli* and *Phylidrum lanuginosum*.

Exotic Species: *Nymphaea caerulea* subsp. *zanzibarensis*.

Condition: Considered to be in variable condition. The deeper billabongs are usually dominated by the exotic waterlily *Nymphaea caerulea* subsp. *zanzibarensis*.

3.1.7 Cleared Land

Approximate extent: 1.42 hectares

Structure: Derived grassland resulting from past clearing of forested parts of the property for a timber mill, livestock grazing and access tracks. Scattered remnant trees occur throughout this type, as do regenerating native shrubs. The ground layer is a mixture of native grasses, forbs and introduced pasture grass species. Pasture on the site does not appear to have been subject to improvement practices such as fertilization.

Frequent Native Species:

- Trees: Remnant and regenerating *Angophora subvelutina*, *Eucalyptus tereticornis* and *Eucalyptus siderophloia*.
- Shrubs: *Banksia oblongifolia*, *Lantana camara*, *Casuarina glauca*, *Persoonia stradbokensis*, *Notelaea longifolia*.
- Groundcover: *Imperata cylindrica*, *Pteridium esculentum*, *Lomandra longifolia*, *Aristida vagans*, *Eragrostis brownii*, *Themeda australis*, *Echinopogon caespitosus*, *Cymbopogon refractus*, *Microlaena stipoides*, *Dichondra repens*.

Exotic Species: *Rhynchelytrum repens*, *Andropogon virginicus*, *Paspalum urvillei*, *Paspalum dilatatum*, *Baccharis halimifolia*, *Chloris gayana*, *Hypochoeris radicata*, *Bidens pilosa*, *Conyza bonariensis*.

Condition: Low condition.

3.2 Condition of the Vegetation Communities

All of the native vegetation present on the subject land is in benchmark condition which equates to the vegetation community having an intact structure and all vegetation layers being dominated by native species. Factors that have detracted from overall condition of some of the vegetation types include previous clearing, logging, disturbance by feral pigs and the incursion of invasive weeds. A condition assessment for each vegetation type is summarised in *Table 3.2* below.

Table 3.2: Summary of the condition assessment for vegetation types on the subject land.

Vegetation Type	Overstorey	Groundcover	Noxious Weeds	Environmental Weeds	Condition Assessment
Forest Red Gum-Swamp Box of the Clarence Valley Lowlands of the North Coast	Heavily logged/thinned but within benchmark; native dominated.	Benchmark; native dominated	<i>Lantana camara</i> – low frequency	<i>Gnaphalium sphaericum</i> – low frequency	Moderate to good
Narrow-leaved Red Gum Woodlands of the Lowlands of the North Coast	Heavily logged/thinned but within benchmark; native dominated.	Benchmark; native dominated	<i>Lantana camara</i> – low frequency	None recorded	Moderate to good
Paperbark Swamp Forest of the Coastal Lowlands of the North Coast	Past logging evident but within benchmark; native dominated.	Benchmark; native dominated	<i>Lantana camara</i> – low frequency; <i>Baccharis halimifolia</i> – low frequency	None recorded	Moderate to good
Grey Gum-Grey Ironbark Open Forest of the Clarence Lowlands of the North Coast	Past logging evident but within benchmark; native dominated.	Benchmark; native dominated	<i>Lantana camara</i> – low to high frequency	None recorded	Moderate to good
Flooded Gum - Tallowwood - Brush Box Moist Open Forest of the Coastal Ranges of the North Coast	Benchmark; native dominated	Benchmark; native dominated	None recorded	None recorded	Moderate to good
Freshwater Wetland Lagoons	n/a	Benchmark - parts of some deeper waterbodies dominated by exotic species	None recorded	<i>Nymphaea caerulea</i> subsp. <i>zanzibarensis</i> recorded in deeper waterbodies	Moderate to good
Cleared Land	n/a	n/a	<i>Baccharis halimifolia</i> – low frequency <i>Lantana camara</i> – high frequency on edges <i>Ambrosia artemisiifolia</i> – low frequency	<i>Senecio madagascariensis</i> – low frequency <i>Conyza bonariensis</i> – high frequency <i>Hypochoeris radicata</i> – high frequency <i>Bidens pilosa</i> – high frequency in patches <i>Rhynchelytrum repens</i> – low frequency <i>Paspalum urvillei</i> – low frequency <i>Paspalum dilatatum</i> – low frequency	Low

Three main forms of disturbance were recorded on the subject land:

- clearing;
- logging/thinning; and
- weeds.

3.2.1 Clearing

Less than 0.5 percent of the subject land has been cleared of native vegetation for provision of a disused timber mill, fencelines and access tracks.

3.2.2 Logging/Thinning

Extensive areas of the property have been moderately to heavily logged and/or thinned in the past, possibly up to 30 years ago. The effects of this impact are still evident in many parts of the site where the canopy is relatively sparse and there is a distinct lack of large mature trees.

3.2.3 Weeds

The subject land generally supports low densities of weed species. Weeds were recorded mainly in cleared areas and on track edges. The heaviest weed infestations in native vegetation occur within the Grey Gum-Grey Ironbark open forest vegetation type, where moderately dense stands of lantana have invaded the understorey at some sites.

3.2.4 Plant Species Richness

A total of 130 species were recorded during this field survey comprising 115 native and 15 exotic species (*Appendix A*). This diversity is considered typical, considering the size of the subject land and the diversity, type and condition of the vegetation communities present.

3.2.5 Exotic Plant Species

A total of 10 introduced plant species were recorded on the subject land, with three of these currently declared noxious in the Richmond Valley LGA, pursuant to the *Noxious Weeds Act 1993* (*Table 3.3*). Most of the recorded exotics were distributed either:

- in cleared areas;
- in and on the edge of regrowth and disturbed forest; or
- in the transition zones between vegetation types.

Table 3.3: Noxious weeds recorded on the subject land.

Species	Common Name	Weed Class	Frequency
<i>Ambrosia artemisiifolia</i>	Annual Ragweed	5	Low frequency in cleared areas or where canopy is open
<i>Baccharis halimifolia</i>	Groundsel Bush	3	Low frequency in cleared areas and wetter sites
<i>Lantana camara</i>	Lantana	4	Light to dense infestations in most forested vegetation types on the subject land
<i>Senecio madagascariensis</i>	Fireweed	4	Low numbers in cleared areas

3.3 Conservation Status of Flora

3.3.1 Threatened Flora Species

A total of 79 species of threatened plant as listed under the TSC Act and/or EPBC Act have been recorded or predicted to occur within 10 kilometres of the subject land (*Table 3.4*). No threatened plants were recorded on site during the current survey. However, the subject land contains potential habitat for 30 threatened plant species (highlighted in bold in *Table 3.4*).

Table 3.4: Threatened plant species previously recorded or potentially occurring in the locality and their likelihood of occurring on the subject land.

All species are currently listed on the TSC and EPBC Acts. V = Vulnerable, E = Endangered

Common Name	Scientific Name	TSC	EPBC	Habitat	Occurrence on Subject Land
White-flowered Wax Plant	<i>Cynanchum elegans</i>	E	E	Occurs in rainforest gullies, scrub and scree slopes (Harden 1992). Usually dry, littoral or subtropical rainforest, and occasionally in scrub or woodland (NPWS 2002).	Potential
Slender Marsdenia	<i>Marsdenia longiloba</i>	E	V	Wet sclerophyll forest, with rainforest species in understorey (Harden 2002; NPWS 1999, 2002).	Potential
Southern Ochrosia	<i>Ochrosia moorei</i>	E	E	Riverine and low-lying sub-tropical rainforest. (NPWS 2002)	Potential
Milky Silkpod	<i>Parsonsia dorrigoensis</i>	V	E	Subtropical and warm temperate rainforest, on rainforest margins on brown clay soils (NPWS 2002).	Unlikely
Heath Wrinklewort	<i>Rutidosis heterogama</i>	V	V	Mostly in heath, often on disturbed roadsides. (Harden 1992). Heath on sandy soils, and moist areas in open forest, and has been recorded along disturbed roadsides (NPWS 2003)	No
Dwarf Heath Casuarina	<i>Allocasuarina defungens</i>	E	E	Grows in tall heath on sand (Harden 2000). The species can also occur on clay soils on sandstone (NPWS 2002).	No
Glenugie Karaka	<i>Corynocarpus rupestris</i> subsp. <i>Rupestris</i>	V	V	Dry rainforest, mainly on dry, stony slopes. (Harden 1992). Dry rainforest on steep volcanic screes on the peak. Soil is scarce, but relatively high in nutrients and very well drained. Fire is generally excluded by the rocky terrain and absence of ground litter (NPWS 2002).	No
Davidson's Plum	<i>Davidsonia jerseyana</i>	E	E	Confined to subtropical rainforest or on the margin with wet sclerophyll forest (Harden 2000). Subtropical rainforest and wet eucalypt forest at low altitudes (below 300 metres) (NPWS 2002). Many trees are isolated in paddocks and on roadsides in former rainforest habitats (NPWS 2002).	Potential
Smooth Davidson's Plum	<i>Davidsonia johnsonii</i>	E	E	Grows in disturbed subtropical rainforest or on the margin with wet sclerophyll forest (Harden 2000). Lowland subtropical rainforest and wet eucalypt forest at altitudes <300m; isolated trees in paddocks and cleared roadsides (NPWS 2002).	Potential
Water Nutgrass	<i>Cyperus aquatilis</i>	E		Occurs in open ephemerally wet sites (Harden 1993). Grows in ephemerally wet sites, such as roadside ditches and seepage areas from small cliffs, in sandstone areas (NPWS 2002).	Potential
Square-stemmed Spike-rush	<i>Eleocharis tetraquetra</i>	E		Grows in swampy areas (Harden 1993). Grows in damp locations on stream edges and in margins of freshwater swamps (NPWS 2002).	Unlikely
Bordered Guinea Flower	<i>Hibbertia marginata</i>	V	V	Grassy forest on sandstone (Harden 2000). Grassy or shrubby dry open eucalypt forest at low altitudes on sandstone (NPWS 2002).	No
Waterwheel Plant	<i>Aldrovanda vesiculosa</i>	E		Shallow freshwater, often caught on submerge vegetation (Harden 2000). Shallow freshwater ponds and wetlands poor in lime and rich in organic matter, at low altitudes (NPWS 2002).	Unlikely

Common Name	Scientific Name	TSC	EPBC	Habitat	Occurrence on Subject Land
Hairy Melichrus	<i>Melichrus hirsutus</i>	E	E	Occurs on sandstone in course sandy soil in the understorey of dry open forest (Chapman & Richards (1997). Occurs in low-altitude dry eucalypt forest with a shrubby understorey on sandy infertile soils with rock outcrops (NPWS 2002).	No
Narrow-leaf Melichrus	<i>Melichrus sp. Gibberagee</i>	E	E	Low-altitude dry eucalypt forest on gentle slopes.	Unlikely
Acalypha	<i>Acalypha eremorum</i>	E		Dry rainforest (Harden 1993). Sub-tropical rainforest, dry rainforest and vine thickets (NPWS 2002).	Potential
Sand Spurge	<i>Chamaesyce psammogeton</i>	E		Occurs on sand dunes near the sea (Harden 2000). Occurs on coastal sand dunes and exposed sites on headlands (NPWS 2002a).	No
Coastal Fontainea	<i>Fontainea oraria</i>	E	E	Low littoral rainforest (Harden 2000). Regrowth littoral rainforest on steep, stony basalt slopes, within a kilometre of the sea (NPWS 2003).	No
Rainforest Cassia	<i>Senna acclinis</i>	E		Rainforest edges, sun-gaps in wet sclerophyll forest, riparian forest and littoral rainforest.	No
Thorny Pea	<i>Desmodium acanthocladum</i>	V	V	Fringes of riverine subtropical and dry rainforest on basalt-derived soils at low elevations (NPWS 2002).	No
Coast Headland Pea	<i>Pultenaea maritime</i>	V		Occurs in grasslands on exposed coastal headlands (Harden 2002).	No
Brush Sophora	<i>Sophora fraseri</i>	V	V	Moist situations, often near rainforest (Harden 2002; NPWS 2002).	Potential
Silverbush	<i>Sophora tomentosa</i>	E		Grows on sea shores (Harden 2002).	No
	<i>Tephrosia filipes</i>	V		Grows in a range of woodland and forest habitats on soils derived from granite, sandstone or metasediments.	No
Rupp's Wattle	<i>Acacia ruppii</i>	E	E	Dry sclerophyll forest and shrubland on sand (Harden 2002), sandstone formations and soils derived from granite. Grows in understorey below Needlebark Stringybark, red bloodwood and smudgy apple (NPWS 2002).	No
White Lace Flower	<i>Archidendron hendersonii</i>	V		Riverine and lowland subtropical rainforest and littoral rainforest. Found on a variety of soils including coastal sands and those derived from basalt and metasediments. (NPWS 2002).	No
Narrow-leaf Finger Fern	<i>Grammitis stenophylla</i>	E		Moist places, usually near streams, on rocks or in trees, in rainforest and moist eucalypt forest.	No
Frogbit	<i>Hydrocharis dubia</i>	P	V	Grows in small shallow freshwater bodies or swamps (Harden 1993).	Potential
	<i>Maundia triglochoides</i>	V		Grows in swamps, creeks or shallow freshwater 300-1000 mm deep on heavy clay, low nutrients. Associated with wetland species such as <i>Triglochin procera</i> (Harden 1993).	Potential
Swamp Mint-bush	<i>Prostanthera palustris</i>	V	V	Grows in poorly drained sandy soils, subject to extended waterlogging, in wet shrubland to heathland.	No
Spiny Mint-bush	<i>Prostanthera spinosa</i>	V		Rocky areas, on skeletal sandy soils (Harden 1992).	No
Stinking Cryptocarya	<i>Cryptocarya foetida</i>	V	V	Scattered, in littoral rainforest (Harden 2000).	No
Crystal Creek Walnut	<i>Endiandra floydii</i>	E	E	Warm temperate and sub-tropical rainforest (Harden 2000; NPWS 2002) with Brush Box overstorey, and in regrowth rainforest and Camphor Laurel forest (NPWS 2002).	Potential

Common Name	Scientific Name	TSC	EPBC	Habitat	Occurrence on Subject Land
Rusty Rose Walnut	<i>Endiandra hayesii</i>	V	V	Lowland sub-tropical rainforest, on sedimentary soils and alluvium, in cool, moist, sheltered valleys (Harden 2000). Sheltered moist gullies in lowland subtropical and warm temperate rainforest on alluvium or basaltic soils (NPWS 2002).	Potential
Green-leaved Rose Walnut	<i>Endiandra muelleri subsp. Bracteata</i>	E		Sub-tropical rainforest, mainly at low altitudes (Harden 2000).	Potential
Slender Screw Fern	<i>Lindsaea incisa</i>	E		Sandy wet soils in wet heathy woodland, riparian vegetation or swamp sclerophyll forest.	Potential
	<i>Rotala tripartite</i>	E		A riparian species that grows in free-standing water with sedges. Grows in exposed silty clay on the edges of farm dams. Also occurs in <i>Melaleuca</i> freshwater wetlands.	Potential
Arrow-head Vine	<i>Tinospora tinosporoides</i>	V	V	Grows in wetter sub-tropical rainforest (Harden 2000). Also in littoral rainforest on fertile, basalt-derived soils (NPWS 2002).	No
Ripple-leaf Muttonwood	<i>Myrsine richmondensis</i>	E	E	Subtropical and dry rainforest and swamp forest on creek flats and slopes on basalt derived soil.	Potential
Sandstone Rough-barked Apple	<i>Angophora robur</i>	V	V	Occurs in dry sclerophyll woodland on shallow sandy soil overlying sandstone in association with other rough-barked apples, various stringybarks and bloodwoods, often co-dominating dry open forests on sandy soils (Chapman & Richards 1997).	No
Netted Bottle Brush	<i>Callistemon linearifolius</i>	V		Grows in dry sclerophyll forest on the coast and adjacent ranges.	Potential
Slaty Red Gum	<i>Eucalyptus glaucina</i>	V	V	Locally frequent, but very sporadic, in grassy woodland on deep, moderately fertile and well-watered soil (Harden 2002). Grassy woodland and dry eucalypt forest on deep, moderately fertile and well-watered soils (NPWS 2002).	Likely
Square-fruited Ironbark	<i>Eucalyptus tetrapleura</i>	V	V	Dry or moist eucalypt forest on moderately fertile soils, often in low areas with poor drainage (NPWS 2002).	Potential
Sweet Myrtle	<i>Gossia fragrantissima</i>	E	E	Grows in subtropical rainforest (Harden 2002). Grows in dry subtropical and riverine rainforest, mostly on basalt-derived soils (NPWS 2002).	Potential
Weeping Paperbark	<i>Melaleuca irbyana</i>	E		Open eucalypt forest on poorly drained sites (Harden 2002).	Potential
Red Lilly Pilly	<i>Syzygium hodgkinsoniae</i>	V	V	Sub-tropical rainforest or gallery forest. (Harden 2002). Riverine and sub-tropical rainforest on rich alluvial or basaltic soils (NPWS 2002).	Unlikely
Square-stemmed Olax	<i>Olax angulata</i>	V	V	Grows in sandy soils and woodland near swamps. (Harden 1992). Low-lying coastal heaths and heathy woodlands on sandy soils near swamps, often in association with Wallum Banksia (<i>Banksia aemula</i> (NPWS 2002).	No
Spider orchid	<i>Dendrobium melaleucaphilum</i>	E		Grows frequently on <i>Melaleuca styphelioides</i> , less commonly on rainforest trees or on rocks in coastal districts (Harden 1993).	Unlikely
Pink Nodding Orchid	<i>Geodorum densiflorum</i>	E		Dry sclerophyll forest at lower altitudes, often on coastal sand (Harden 1993; NPWS 2002).	Potential

Common Name	Scientific Name	TSC	EPBC	Habitat	Occurrence on Subject Land
Red-flowered King of the Fairies	<i>Oberonia titania</i>	V		Grows in rainforest; also in mangroves, coastal scrub and gorges, in sclerophyll forest (Harden 1993). Habitat includes coastal melaleuca swamps (Bishop 2000).	Potential
Brown Fairy-chain Orchid	<i>Peristeranthus hillii</i>	V		Largely confined to littoral rainforest, but extending into adjacent hills. Tends to grow in inter-dunes in araucarian forest. Grows on trees and woody climbers in rainforest – particularly in littoral rainforest (Harden 1993).	No
Southern Swamp Orchid	<i>Phaius australis</i>	E	E	Swampy forest or swampy grassland	Potential
Lady Tankerville's Swamp Orchid	<i>Phaius tancarvilleae</i>	E	E	Grows in <i>Melaleuca quinquenervia</i> swamps, on the coast at or near sea level (Harden 1993). Found in swampy grassland or swamp forest, including rainforest, eucalypt and paperbark forest. (NPWS 2002).	Potential
Hartman's Sarcophilus	<i>Sarcophilus hartmannii</i>	V	V	Epiphyte, usually growing on volcanic rocks, often in shallow soil, in sclerophyll forest or exposed sites from 500 to 1000 metres ASL (Harden 1993).	No
Brush Sauropus	<i>Phyllanthus microcladus</i>	E		Along creeks or rivers, in rainforest (Harden 2000).	Potential
Hairy Jointgrass	<i>Arthraxon hispidus</i>	V	V	Occurs north from Kundabung where it grows in grassland which was previously forested. It prefers moist shady sites and is often found near creeks or swamps (Harden 1993; NPWS 2002).	Potential
Lemon-scented Grass	<i>Elyonurus citreus</i>	E		Sandy soils near rivers or along the coast (Harden 1993).	No
	<i>Paspalidium grandispiculatum</i>	V	V	Restricted to open forest on poor sandy soils on sandstone.	No
Native Milkwort	<i>Polygala linariifolia</i>	E		Sandy soils in dry eucalypt forest and woodland with a sparse understorey.	No
Tall Knotweed	<i>Persicaria elatior</i>	V	V	Occurs in damp or swampy situations, sometimes in association with <i>Melaleuca linariifolia</i> (NPWS 2002).	Potential
Needle-leaf Fern	<i>Belvisia mucronata</i>	E		Usually found forming small clumps on trees or rocks in rainforest (Harden 2000).	No
Basket Fern	<i>Drynaria rigidula</i>	E		Creeping or clump-forming species found in rainforest (Harden 2000). Grows on plants, rocks or on the ground, usually in rainforest but also in moist eucalypt forest (NPWS 2002).	Potential
Banyabba Grevillea	<i>Grevillea banyabba</i>	V	V	Grows in sandy soil in sclerophyll forest, near or at the top of ridges (Harden 2002). Shrubby open eucalypt forest on low ridges and slopes with poor sandy soil, often in association with Bastard White Mahogany (<i>Eucalyptus psammitica</i>), Sandstone Rough-Barked Apple (<i>Angophora robur</i>) and Pink Bloodwood (<i>Corymbia intermedia</i>) (NPWS 2002).	No
Mason's Grevillea	<i>Grevillea masonii</i>	E	E	Confined to degraded verges and pastureland of former open Eucalypt woodland, at low elevations (Harden 2002). Mainly in disturbed road verges and pasture at low altitudes in gravelly loams. Its former habitat (open eucalypt woodland) has been largely cleared for agriculture. NPWS 2002).	No
Four-tailed Grevillea	<i>Grevillea quadricauda</i>	V	V	Grows in gravelly loam or sand, as an undershrub in Eucalypt woodland, usually along creek or drainage lines (Harden 2002; NPWS 2002).	No
Rough-shelled Bush Nut	<i>Macadamia tetraphylla</i>	V	V	Subtropical rainforest in coastal areas (Harden 2002; NPWS 2002).	No
Northern Clematis	<i>Clematis fawcettii</i>	V	V	Usually found near streams in drier rainforest. (Harden 2000; NPWS 2002).	No

Common Name	Scientific Name	TSC	EPBC	Habitat	Occurrence on Subject Land
	<i>Oldenlandia galioides</i>	E		Margins of seasonally inundated wetlands in paperbark swamps and forest red gum woodlands (NPWS 2002).	Potential
Scented Acronychia	<i>Acronychia littoralis</i>	E	E	Grows in littoral rainforest on sand north of Port Macquarie (Harden 2002; NPWS 2002).	No
Orara Boronia	<i>Boronia umbellate</i>	V	V	Occurs in sheltered gullies in sclerophyll forest on conglomerate substrate (Chapman & Richards 1997).	No
Axe-Breaker	<i>Geijera paniculata</i>	E		Dry and Sub-tropical Rainforest (Harden 2002). Dry sub-tropical rainforest and vine scrub, often along rivers (NPWS 2002)	Unlikely
Austral Toadflax	<i>Thesium austral</i>	V	V	Grows in grassland or woodland often in damp sites. It is a semi-parasitic herb and hosts are likely to be <i>Themeda australis</i> and <i>Poa</i> spp. (Harden 1992).	Unlikely
Small-leaved Tamarind	<i>Diploglottis campbellii</i>	E	E	Grows in riverine rainforest (Harden 2002). Riverine and subtropical rainforest and brushbox forest (NPWS 2002). Soils include those derived from basalt and quartz monzonite (NPWS 2002).	Unlikely
Rusty Plum, Plum Boxwood	<i>Niemeyera whitei</i>	V		Understorey of moist eucalypt forest and rainforest north of the Hastings River (Harden 2000; NPWS 2002a).	Potential
Swamp Foxglove	<i>Centranthera cochinchinensis</i>	E		Grows in moist sites (Harden 1992).	Unlikely
Noah's False Chickweed	<i>Lindernia alsinoides</i>	E		Swampy sites in sclerophyll forest and coastal heath (Harden 1992).	Unlikely
Moonee Quassia	<i>Quassia</i> sp. Mooney Creek	E	E	Wet sclerophyll forest, typically comprising canopy species such as <i>Eucalyptus microcorys</i> (Tallowwood), <i>Lophostemon confertus</i> (Brushbox), <i>Syncarpia glomulifera</i> (Turpentine), and <i>Allocasuarina torulosa</i> (Forest Oak). Usually supports a varying density and diversity of rainforest understorey species.	No

3.3.2 Vegetation Community Perspective

The NSW coastal floodplain environments have been extensively cleared and drained largely for the purposes of agricultural development. Most remaining tracts of native floodplain vegetation are fragmented and exposed to threatening processes, with only a relatively small proportion held in public tenure (i.e. conservation reserves, state forests, or vacant Crown land). The subject land represents an unusually large contiguous tract of remnant native floodplain vegetation on the Bungawalbin floodplain. Although the site has been subject to vegetation clearing and moderate to heavy logging, the vegetation types on the subject land are in good condition, particularly given the position of the site in the landscape.

Four vegetation types on the subject land represent examples of Endangered Ecological Communities (EECs) pursuant to the TSC Act (*Table 3.5*).

Table 3.5: Endangered Ecological Communities occurring on the subject land.

Vegetation Type	Endangered Ecological Community
Forest Red Gum-Swamp Box of the Clarence Valley Lowlands of the North Coast	Subtropical Coastal Floodplain Forest of the NSW North Coast bioregion
Narrow-leaved Red Gum Woodlands of the Lowlands of the North Coast	Subtropical Coastal Floodplain Forest of the NSW North Coast bioregion
Paperbark Swamp Forest of the Coastal Lowlands of the North Coast	Swamp Sclerophyll Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner Bioregions
Freshwater Wetland Lagoons	Freshwater Wetlands on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions

Subtropical Coastal Floodplain Forest EEC

The Subtropical Coastal Floodplain Forest EEC on the subject land extends over an area of 237.7 hectares. This community differs from other communities on the coastal floodplains because of its dominance by a mixed eucalypt canopy over a relatively low abundance or sub-dominance of Swamp Oak and paperbark species and the prominent groundcover of soft-leaved forbs and grasses (NSW Scientific Committee 2004). The remaining area of Subtropical Coastal Floodplain Forest is likely to be considerably less than 30 percent of its original range (Keith 2004). There are no recent estimates of the area of Subtropical Coastal Floodplain Forest lost on the Clarence floodplain, but it is likely that far less than 30 percent of the original extent remains (Pressey 1987).

Swamp Sclerophyll Forest of Coastal Floodplains EEC

Swamp Sclerophyll Forest EEC on the subject land covers an area of 22.3 hectares. It is estimated that much less than 30 percent of the original extent of Swamp Sclerophyll Forest remains on coastal floodplains of the NSW North Coast Bioregion (NSW Scientific Committee 2004). At a local scale, it was estimated that there was less than 2500 hectares on the Clarence floodplain in 1983 (Pressey 1987), however, there are no recent estimates to quantify losses since that time.

Freshwater Wetlands on Coastal Floodplains EEC

The Freshwater Wetland EEC on the subject land is confined to a series of billabongs along the central drainage line. This community is distinguished from other floodplain communities by its scarcity or absence of woody plants, and the presence of amphibious, emergent, floating or submerged aquatic forbs, grasses or sedges. It is estimated that about 30 percent of the original extent of Freshwater Wetlands remains on coastal floodplains in the North Coast Bioregion (NSW Scientific Committee 2010). At a local scale, there was an estimated 10,600 hectares on the lower Clarence floodplain in 1982 (Pressey 1987), however, there are no recent estimates of the area of freshwater wetland lost on the Clarence floodplain since that time.

4 FAUNA HABITAT ASSESSMENT RESULTS

4.1 Opportunistic Fauna Records

A total of 61 species of vertebrate were recorded during the survey, including 45 species of bird, seven reptiles, six mammals and three frogs (*Appendix B*). Two threatened species, black bittern and grey-crowned babbler, were recorded. A black bittern was observed at the system of lagoons on the central drainage channel and two old babbler nests/roosts were recorded in Dry Open Forest with a grassy understorey (*Figure 4.1*). Six species listed as migratory on the EPBC Act were recorded. These species were recorded in dry open forest (pacific black duck), cleared land (rainbow bee-eater), riparian forest (rufous fantail, spectacled monarch), moist open forest (wedge-tailed eagle, rufous fantail) and above dry open forest (white-throated needletail). Three introduced species, feral pig, dog and red fox, were recorded. Dog and fox scats were recorded along vehicle tracks and pig diggings and scats were recorded around the lagoon system and in swamp forest.

4.2 Fauna Habitats

Habitat types are not always synonymous with vegetation types as they are often derived from a combination of abiotic variables and vegetation structure as well as floristic composition. Consequently, the seven vegetation types identified on the subject land were reduced to five habitat types:

1. grassy dry open forest.
2. swamp sclerophyll forest.
3. shrubby dry open forest.
4. riparian forest.
5. cleared land.

The approximate distribution and extent of habitat types is illustrated in *Figure 3.1*. The results of the habitat assessment are discussed below.

4.3 Overview of Habitat Condition

Dry forests in the subject land have been subject to extensive selective logging over a prolonged period of time, although substantive logging may have ceased more than 20 years ago. These forests consist of even-aged regeneration that is approximately 30 to 40 years old. Much of the hollow resource in dry forest consists of stags. Moist forest near Bungawalbin and Physics Creeks has been subject to minor selective logging and contain mature canopy trees (*Plates 4 and 5*). These trees would provide a hollow resource for a variety of hollow dependent fauna including large forest owls, insectivorous bats, arboreal mammals, cockatoos, parrots and snakes. Fire appears to have been excluded from the subject site for approximately 20 to 30 years which has enabled a diverse understorey and ground layer to develop and stags to persist. Feral animals are likely to occur throughout the site, which is typical for most habitats in the locality. Evidence of feral dogs, foxes and pigs was recorded on site during the current survey.

4.3.1 Grassy Dry Open Forest

Grassy dry open forest (GDOF) was the most widespread habitat type on the subject land (*Plate 1*). The distribution and extent of GDOF generally corresponds with the red gum vegetation types, which cover approximately 249.11 hectares.

Condition

GDOF has been heavily logged, although logging appears to have stopped about 20 to 30 years ago, as evidenced by the age of canopy vegetation, scarcity of large mature trees and a relatively homogenous cohort of younger trees with similar trunk diameters. There is no evidence of regular fire or livestock grazing and weeds, mainly lantana, are either absent or present as scattered individuals. GDOF has not been burnt for over 20 years. Vegetation structure has been affected by logging.

Foraging Resources

The overstorey stratum consists of a limited mixture of eucalypt species including forest red gum, narrow-leaved red gum, grey ironbark, pink bloodwood and small-fruited grey gum, with a midstorey of swamp box, *Angophora* sp., red ash and wattle (*Acacia* spp.). The combination of these species would provide a reliable blossom resource for nectivorous fauna during winter and summer months. Black she-oak (*Allocasuarina littoralis*) was an uncommon midstorey species and represents a limited foraging resource for glossy black-cockatoo. The understorey stratum consists of extensive areas of dense (>80%) grass cover with grasses becoming more scarce in areas with a well-developed shrub layer. *Banksia integrifolia* was an uncommon mid-storey species. Soil tended to be friable with areas of loam interspersed with sandy loam. Epiphytes, banksia, *Allocasuarina* spp., figs, melaleuca and decortivating bark were absent from most sample plots. Mistletoe and fleshy fruits were scarce.

Sheltering/Breeding Resources

The mean density of Hollow Bearing Trees (HBT) in GDOF was 8/ha with 15 hollows/ha. Small, medium and large trunk and branch hollows were present. The size distribution of hollows was consistent with most disturbed dry forests where small and medium hollows are most abundant and large and very large hollows uncommon. Half the HBT were stags and 40 percent of all hollows were situated on stags, which would be vulnerable to destruction by wildfire. The hollow resource is suitable for arboreal mammals, forest owls and birds.

The habitat is subject to flooding and contains numerous small undulations that would act as ephemeral pools for frogs. Large (>15cm diameter) woody debris was common with mean density of 32 logs/ha. Hollow logs were rare with a mean density of 4/ha. Ground cover was variable. Dense grass cover would provide suitable shelter for cover-dependent macropods and small ground mammals, whilst areas of sparse grass and dense leaf litter are more suitable for bush stone-curlew and brush-tailed phascogale.

4.3.2 Shrubby Dry Open Forest

Shrubby dry open forest (SDOF) seems to occur in moister areas along drainage lines and depressions (*Plate 3*). In contrast to GDOF it has a well-developed shrub layer dominated by wattles and red ash. It is analogous with the grey gum-grey ironbark vegetation type, which covers an area of approximately 92.35 hectares.

Condition

SDOF has been heavily logged, although logging appears to have ceased about 20 to 30 years ago. The habitat contains some mature (emergent) small-fruited grey gum and flooded gum and a relatively homogenous cohort of younger trees with similar trunk diameters. Mature forest elements are restricted to the southeast corner of the site adjoining riparian forest. There was no evidence of livestock grazing and fire appears to have been excluded for the past 20 years. The habitat has a moderate but patchy infestation of lantana.

Foraging Resources

The overstorey stratum consists of a limited mixture of eucalypt species including small-fruited grey gum, flooded gum and grey ironbark, with a midstorey of wattle and red ash. The habitat contains a moderate summer blossom resource for nectivorous fauna and ironbark would provide some blossom over the winter/early spring period. Epiphytes, Banksia, *Allocasuarina* spp., figs, *Melaleuca* spp. and decortivating bark were absent. Mistletoe and fleshy fruits were scarce. The understorey and ground layer is dominated by lantana, saw-sedge (*Gahnia* spp.) and Blady Grass with variable cover (~30% to 50%). Soil was classified as sandy loam. The ground layer has a thick (5-10cm) layer of leaf litter that would provide suitable foraging substrate for ground-dwelling mammals and birds.

Sheltering/Breeding Resources

The density of HBT in SDOF was 16/ha with 36.6 hollows/ha. Hollow type and size was restricted to small and medium branch hollows, which would be suitable for arboreal and scansorial mammals, small to medium birds (i.e. treecreepers, nightjars and small parrots) and insectivorous bats. Larger hollow classes are likely to occur but were not recorded due to the small sample size. No stags were recorded during the hollow survey, with most hollows present in mature grey gum, bloodwood and ironbark.

Parts of the habitat are subject to inundation and may represent frog breeding habitat, caves, scree slopes, roost or nest trees. Large (>15cm diameter) woody debris was common with a density of 90 logs/ha recorded. No hollow logs were present in the quadrat, although this resource is likely to occur, albeit at low density. Ground cover was moderate and dense leaf litter would provide foraging habitat for insectivorous ground mammals and birds.

4.3.3 Swamp Sclerophyll Forest

Swamp sclerophyll forest habitat follows a broad depression through the central-eastern section of the subject site (*Figure 3.1; Plate 6*). This habitat type is analogous with the paperbark vegetation type, and covers an area of approximately 22.21 hectares.

Condition

Swamp sclerophyll habitat has not been heavily logged, although there is some evidence of tree removal from the ecotone with DOF. Logging has not occurred for approximately 20 to 30 years. There was no evidence of livestock grazing or fire, which appears to have been excluded for at least 20 years. The habitat has a light infestation of groundsel. Feral pig (*Sus scrofa*) diggings were recorded in areas with sparse sedge cover.

Foraging Resources

The understorey, midstorey and overstorey are dominated by a mix of broad-leaved paperbark and swamp box with occasional forest red gum. Habitat would provide a moderate autumn/winter blossom resource for nectivorous fauna. Epiphytes, Banksia, *Allocasuarina* spp., figs, fleshy fruits and wattles were absent. Mistletoe was scarce, whilst blossom producing species (particularly paperbarks) were abundant. The ground layer is dominated by dense sedge (*Baumea rubiginosa* and *B. articulata*) to one metre with cover ranging from 25 to 90 percent. Swamp forest was dry during this study but would retain water for most of the wet season (i.e. late summer through autumn when it would provide good breeding habitat for insects and foraging habitat for frogs, birds and small mammals).

Sheltering/Breeding Resources

The mean density of HBT in DOF was 8/ha with 14 hollows/ha. Small and medium branch and trunk hollows were most common, although large and very large hollows were also recorded. Decorticating bark was present on >75 percent of mid and overstorey trees and shrubs. The hollow resource is suitable for arboreal mammals, birds and insectivorous bats. The habitat does not contain caves, scree slopes, known roost or nest trees or flying-fox camps.

The habitat is subject to flooding and would retain water for most of the summer/autumn period providing breeding habitat for a range of frogs. Large (>15cm diameter) woody debris was abundant with a density of 144/ha recorded in the only plot sampled. Approximate hollow log abundance was 48/ha. The combination of dense ground cover, abundant logs and water could support a range of small ground mammals such as *Rattus* spp. and *Antechinus* spp. Dense ground cover would provide suitable shelter for cover-dependent macropods and small ground mammals.

4.3.4 Riparian Forest

Riparian forest occurs along the edges and side channels of Bungawalbin and Physics Creeks on the southern boundary (Figure 3.1; Plates 4 and 5). Riparian forest is analogous with the flooded gum vegetation type, which covers an area of approximately 22.61 hectares.

Condition

Riparian forest has been subject to selective logging, although not for (approximately) 50 years. Vegetation at both sample plots was classified as "mature age" and the plot on Bungawalbin Creek had old growth elements, such as senescing flooded gum and pink bloodwood. No evidence of fire or livestock grazing was recorded and weeds were restricted to a light infestation of lantana along Physics Creek.

Foraging Resources

The overstorey stratum consists of emergent mature flooded gum and pink bloodwood with brush box, swamp box and weeping lillypilly (*Waterhousia floribunda*) in the midstorey. Weeping lillypilly was more extensive in the Bungawalbin Creek riparian zone than at Physics Creek. The habitat contains a moderate (25-50% of trees and shrubs) summer blossom resource for nectivorous fauna and a moderate fleshy fruit resource due mainly to the presence of weeping lillypilly. Winter flowering eucalypts, banksia, *Melaleuca* and *Allocasuarina* spp. are absent. Other foraging resources included occasional figs, mistletoe and wattles. The ground layer was dominated by rainforest shrubs and seedlings with a well-developed (5-10cm deep) litter layer. The combination of permanent water an intact riparian zone and dense leaf litter represents ideal foraging habitat for stream dwelling frogs such as the barred frogs (*Mixophyes* spp.). The substrate was dominated by sandy alluvium.

Sheltering/Breeding Resources

The mean density of HBT in riparian forest was 20/ha with 36 hollows/ha. Small and medium branch hollows were most common, although large trunk and branch and small trunk hollows were also represented. The abundance of HBT was higher than typically recorded in disturbed forest and emphasizes the value of riparian forest for hollow dependent fauna. The size distribution of hollows was consistent with most forests where small and medium hollows are most abundant and large and very large hollows are uncommon. All but one of the HBT was living. The hollow resource is suitable for arboreal mammals, insectivorous bats, birds and large forest owls. The creek bank with intact riparian zone, dense leaf litter and abundant overhangs represents ideal refuge habitat

for giant barred frog (*Mixophyes iteratus*). Large (>15cm diameter) woody debris was common with mean density of 88 logs/ha. Hollow logs were rare with a mean density of 8/ha.

4.3.6 Cleared Land

Cleared land occurs mainly around the disused mill and along access tracks that traverses the eastern and western property boundaries (Figure 3.1). It is highly modified but contains some natural elements such as mature trees and regrowth shrubs. Cleared land covers approximately 1.42 hectares.

Condition

Cleared land has been previously cleared and maintained as grazing pasture and access tracks. The habitat includes some mature trees and regrowth coast banksia and forest red gum. There is evidence of fire in the past 5 to 10 years and light weed infestation, mainly lantana. There is no evidence of recent livestock grazing. The habitat contains a shed and timber mill with supporting infrastructure.

Foraging Resources

Foraging resources are limited to flying insects and blossom on coastal banksia and *Angophora* spp. Regrowth eucalypts are too young to provide an important blossom resource. Insectivorous bats and birds adapted to fragmented forest would forage throughout the habitat.

Sheltering/Breeding Resources

The habitat contains several rainbow bee-eater, a migratory species listed on the EPBC Act, nests and that species was observed foraging throughout the habitat. Common birds adapted to fragmented habitats, such as Australian magpie, pied butcherbird and laughing kookaburra, would forage throughout the habitat.

4.3.7 Adequacy of Hollow-bearing Tree Densities

Hyder (2010) predicted that the Devils Pulpit upgrade would remove approximately 7.2 HBT per hectare. The average density of HBT on the subject land, excluding cleared land habitat, is 13 per hectare, almost double the density predicted for the Devils Pulpit upgrade. Although the density of HBT predicted for the subject land is based on a limited number of samples it is sufficient to conclude that the site contains a higher density than the Devils Pulpit alignment.

4.4 Threatened and Migratory Fauna Species

4.4.1 Threatened Species in the Locality

Searches of the OEH Atlas of NSW Wildlife and EPBC Act Matters of National Environmental Significance (MNES) identified 39 threatened fauna species as either known or considered likely to occur in the locality (i.e. within 10 kilometres of the subject land). An additional eight species were added to this list from unpublished data and on the basis of habitat present. Seventeen of the identified species are listed nationally as threatened on the EPBC Act.

4.4.2 Threatened Fauna Habitat Resources

The subject land provides known habitat for the black bittern (recorded during the current survey) and giant barred frog (previously recorded along Bungawalbin Creek). The subject land also provides potential habitat for

an additional 31 threatened fauna species (*Table 4.1*). Of these, the subject land provides sufficient habitat resources to support the complete lifecycles of 20 threatened fauna species. Several species including squirrel glider, yellow-bellied glider, brush-tailed phascogale, bush stone-curlew, giant barred frog, green-thighed frog, powerful owl, masked owl and southern myotis, have been recorded in proximity to the site and there is a very high likelihood that the site supports populations (or part thereof) of these species. Spotted-tailed quoll has also been recorded immediately northeast of the site.

Grassy Dry Open Forest

Grassy dry open forest provides potential habitat resources for up to 27 threatened fauna species (*Table 4.1*). It contains a range of key habitat components for threatened species, including:

- a mixed shrub layer that includes some *Banksia integrifolia*;
- ephemeral drainage depressions suitable for green-thighed frogs;
- a seasonal drainage line with small lagoons suitable as refuge habitat for threatened frogs and foraging habitat for insectivorous bats and black bittern;
- suitable perch and nest sites (tall eucalypts) for raptors situated close to high quality habitat for prey species (i.e. lorikeets & honeyeaters).
- dense grass cover and friable soils suitable for rufous bettong;
- abundant winter flowering eucalypts (i.e. grey ironbark and forest red gum) that provide valuable food resources for nectivorous threatened species including swift parrot, regent honeyeater, little lorikeet, squirrel glider, yellow-bellied glider and grey-headed flying-fox;
- known habitat for bandicoots (*Perameles* spp. & *Isodooon* spp.) which represent a food resource for spotted-tailed quoll;
- patches with sparse ground cover and rough-barked trees suitable for brush-tailed phascogale;
- forest red gum in the canopy stratum, which represents a potential koala food tree;
- open forest structure would provide suitable foraging habitat for fast flying insectivorous bats, such as east-coast freetail bat and yellow-bellied sheathtail bat;
- DOF in Bungawalbin Nature Reserve (NR) and neighboring properties has been used by emu and that species may also use DOF on the subject site; and
- moderate abundance of small and medium branch-based tree hollows, which provide suitable shelter for a variety of hollow-dependent threatened fauna including little lorikeet, squirrel glider, brush-tailed phascogale and threatened microbats.

Shrubby Dry Open Forest

Shrubby dry open forest provides potential habitat resources for 11 threatened fauna species (*Table 4.1*). It contains a range of key habitat components for threatened species, including:

- acts as a buffer to moist forest along Bungawalbin and Physics Creeks;
- contains numerous mature trees with large, medium and small trunk and branch hollows suitable for yellow-bellied glider, squirrel glider, quoll, microbats and hollow-dependent birds;
- winter flowering eucalypts (i.e. grey ironbark) that provide valuable food resources for nectivorous threatened species including the swift parrot, regent honeyeater, little lorikeet, squirrel glider, yellow-bellied glider and grey-headed flying-fox; and
- tallowwood and small-fruited grey gum and flooded gum in the canopy stratum, which represent potential koala food trees.

Swamp Forest

Swamp forest provides potential habitat resources for 13 threatened fauna species (*Table 4.1*). It contains a range of key habitat components for threatened species, including:

- winter flowering eucalypts (i.e. forest red gum and swamp mahogany) that provide valuable food resources for nectivorous threatened species including swift parrot, regent honeyeater, little lorikeet, squirrel glider, yellow-bellied glider and grey-headed flying-fox;
- forest red gum in the canopy stratum, which represents a potential koala food resource;
- areas of ephemeral to semi-permanent freshwater supporting aquatic invertebrates, which provide suitable foraging resources for a wide range of species, including threatened microbats;
- seasonally flooded paperbark forest adjoining DOF which provides breeding sites for green-thighed frog;
- a dense groundcover of sedges and rushes, which provides suitable habitat for small ground mammals, which are a primary food resource for masked owl; and
- a moderate abundance of small and medium sized branch hollows, which would provide suitable shelter for threatened hollow dependent fauna.

Riparian Forest

Riparian forest provides potential habitat resources for 19 threatened fauna species (*Table 4.1*). Key habitat components represented by riparian forest include:

- known breeding, foraging and refuge habitat for giant barred frog;
- an abundant arboreal hollow resource suitable for a range of hollow dependent species, including insectivorous bats, gliders, phascogale, quoll, threatened snakes and large-forest owls;
- a riparian corridor, with abundant hollow resource, that links most of the lowland dry sclerophyll forest in the Bungawalbin Catchment including several conservation reserves. The connectivity provided by the riparian forest would benefit most threatened species predicted to occur onsite by assisting with ecosystem function;
- fleshy fruits suitable for wompoo fruit-dove;
- riparian forest with permanent water which provides foraging habitat for specialist riparian bats such as southern myotis; and
- an open ground layer with dense leaf litter suitable for brush-tailed phascogale.

Cleared Land

Cleared land provides potential habitat resources for 11 threatened fauna species (*Table 4.1*). It contains two key habitat components for threatened species, including:

- an open woodland environment preferred by bush stone-curlew, grey-crowned babbler and, to a lesser extent, hooded robin; and
- fragmented forest that contains a small foraging resource for squirrel gliders, masked owl, spotted-tailed quoll and insectivorous bats.

Table 4.1: Potential habitat resources for threatened fauna, listed on the Atlas of NSW Wildlife or identified in the EPBC Act MNES search, in each habitat type. r – roosting/shelter habitat; f - foraging habitat; b - breeding habitat; * - limited or sub-optimal habitat; ** species included based on unpublished records.

Scientific Name	Common Name	DOF	MOF	SF	RF	L	CL
<i>Mixophyes iteratus</i>	Giant Barred Frog				r, f, b		
<i>Litoria brevipalmata</i>	Green-thighed Frog	r, f, b		r, f, b			
<i>Hoplocephalus stephensii</i>	Stephen's-banded Snake				r, b, f		
<i>Hoplocephalus bitorquatus</i>	Pale-headed Snake	r, f, b			r, f, b		
<i>Dromaius novaehollandiae</i>	Emu population	r, f, b					
<i>Ptilinopus magnificus</i>	Wompoo Fruit-Dove				r, f		
<i>Ixobrychus flavicollis</i>	Black Bittern**	r, f, b*			r, f, b		
<i>Hieraaetus morphnoides</i>	Little Eagle	r, f	r, f	r, f	r, f		
<i>Burhinus grallarius</i>	Bush Stone-Curlew**	f, r, b					f, r, b
<i>Calyptorhynchus banksii banksii</i>	Red-tailed Black-Cockatoo	f					
<i>Calyptorhynchus lathami</i>	Glossy Black-Cockatoo	f*					
<i>Glossopsitta pusilla</i>	Little Lorikeet	r, f, b	r, f, b	r, f, b	r, f, b		
<i>Lathamus discolor</i>	Swift Parrot	r, f		r, f			
<i>Ninox connivens</i>	Barking Owl	r, f, b		r, f, b	r		
<i>Ninox strenua</i>	Powerful Owl	r, f	r, f, b	r, f	r, f, b		
<i>Tyto novaehollandiae</i>	Masked Owl	f	r, f, b	f	r, f, b		f
<i>Pomatostomus temporalis temporalis</i>	Grey-crowned Babbler	f, r, b					f, r, b
<i>Anthochaera phrygia</i>	Regent Honeyeater	f, r		f, r			
<i>Meliphreptus gularis</i>	Black-chinned Honeyeater**	f, r					
<i>Melanodryas cucullata cucullata</i>	Hooded Robin						f*, r*
<i>Dasyurus maculatus</i>	Spotted-tailed Quoll	f, r*	f, r, b	f	f, r, b		f
<i>Phascogale tapoatafa</i>	Brush-tailed Phascogale	f, r, b			f, r, b		
<i>Phascolarctos cinereus</i>	Koala	f*, r, b*	f*, r, b*	f*, r, b*			
<i>Petaurus australis</i>	Yellow-bellied Glider	f	f	f	f, r, b		
<i>Petaurus norfolcensis</i>	Squirrel Glider	f, b, r	f, r, b	f, r, b	f, r, b		f
<i>Aepyprymnus rufescens</i>	Rufous Bettong	f, r, b					
<i>Pteropus poliocephalus</i>	Grey-headed Flying-fox	f	f	f	f, r		f
<i>Miniopterus australis</i>	Little Bentwing-bat		f, r, b		f, r, b	f	f
<i>Miniopterus schreibersii oceanensis</i>	Eastern Bentwing-bat		f		f	f	f
<i>Myotis macropus</i>	Southern Myotis				f, r, b		
<i>Nyctophilus bifax</i>	Eastern Long-eared Bat				f, r, b	f	
<i>Chalinolobis dwyeri</i>	Large-eared Pied Bat	f*		f*		f*	
<i>Scoteanax rueppellii</i>	Greater Broad-nosed Bat**	f, r					
<i>Saccolaimus flaviventris</i>	Yellow-bellied Sheath-tail Bat**	f, r					f
<i>Mormopterus norfolcensis</i>	East-coast Freetail Bat**	f, r					f
<i>Pseudomys novaehollandiae</i>	New Holland Mouse	f*, r*, b*					

4.4.3 Nationally Listed Threatened Fauna Species

Four Nationally listed threatened species, swift parrot, regent honeyeater, spotted-tailed quoll and grey-headed flying-fox, were deemed likely to be affected by the Devils Pulpit upgrade (Hyder 2010). The Conditions of Approval for the upgrade specified the need to provide 152 hectares of suitable habitat as compensation. In northern NSW swift parrots are known to forage on mature forest red gum and narrow-leaved ironbark (DPIWE

2001). Forest red gum is a dominant canopy species within the dry open forest habitat and also occurs in swamp forest, although mature specimens are uncommon. In coastal northern NSW, where they are an uncommon visitor, regent honeyeaters forage on swamp mahogany and spotted gum (OEH 2012), although they are also known to forage on forest red gum (Higgins *et al.* 2001), which is the dominant canopy species in dry open forest. The predicted area of potential habitat on the subject land for both swift parrot and regent honeyeater is 249 hectares (Table 4.2). The potential value of DOF will improve as the forest ages.

Grey-headed flying-fox forage on a range of blossom and fruit (Churchill 2008). Due to the abundance of myrtaceous species the entire subject site contains potential foraging habitat for grey-headed flying-fox. Individuals may occasionally roost in riparian forest, although the site does not contain a known camp. The status of spotted-tailed quoll in coastal north-eastern NSW is unclear. There are records of spotted-tailed quoll immediately north of the subject site, to the east and west. Spotted-tailed quolls have broad habitat requirements and forage in both moist and dry forest types (Menkhorst & Knight 2004). A key feature of habitat seems to be abundant supply of prey, which includes both arboreal and ground mammals, and availability of dens. The subject land (and locality) is suspected to contain a moderate abundance of ground and arboreal mammals that could support quolls. Given the species broad habitat requirements and the predicted (moderate) abundance of potential prey it is likely that quolls would occupy large home ranges and use a range of habitat types in the locality.

Table 4.2: Extent of potential habitat for nationally listed threatened fauna species on the subject land.

Species	Predicted Habitats	Total area of Habitat (ha)
Swift Parrot	Dry Open Forest	249
Regent Honeyeater	Dry Open Forest	249
Spotted-tailed Quoll	Dry Open Forest, Moist Open Forest and Riparian Forest	364
Grey-headed Flying-fox	All habitats	387

4.4.4 Migratory Species

Six nationally listed migratory species, pacific black duck, wedge-tailed eagle, white-throated needletail, black-faced monarch, rufous fantail and rainbow bee-eater, were recorded on the subject land during the field survey. The EPBC Act internet-based database predicts the occurrence of a further three migratory species in the locality (Table 4.3). Fork-tailed swift is predicted to forage above the site. Moist open forest and riparian forest are predicted to provide the most important foraging and roosting habitat for a suite of small passerines that use moister habitats during migration. Rainbow bee-eater was recorded foraging and nesting in cleared land.

Table 4.3: Potential habitat resources for migratory fauna species in each habitat type on the subject land. r - roosting habitat; f - foraging habitat; b - breeding habitat; * - limited or sub-optimal habitat.

Scientific Name	Common Name	DOF	MOF	SS	RF	CL
<i>Anas superciliosa</i>	Pacific Black Duck	f, r			f, r	
<i>Aquila audax</i>	Wedge-tailed Eagle	f	r, b		r	f
<i>Apus pacificus</i>	Fork-tailed Swift					
<i>Hirundapus caudacutus</i>	White-throated Needletail					
<i>Merops ornatus</i>	Rainbow Bee-eater	f				f, r, b
<i>Monarcha melanopsis</i>	Black-faced monarch		f, r		f, r	
<i>Monarcha trivirgatus</i>	Spectacled Monarch		f, r		f, r	
<i>Myiagra cyanoleuca</i>	Satin Flycatcher		f, r		f, r, b	
<i>Rhipidura rufifrons</i>	Rufous Fantail		f, r		f, r	

4.5 Habitat Connectivity

There is general consensus in the scientific community that establishing and maintaining landscape connectivity between habitat remnants within a fragmented landscape enhances the long-term conservation value of the areas being reserved (Meffe & Carroll 1994; Bennett 2003). Therefore, the potential long-term conservation value of the subject land will be higher if it forms part of a linked system of multiple remnants rather than being isolated within a fragmented landscape.

At a local level, the subject land connects the mosaic of habitat types contained within the Bungawalbin NR immediately north with extensive floodplain forest and riparian habitats retained on private lands east, west and south of the site. Furthermore, the southern portion of the subject land is likely to represent an important riparian corridor, linking most of the lowland dry sclerophyll forest in the Bungawalbin Catchment including several conservation reserves and private properties with conservation covenants.

In terms of regional corridor function, the subject land has been identified and mapped as part of a regional wildlife corridor (Scotts *et al.* 2003).

4.6 Habitat Conservation Value

In terms of providing habitat resources for threatened and migratory fauna species the dry open forest and riparian forest habitats have high conservation value, the swamp forest and moist open forest have moderate conservation value and area of cleared land has relatively low conservation value. However, the collective value of habitat resources on the subject land is an example of the whole being greater than the sum of its parts, the overall conservation value of the site being greater than that of the sum of each habitat type. The two main reasons for this greater overall conservation value are :

- the high diversity of habitat types with complimentary habitat resources in close proximity to each other ; and
- important wildlife corridor function of the overall site and particularly the linkage with Bungawalbin Creek.

4.6.1 Local Conservation Value

With the exception of the cleared land all of the habitat types on the subject site have high conservation value at the local level. The diverse mosaic of poorly conserved coastal floodplain habitat types provide valuable extensions to habitats contained within Bungawalbin NR and surrounding tracts of private native forest. Protection of habitats on the subject land would also enhance the viability of local populations of threatened fauna with large home ranges such as threatened forest owls, brush-tailed phascogale, yellow-bellied glider and spotted-tailed quoll by forming a larger contiguous area of protected habitat in the locality.

4.6.2 Regional Conservation Value

As mentioned previously, the subject land provides regional wildlife corridor functions (Scotts *et al.* 2003). The site also provides potential habitat resources for up to 33 state listed threatened fauna species. In addition, habitat resources on the subject land are sufficient to accommodate the lifecycles of up to 20 of the state listed threatened fauna species known or likely to occur in the locality. The subject land would also provide suitable drought refuge habitat for several threatened fauna species including regent honeyeater, green-thighed frog, giant barred frog and black-chinned honeyeater.

4.6.3 National Conservation Value

The subject land provides potential habitat resources for seven nationally listed threatened fauna species and nine nationally listed migratory species. Furthermore, habitat resources on site are suitable for all stages of the lifecycles of three nationally listed threatened species and two migratory species. The subject land would provide suitable drought refuge for the nationally listed regent honeyeater, protect known habitat for giant-barred frog and provide a staging area for migratory species.

5 SUITABILITY FOR ACQUISITION

The following discussion relates the assessment findings to the objectives stated in *Section 1.2.2* to determine whether the subject land meets the selection criteria for offset lands as stipulated in the Pacific Highway Upgrade Devil's Pulpit Biodiversity Offset Strategy.

5.1 Location of the Study Area

The first selection criterion is that the subject land is to be located within a 30 kilometre radius of the upgrade project. The subject land is situated within 15 kilometres of the Devil's Pulpit Pacific Highway Upgrade.

5.2 Consistency of Vegetation Types

The second selection criterion is that the subject land contains vegetation types consistent with those affected by the upgrade project. The subject land contains approximately 341.46 hectares of native vegetation types consistent with those affected by the upgrade project (*Table 5.1*). The subject land also contains 46.24 hectares of vegetation types additional to those affected by the upgrade project.

Table 5.1: Comparison of equivalent vegetation types available as compensatory habitat on the subject land.

Affected Vegetation Communities	Area Impacted by the Upgrade Project (ha)	Equivalent Vegetation Types on the Subject Land	Available Offset Area (ha)
Blackbutt - Spotted Gum shrubby open forest on sandstones of the lower Clarence Valley of the North Coast	56	Grey Gum-Grey Ironbark Open Forest of the Clarence Lowlands of the North Coast	92.35
Scribbly Gum - Red Bloodwood heathy open forest of the coastal lowlands of the North Coast			
Spotted Gum - Grey Ironbark - Pink Bloodwood open forest of the Clarence Valley lowlands of the North Coast			
Narrow-leaved Red Gum woodlands of the lowlands of the North Coast	18.6	Narrow-leaved Red Gum woodlands of the lowlands of the North Coast	249.11
Forest Red Gum - Swamp Box of the Clarence Valley lowlands of the North Coast		Forest Red Gum - Swamp Box of the Clarence Valley lowlands of the North Coast	

5.3 Suitability for Threatened Species and Migratory Fauna

The third selection criterion is that the subject land must contain habitats suitable for the threatened species impacted by the upgrade project (including patch sizes).

5.3.1 Threatened Flora

Potential habitat exists on the subject land for up to 30 threatened flora species including the two species potentially affected by the Devil’s Pulpit upgrade, *Cyperus aquatilis* and *Maundia triglochoides*. Consequently, the subject land contains suitable habitat for all of the threatened flora species potentially affected by the upgrade project.

5.3.2 Threatened Fauna

A total of 27 threatened fauna species were known or predicted to be affected by the Devils Pulpit upgrade (Table 5.2). The subject land contains suitable habitat for 21 of these species and an additional 14 species are predicted to occur. Affected threatened fauna species for which suitable habitat does not exist on the subject land have specific habitat requirements or restricted distributions, for example:

- caves (i.e. eastern cave bat);
- acid swamps (wallum froglet);
- specific food resource (glossy black cockatoo);
- mature open forest (brown treecreeper).

Glossy black cockatoo and brown treecreeper are known to occur in the locality. Glossy-black cockatoo may occasionally traverse the site but there is insufficient foraging habitat (i.e. Allocasuarina stands) to support birds.

Table 5.2: Likely occurrence on the subject property of threatened fauna known or predicted to occur in the Devils Pulpit upgrade corridor. * - habitat predicted to be sub-optimal.

Status	Common Name	Status		Predicted use of the Subject Property
		TSC	EPBC	
Threatened Species	Wallum Froglet	V		
	Green-thighed Frog	V		✓
	Koala	V	V	✓*
	Spotted-tailed Quoll	V	E	✓
	Brush-tailed Phascogale	V		✓
	Rufous Bettong	V		✓
	Squirrel Glider	V		✓
	Yellow-bellied Glider	V		✓
	Grey-headed Flying-fox	V	V	✓
	Large-footed Myotis	V		✓
	Greater Broad-nosed Bat	V		✓
	Eastern Falsistrelle	V		
	Yellow-bellied Sheath-tail Bat	V		✓
	Little Bentwing Bat	V		✓
	Eastern Bentwing Bat	V		✓
	Hoary Wattled Bat	V		
	Eastern Cave Bat	V		
	East-coast Freetail Bat	V		✓
	Emu	EP		✓
	Glossy Black-Cockatoo	V		

Status	Common Name	Status		Predicted use of the Subject Property
		TSC	EPBC	
Migratory Species	Little Lorikeet	V		✓
	Barking Owl	V		✓
	Masked Owl	V		✓
	Powerful Owl	V		✓
	Brown Treecreeper	V		
	Grey-crowned Babbler	V		✓
	Black-chinned Honeyeater	V		✓
	Brown Goshawk		M	✓
	Pacific Baza		M	✓
	Collared Sparrowhawk		M	✓
	Masked Lapwing		M	
	White-throated Needletail		M	✓
	Fork-tailed Swift		M	✓

5.4 Vegetation Condition

The fourth selection criterion is that the subject land must comprise vegetation of at least moderate to good condition (according to OEH native vegetation benchmarks database).

All of the native vegetation communities on the subject land are in 'moderate to good' (benchmark) condition indicating they are of high to very high conservation value. The only vegetation on the site in low condition is that persisting within areas of cleared land, which represents a very small proportion of the subject land.

5.5 Habitat Connectivity

The fifth selection criterion is that the subject land must comprise land that enables connectivity between adjacent areas of vegetation.

As discussed in *Section 4.3*, the subject land provides important local and regional habitat connectivity functions. The subject land connects Bungawalbin NR with extensive floodplain forest and riparian habitats on private land and provides an important riparian corridor, linking most of the lowland dry sclerophyll forest in the Bungawalbin Catchment including several conservation reserves. The subject land is also recognized as a regional wildlife corridor.

5.6 Suitability for Ongoing Conservation Management

The final selection criterion is that the subject land must be suitable for ongoing management for conservation through an appropriate legal instrument. OEH has identified the subject land as having potentially high conservation value. Furthermore, the subject land adjoins Bungawalbin NR, which is currently managed for conservation by the Parks and Wildlife group of OEH. Consequently, the land would be suitable for purchase by RMS, upon which it could be handed over to OEH for addition to Bungawalbin NR.

6 MANAGEMENT CONSIDERATIONS

Future management of the subject land should aim to protect existing conservation values of the land and rehabilitate areas that are currently in 'low' condition or under threat of losing condition due to ongoing impacting processes. Management considerations for the subject land have been summarized in *Table 6.1*. Final management works could be developed and undertaken by the Parks and Wildlife group of the Office of Environment and Heritage (OEH) as part of the long term management of the subject land.

Table 6.1: Summary of management recommendations, potential performance measures and priorities for action for the subject land.

Recommendation	Performance Measure	Priority
Administrative and Planning		
The subject land is proposed as part of the compensatory land package for offsetting the Devil's Pulpit Pacific Highway Upgrade.	The property is proposed to OEH and DoP for consideration as suitable compensatory land.	High
The subject land be purchased and transferred from its private freehold tenure to conservation estate (Bungawalbin NR) managed by the Parks & Wildlife Group of OEH.	RMS purchase the property for incorporation into the NPWS reserve system.	High
Revegetation		
Active weed control to be undertaken in areas currently infested with lantana and groundsel bush. Revegetate existing non-essential vehicle and pedestrian access tracks and ascertain need for active assistance in weed suppression and native regrowth enhancement.	Weed levels are reduced. Disturbed areas assessed and appropriate regeneration strategies implemented.	Medium
Plan of Management (PoM)		
Management requirements and priorities for the subject land should be prepared and incorporated into the existing Bungawalbin NR Plan of Management (PoM). The amended PoM should take into account any information arising from environmental and cultural heritage surveys that have been or are currently being undertaken. The PoM should include site-specific weed management strategies to address both noxious and environmental weeds affecting native vegetation on the subject land.	A PoM for the subject land is prepared and implemented in accordance with actions and priorities in the Bungawalbin NR PoM. The PoM will contain weed management strategies consistent with the requirements of controlling noxious weeds in the Richmond Valley LGA.	Medium

7 CONCLUSIONS

The subject land compares favourably with the selection criteria for offset lands as stipulated in the Pacific Highway Upgrade Devil's Pulpit Biodiversity Offset Strategy. The site has many features that make it suitable for acquisition as part of a compensatory habitat package for the Devil's Pulpit upgrade project or other RMS projects in the Northern NSW Bioregion, including:

- close proximity to the upgrade project;
- the subject land adjoins existing conservation reserves and other large tracts of native vegetation;
- the subject land contains a diverse range of habitat types that provide suitable habitat resources for 33 threatened fauna species and 30 threatened plant species;
- the subject land contains a wide range of key habitat components for threatened fauna;
- the subject land contains three EECs covering a total of approximately 271.32 hectares; and
- the subject land provides important local and regional wildlife corridor functions.

In conclusion, the site would be a worthy acquisition either as part compensation for the upgrade project or as compensatory habitat for other RMS projects in the North Coast Bioregion. Of particular note is the occurrence of known habitat for the giant barred frog (*Mixophyes iteratus*) on the subject land, which may present a suitable offset option for removal of this species' habitat on the Sapphire to Woolgoolga Pacific Highway Upgrade Project.

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APPENDIX A

FLORA SPECIES RECORDED DURING FIELD SAMPLING

Table A1: Vascular plant species recorded on the subject land.

Family	Species	Exotic	Common Name
Fabaceae - Mimosoideae	<i>Acacia concurrens</i>		Curracabah
Fabaceae - Mimosoideae	<i>Acacia fimbriata</i>		Fringe Wattle
Fabaceae - Mimosoideae	<i>Acacia irrorata</i>		Green Wattle
Fabaceae - Mimosoideae	<i>Acacia melanoxydon</i>		Blackwood
Fabaceae - Mimosoideae	<i>Acacia longissima</i>		
Fabaceae - Mimosoideae	<i>Acacia longifolia</i> subsp. <i>longifolia</i>		Sydney Golden Wattle
Adiantaceae	<i>Adiantum aethiopicum</i>		Common Maidenhair
Casuarinaceae	<i>Allocasuarina littoralis</i>		Black Oak
Casuarinaceae	<i>Allocasuarina torulosa</i>		Forest Oak
Rhamnaceae	<i>Alphitonia excels</i>		Red Ash
Asteraceae	<i>Ambrosia artemisiifolia</i>	Y	Annual Ragweed
Myrtaceae	<i>Angophora subvelutina</i>		Broad-leaved Apple
Poaceae	<i>Andropogon virginicus</i>	Y	Whiskey Grass
Poaceae	<i>Aristida vagans</i>		Three-awn Speargrass
Asteraceae	<i>Baccharis halimifolia</i>	Y	Groundsel Bush
Proteaceae	<i>Banksia integrifolia</i> subsp. <i>integrifolia</i>		Coast Banksia
Proteaceae	<i>Banksia oblongifolia</i>		Fern-leaved Banksia
Cyperaceae	<i>Baumea articulate</i>		Jointed Twig-rush
Cyperaceae	<i>Baumea juncea</i>		Twig-rush
Cyperaceae	<i>Baumea rubiginosa</i>		
Asteraceae	<i>Bidens pilosa</i>	Y	Cobbler's Pegs
Blechnaceae	<i>Blechnum indicum</i>		Swamp Water Fern
Phyllanthaceae	<i>Breynia oblongifolia</i>		Coffee Bush
Myrtaceae	<i>Callistemon salignus</i>		Willow Bottlebrush
Casuarinaceae	<i>Casuarina glauca</i>		Swamp Oak
Apiaceae	<i>Centella asiatica</i>		Indian Pennywort
Sinopteridaceae	<i>Cheilanthes sieberi</i>		Mulga Fern
Vitaceae	<i>Cissus Antarctica</i>		Water Vine
Vitaceae	<i>Cissus hypoglauca</i>		Water Vine
Asteraceae	<i>Conyza bonariensis</i>	Y	Flaxleaf Fleabane
Asteraceae	<i>Conyza</i> sp.	Y	
Asteliaceae	<i>Cordyline stricta</i>		Narrow-leaved Palm Lily
Myrtaceae	<i>Corymbia intermedia</i>		Pink Bloodwood
Lauraceae	<i>Cryptocarya triplinervis</i> var. <i>triplinervis</i>		Three-veined Cryptocarya
Poaceae	<i>Cymbopogon refractus</i>		Barbed Wire Grass
Poaceae	<i>Cynodon dactylon</i>		Couch
Amaranthaceae	<i>Deeringia amaranthoides</i>		Deeringia
Phormiaceae	<i>Dianella caerulea</i>		Blue Flax-lily
Phormiaceae	<i>Dianella longifolia</i>		Blue Flax-lily
Phormiaceae	<i>Dianella revolute</i>		Blue Flax-lily
Convolvulaceae	<i>Dichondra repens</i>		Kidney Weed
Dioscoreaceae	<i>Dioscorea transversa</i>		Native Yam
Sapindaceae	<i>Dodonaea triquetra</i>		Large-leaf Hop-bush
Solanaceae	<i>Duboisia myoporoides</i>		Corkwood
Poaceae	<i>Echinopogon ovatus</i>		Forest Hedgehog Grass
Elaeocarpaceae	<i>Elaeocarpus reticulatus</i>		Blueberry Ash
Lauraceae	<i>Endiandra muelleri</i>		Green-leaved Rose Walnut
Lauraceae	<i>Endiandra sieberi</i>		Hard Corkwood
Poaceae	<i>Entolasia marginata</i>		Bordered Panic
Poaceae	<i>Entolasia stricta</i>		Wiry Panic
Poaceae	<i>Eragrostis</i> sp.		
Myrtaceae	<i>Eucalyptus grandis</i>		Flooded Gum
Myrtaceae	<i>Eucalyptus microcorys</i>		Tallowwood
Myrtaceae	<i>Eucalyptus propinqua</i>		Small-fruited Grey Gum
Myrtaceae	<i>Eucalyptus robusta</i>		Swamp Mahogany
Myrtaceae	<i>Eucalyptus seeana</i>		Narrow-leaved Red Gum
Myrtaceae	<i>Eucalyptus siderophloia</i>		Grey Ironbark
Myrtaceae	<i>Eucalyptus tereticornis</i>		Forest Red Gum
Luzuriagaceae	<i>Eustrephus latifolius</i>		Wombat Berry
Santalaceae	<i>Exocarpus cupressiformis</i>		Cherry Ballart
Moraceae	<i>Ficus coronate</i>		Creek Sandpaper Fig
Cyperaceae	<i>Gahnia aspera</i>		Rough Saw-sedge

Family	Species	Exotic	Common Name
Cyperaceae	<i>Gahnia clarkei</i>		Tall Saw-sedge
Luzuriagaceae	<i>Geitonoplesium cymosum</i>		Scrambling Lily
Geraniaceae	<i>Geranium</i> sp.		
Phyllanthaceae	<i>Glochidion ferdinandi</i>		Cheese Tree
Fabaceae - Faboideae	<i>Glycine</i> sp.		
Asteraceae	<i>Gnaphalium sphaericum</i>	Y	Common Cudweed
Sapindaceae	<i>Guioa semiglauc</i>		Guioa
Dilleniaceae	<i>Hibbertia dentata</i>		Twining Guinea Flower
Dilleniaceae	<i>Hibbertia obtusifolia</i>		Hoary Guinea Flower
Dilleniaceae	<i>Hibbertia scandens</i>		Climbing Guinea Flower
Asteraceae	<i>Hypochaeris radicata</i>	Y	Catsear
Dennstaedtiaceae	<i>Hypolepis muelleri</i>		Harsh Ground Fern
Poaceae	<i>Imperata cylindrica</i>		Blady Grass
Sapindaceae	<i>Jagera pseudorhus</i>		Foambark
Verbenaceae	<i>Lantana camara</i>	Y	Lantana
Cyperaceae	<i>Lepidosperma laterale</i>		
Cyperaceae	<i>Lepironia articulata</i>		Jointed Twig-rush
Lomandraceae	<i>Lomandra longifolia</i>		Spiny-headed Mat-rush
Lomandraceae	<i>Lomandra multiflora</i>		Many-flowered Mat-rush
Myrtaceae	<i>Lophostemon confertus</i>		Brush Box
Myrtaceae	<i>Lophostemon suaveolens</i>		Swamp Box
Moraceae	<i>Maclura cochinchinensis</i>		Cockspur Thorn
Myrtaceae	<i>Melaleuca alternifolia</i>		Tea-tree
Myrtaceae	<i>Melaleuca nodosa</i>		Prickly-leaved Paperbark
Myrtaceae	<i>Melaleuca quinquenervia</i>		Broad-leaved Paperbark
Myrtaceae	<i>Melaleuca sieberi</i>		
Poaceae	<i>Microlaena stipoides</i> var. <i>stipoides</i>		Weeping Grass
Rubiaceae	<i>Morinda jasminoides</i>		Sweet Morinda
Myrsinaceae	<i>Myrsine howittiana</i>		Brush Muttonwood
Myrsinaceae	<i>Myrsine variabilis</i>		Muttonwood
Lauraceae	<i>Neolitsea dealbata</i>		White Bolly Gum
Oleaceae	<i>Notelaea longifolia</i>		Large Mock-olive
Oleaceae	<i>Notelaea venosa</i>		Smooth Mock-olive
Nymphaeaceae	<i>Nymphaea caerulea</i> subsp. <i>Zanzibarensis</i>	Y	Cape Waterlily
Poaceae	<i>Oplismenus aemulus</i>		Basket Grass
Poaceae	<i>Oplismenus imbecillis</i>		
Poaceae	<i>Ottocloa gracillima</i>		
Oxalidaceae	<i>Oxalis perennans</i>		Woodsorrel
Asteraceae	<i>Ozothamnus diosmifolius</i>		White Dogwood
Poaceae	<i>Panicum simile</i>		Two-colour Panic
Apocynaceae	<i>Parsonia straminea</i>		Common Silkpod
Poaceae	<i>Paspalum dilatatum</i>	Y	Paspalum
Poaceae	<i>Paspalum urvillei</i>	Y	Vasey Grass
Proteaceae	<i>Persoonia stradbrokeensis</i>		
Philydraceae	<i>Philydrum lanuginosum</i>		Woolly Frogmouth
Thymelaeaceae	<i>Pimelea linifolia</i> subsp. <i>linifolia</i>		
Lobeliaceae	<i>Pratia purpurascens</i>		Whiteroot
Rubiaceae	<i>Psychotria loniceroides</i>		Hairy Psychotria
Dennstaedtiaceae	<i>Pteridium esculentum</i>		Bracken
Fabaceae - Faboideae	<i>Pultenaea villosa</i>		Hairy Bush-pea
Smilacaceae	<i>Ripogonum album</i>		White Supplejack
Poaceae	<i>Rhynchelytrum repens</i> *		Red Natal Grass
Asteraceae	<i>Senecio madagascariensis</i>	Y	Fireweed
Malvaceae	<i>Sida rhombifolia</i>	Y	Paddy's Lucerne
Smilacaceae	<i>Smilax australis</i>		Wait-a-while
Smilacaceae	<i>Smilax glycyphylla</i>		Sweet Sarsaparilla
Solanaceae	<i>Solanum mauritianum</i>	Y	Wild Tobacco
Menispermaceae	<i>Stephania japonica</i> var. <i>discolor</i>		Snake Vine
Poaceae	<i>Themeda australis</i>		Kangaroo Grass
Ulmaceae	<i>Trema aspera</i>		Native Peach
Juncaginaceae	<i>Triglochin procer</i>		Water Ribbons
Ericaceae - Styphelioideae	<i>Trochocarpa laurina</i>		Tree Heath
	<i>Trophis scandens</i>		Burny Vine

Family	Species	Exotic	Common Name
Violaceae	<i>Viola hederacea</i>		Native Violet
Myrtaceae	<i>Waterhousia floribunda</i>		Weeping Lilly Pilly
Monimiaceae	<i>Wilkiea huegeliana</i>		Veiny Wilkiea
Xanthorrhoeaceae	<i>Xanthorrhoea fulva</i>		Grass-tree
Xanthorrhoeaceae	<i>Xanthorrhoea macronema</i>		Grass-tree

APPENDIX B

FAUNA SPECIES RECORDED DURING FIELD SAMPLING

Table B1: List of fauna recorded opportunistically in the subject land during the site assessment.

Group	Species Name	Common Name	
Birds	<i>Anas superciliosa</i>	Pacific Black Duck ^M	
	<i>Ixobrychus flavicollis</i>	Black Bittern ^{V, NSW}	
	<i>Aquila audax</i>	Wedge-tailed Eagle ^M	
	<i>Phaps chalcoptera</i>	Common Bronzewing	
	<i>Geopelia striata</i>	Peaceful Dove	
	<i>leucosarcia melanoleuca</i>	Wonga Pigeon	
	<i>Alisterus scapularis</i>	Australian King Parrot	
	<i>Trichoglossus haematodus</i>	Rainbow Lorikeet	
	<i>Cacomantis variolosus</i>	Brush Cuckoo	
	<i>Cacomantis flabelliformis</i>	Fan-tailed Cuckoo	
	<i>Eudynamys scolopacea</i>	Common Koel	
	<i>Hirundapus caudacutus</i>	White-Throated Needletail ^M	
	<i>Alcedo azurea</i>	Azure Kingfisher	
	<i>Dacelo novaeguineae</i>	Laughing Kookaburra	
	<i>Todiramphus sanctus</i>	Sacred Kingfisher	
	<i>Merops ornatus</i>	Rainbow Bee-eater ^M	
	<i>Cormobates leucophaeus</i>	White-throated Treecreeper	
	<i>Malurus lamberti</i>	Varigated Fairy-wren	
	<i>Sericornis frontalis</i>	White-browed Scrubwren	
	<i>Gerygone olivacea</i>	White-throated Gerygone	
	<i>Acanthiza pusilla</i>	Brown Thornbill	
	<i>Philemon corniculatus</i>	Noisy Friarbird	
	<i>Manorina melanocephala</i>	Noisy Miner	
	<i>Meliphaga lewinii</i>	Lewins Honeyeater	
	<i>Lichenostomus chrysops</i>	Yellow-faced Honeyeater	
	<i>Lichenostomus fuscus</i>	Fucous Honeyeater	
	<i>Acanthorhynchus tenuirostris</i>	Eastern Spinebill	
	<i>Myzomela sanguinolenta</i>	Scarlet Honeyeater	
	<i>Eopsaltria australis</i>	Eastern Yellow Robin	
	<i>Pomatostomus temporalis</i>	Grey-crowned Babbler ^{V, NSW, S}	
	<i>Pachycephala rufiventris</i>	Rufous Whistler	
	<i>Colluricincla harmonica</i>	Grey Shrike Thrush	
	<i>Monarcha trivirgatus</i>	Spectacled Monarch ^M	
	<i>Myiagra rubecula</i>	Leaden Flycatcher	
	<i>Rhipidura rufifrons</i>	Rufous Fantail ^M	
	<i>Rhipidura fuliginosa</i>	Grey Fantail	
	<i>Rhipidura leucophrys</i>	Willie Wagtail	
	<i>Coracina papuensis</i>	White-bellied Cuckoo-shrike	
	<i>Coracina tenuirostris</i>	Cicadabird	
	<i>Oriolus sagittatus</i>	Olive-backed Oriole	
	<i>Artamus leucorhynchus</i>	White-breasted Woodswallow	
	<i>Cracticus nigrogularis</i>	Pied Butcherbird	
	<i>Gymnorhina tibicen</i>	Australian Magpie	
	<i>Neochima temporalis</i>	Red-browed Finch	
	<i>Dicaeum hirundinaceum</i>	Mistletoebird	
	Mammals	<i>Pseudocheirus peregrinus</i>	Common Ringtail Possum ^S
		<i>Macropus rufogriseus</i>	Red-necked Wallaby
<i>Macropus giganteus</i>		Eastern Grey Kangaroo	
<i>Sus scrofa</i>		Feral Pig ^{I, S}	

Group	Species Name	Common Name
	<i>Canis familiaris</i>	Feral Dog ^{I, S}
	<i>Vulpes vulpes</i>	Red Fox ^{I, S}
Reptiles	<i>Physignathus lesueurii</i>	Water Dragon
	<i>Pogona barbata</i>	Bearded Dragon
	<i>Dendrelaphis punctulata</i>	Green Tree Snake
	<i>Varanus varius</i>	Lace Monitor
	<i>Chelodina longicollis</i>	Snake-necked turtle
	<i>Eulamprus quoyii</i>	Eastern Water Skink
	<i>Emydura macquarii</i>	Macquarii Turtle
Frogs	<i>Litoria fallax</i>	Eastern Dwarf Tree Frog
	<i>Litoria dentata</i>	Bleating Tree Frog
	<i>Litoria latopalmata</i>	Broad-palmed Frog

I = introduced species; M = migratory species; S = identified by signs; V = vulnerable; NSW = New South Wales.