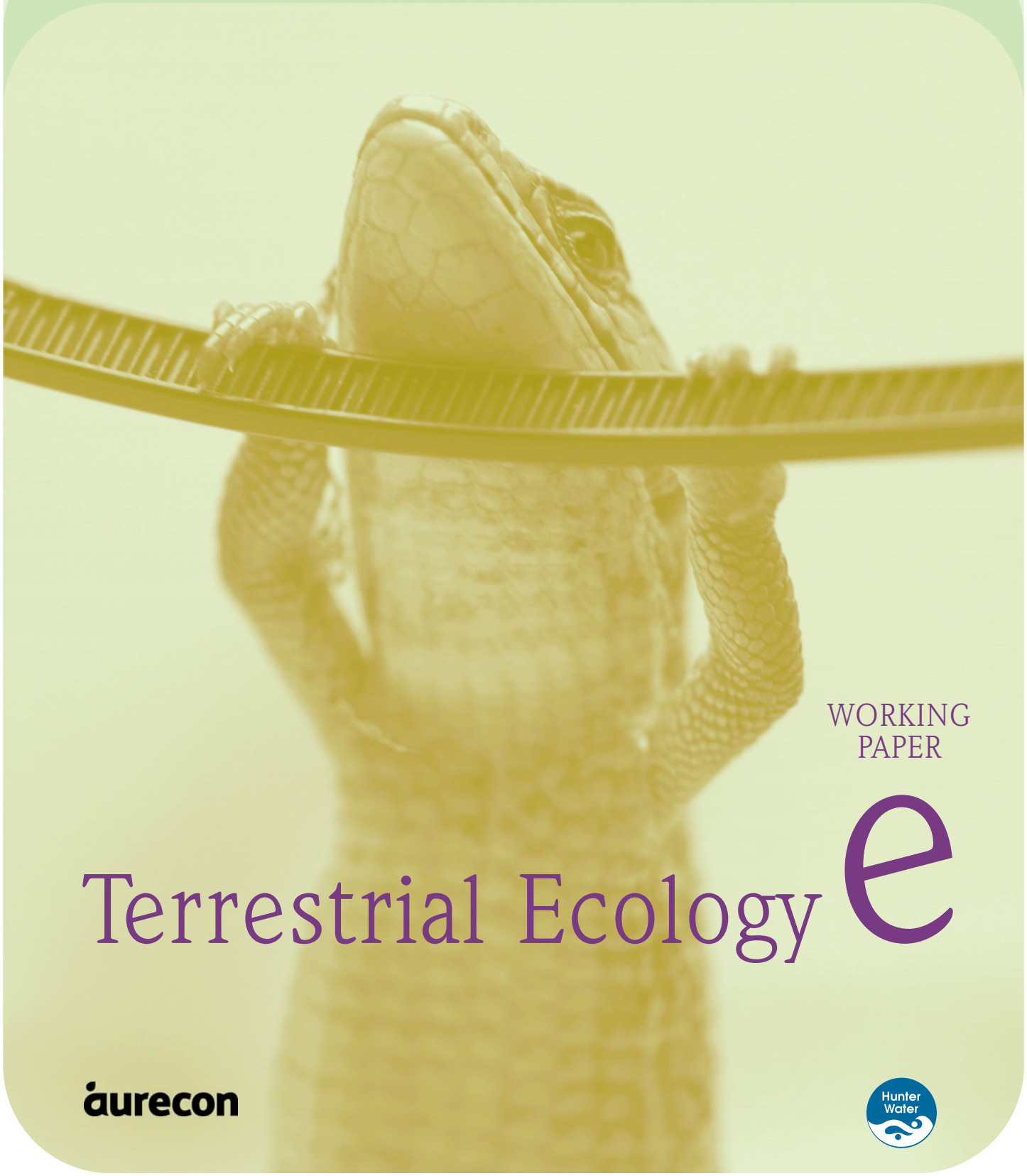
Tillegra Dam

Planning and Environmental Assessment



WORKING PAPER

Terrestrial Ecology e

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Hunter Water

SPECIALIST TERRESTRIAL ECOLOGY REPORT

FOR THE PROPOSED CONSTRUCTION & OPERATION OF THE TILLEGRA DAM, WEST OF DUNGOG, NSW

FINAL REPORT

Prepared for
Connell Wagner Pty Ltd
and Hunter Water Corporation

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EEC PROJECT No. 0583CW
26 September 2008
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EXECUTIVE SUMMARY

This report assesses the potential impacts on flora and fauna of the proposed Tillegra Dam. In order to determine those threatened species, populations and endangered ecological communities that may be present within the study area, a combination of literature review and habitat assessment was undertaken. Following this, field survey work was undertaken in order to compile a list of species present and prepare vegetation mapping for the study area. The results of the field surveys assisted in assessing the potential impacts of the Proposal on the terrestrial ecology of the study area, including threatened species, populations and endangered ecological communities.

The study area is situated within a rural landscape with large areas of bushland contained in reserves and state forests further to the north. The vast majority of land within the study area was found to consist of cleared pasture with scattered trees. Areas of remnant native vegetation are limited mainly to riparian zones, Tillegra Travelling Stock Reserve (TSR) and slopes and ridges north and south of the proposed dam area. As a result of the undulating terrain and presence of natural springs, those areas of remnant vegetation that do occur within the study area contain a range of habitats including riparian zones, areas of rainforest and drier sclerophyll forest.

The overall species diversity was found to be high with a total of 315 flora species from 100 families identified. This total includes 21 ferns, 220 dicotyledons and 73 monocotyledons. Of the total species recorded, 78 species of exotic flora were identified, representing approximately 25% of the total species. A total of 157 fauna species were positively identified (comprising 95 bird, 32 mammal, 16 frog and 14 reptile species). A further five species of insectivorous bat were given a probable identification and two species given a tentative (possible) identification based on ultrasonic call analysis.

Eight threatened fauna species, two endangered ecological communities and one intergrade endangered ecological community were positively identified within the study area. Additional threatened flora and fauna species have potential to occur, based on the availability of suitable habitat.

An assessment of impact on those threatened species and endangered ecological communities recorded or with potential to occur within the study area has been undertaken in accordance with Part 3A of the NSW *Environmental Planning and Assessment Act 1979* and the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*. Given the size of the proposed inundation area and extent of clearing likely to be required, large areas of habitat for a number of these threatened species and endangered ecological communities are expected to be impacted.

In particular the proposal is likely to result in the loss of approximately 145 hectares of the endangered ecological community *River-flat Eucalypt Forest on Coastal Floodplains* protected under the NSW *Threatened Species Conservation Act 1995*. Further, a number of threatened fauna species would be displaced from the subject site. These losses cannot be avoided or mitigated and would need to be offset.

Where ever possible, offsets should be located in areas that have similar ecological characteristics, to allow like for like or better conservation outcomes to occur (DECC 2007b). On this basis, to achieve the offsetting principle, restoration of river-flat floodplain habitat upstream and downstream of the inundation area would need to occur. As this land would not be owned by the Hunter Water Corporation any revegetation proposal would need to be carried out with the permission of land owners in these areas.

As landholder permission may be difficult to secure in certain circumstances, an alternate offset proposal is to establish a riparian habitat corridor around the dam on HWC owned land. Whilst this would perform similar functions as the existing riparian vegetation in terms of providing habitat for native fauna as well as connectivity with other vegetation communities above and below the dam, it should be noted that the above EEC is unlikely to regenerate above the high water level of the proposed dam as it will not be located on a floodplain and a drier open forest is most likely to occur.

It is considered unlikely that the existing riparian vegetation downstream of the proposed dam wall will be impacted upon by the proposal. It is possible that there will be an increase in riparian vegetation, particularly within the river channel, as a result of changes to flow regimes.

A variety of terrestrial fauna species may be lost or displaced as a result of the proposal, including several subject threatened species protected under both State and Commonwealth legislation, however it is likely that most local populations would continue to inhabit the existing remnants above the high water level. Exceptions to this could be some of the frog species that require specific riparian habitat.

As part of this assessment, additional expert advice was sought to clarify whether the project was likely to affect any threatened frog species, including the Giant Barred Frog, Green and Golden Bell Frog and Stuttering Frog (Appendix 8). Whilst field surveys did not find any threatened frog species, additional work indicated that a few small areas of potential Stuttering Frog habitat exists in the inundation area of the dam, at Heatherbrae Road near Munni Bridge and a larger remnant along the cliff line at 'Underbank'. These areas are small, fragmented and isolated. As a consequence should individuals of this species actually occur at these sites, their long term persistence at these locations is considered to be already severely compromised.

With regards to the EPBC Act, a total of 21 threatened or migratory species were considered as having some potential to occur within the project area. The assessment determined however that there was not likely to be any significant and notable impact on these species. Consequently the proposal will not affect a matter of national environmental significance as related to terrestrial flora and fauna.

Of the non-threatened species impacted upon by the proposal, aquatic mammals, the platypus and Australian water rat will be most affected. An estimated 19.2 km section of river and riparian habitat for these species will be destroyed. Habitats created by the dam will be substantially different to that existing in the river however some areas may be suitable for both species along the fringes of the dam when full capacity is reached, particularly where major creeks enter the dam.

The proposal is expected to contribute to a number of NSW and Commonwealth listed key threatening processes, in particular through altering the flow regime of rivers and streams within the study area, the clearing of native vegetation and the loss of hollow-bearing trees. Given the size of the proposed dam, the proposal is also likely to create a barrier to fauna movement for less mobile species and could impact the ability of some species to disperse. Proposed mitigative measures, such as the creation of compensatory habitat and corridor linkages through the revegetation of cleared land, aim to assist in minimising impacts on threatened species and endangered ecological communities.

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1.0 INTRODUCTION

1.1 Background and Scope

This Flora and Fauna Impact Assessment Report has been prepared for Connell Wagner Pty Ltd on behalf of the Hunter Water Corporation (HWC), to support a development application under Part 3A of the Environmental Planning and Assessment Act 1979 (EP&A Act). It is proposed to construct a water storage dam at Tillegra west of Dungog, NSW. The proposal would also involve the relocation of a 16.9 km long section of Salisbury Road and other minor roads would also be realigned. A substantial tree planting commitment is proposed by HWC and it is intended to locate some revegetation areas so as to enhance connectivity of existing vegetation in the locality.

These activities are hereafter referred to as *the proposal*.

The general aims of this assessment are to:

- describe the existing biological environment of the study area in relation to terrestrial flora and fauna;

- discuss the potential impacts of the various components of the proposal on any threatened species, populations or ecological communities that occur or are likely to occur within the study area; and

- provide discussion on the significance of the impacts and measures proposed to mitigate those impacts.

The environmental studies have been conducted in three stages:

a) the first stage being a review of available literature pertaining to the study area and surrounding locality;

b) the second stage being a habitat assessment and field survey of the study area to assess the likelihood of any threatened species, endangered populations or endangered ecological communities occurring; and

c) the third stage being the assessment of impact of the proposal on flora and fauna in accordance with the relevant NSW and Commonwealth legislation and NSW planning instruments.

Within this report, reference is given to the relevant sections of the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act); NSW *Threatened Species Conservation Act 1995* (TSC Act); *National Parks and Wildlife Act 1974* (NP&W Act); *Environmental Planning and Assessment Act 1979* (EP&A Act), plus associated regulations and subsequent amendments to these.

With regards to the terrestrial flora and fauna report,

- the *subject site* is defined as the land area directly affected by the development proposal. For this study the subject site has several major components:

- a dam wall and spillway construction area;
- the entire area proposed for inundation;
- a corridor within which it is proposed to select a preferred alignment for a road to replace Salisbury Road;
- a pipeline and pump station connecting Tillegra Dam to the Chichester Trunk Gravity Main (CTGM);
- substantial tree planting for carbon offsetting; and
- ancillary public infrastructure relocation and upgrading

- the *study area* consists of the subject site plus the immediately surrounding land potentially affected by the proposal either directly or indirectly; and

- the *study locality* is the area of land within a twenty (20) kilometre radius of the centre of the subject site.

1.2 General Description of the Study Locality, Study Area and Subject Site

A broad description of the prominent natural and developed features of the study area and study locality is provided in **Table 1** below. The study area is located entirely within the Dungog LGA. The location of the study area within the study locality is shown in **Figure 1**.

Table 1, Study Locality, Study Area and Subject Site

Client	Connell Wagner Pty Ltd on behalf of HWC
Location	Tillegra (west of Dungog, NSW) Map sheet: 9233 Dungog Zone 56 375000E 6426000N (AGD 66)
LGA	Dungog
Bioregion	North Coast
Botanical subregion	North Coast
Zoning	Predominantly Rural 1(a), with a small area zoned Environment 7(a) (Tillegra TSR) and Recreation 6(a).
Study Locality Description	The study locality is situated around the Williams River west of Dungog. Landuse within the locality is predominantly rural and includes Dungog township, Chichester Dam and large areas of bushland (including Chichester State Forest).
Elevation	Elevation within the subject site varies from approximately 100-230m asl
Subject Site Description, Current landuse and general condition	The subject site consists of predominantly cleared general grazing and dairy pasture and associated roads and buildings. Native vegetation within the subject site is limited to a few remnant patches (including Tillegra TSR), scattered trees and riparian vegetation along the Williams River and various tributaries. Much of the remnant vegetation (including riparian vegetation) has been heavily grazed and the understorey is greatly reduced in many areas or infested with lantana. Tillegra TSR represents the best quality native vegetation within the subject site and the understorey remains relatively intact through much of the reserve.
Surrounding landuse	The study area is situated amongst a rural landscape, with large areas of bushland to the north and north-east contained within Chichester State Forest, Fosterton State Forest, Black Bulga State Conservation Area, Killarney Nature Reserve and Monkerai Nature Reserve. The Williams River flows through the study area and continues to the south-west past Dungog.

1.3 Description of the Proposal

Hunter Water Corporation (HWC) proposes to construct a 450GL dam at Tillegra, north-west of Dungog in the Hunter Valley. The proposal involves the construction of a dam wall and spillway at Tillegra, the inundation of 2100ha of land and the construction of a road, electrical and telecommunications installations north of the proposed dam area.

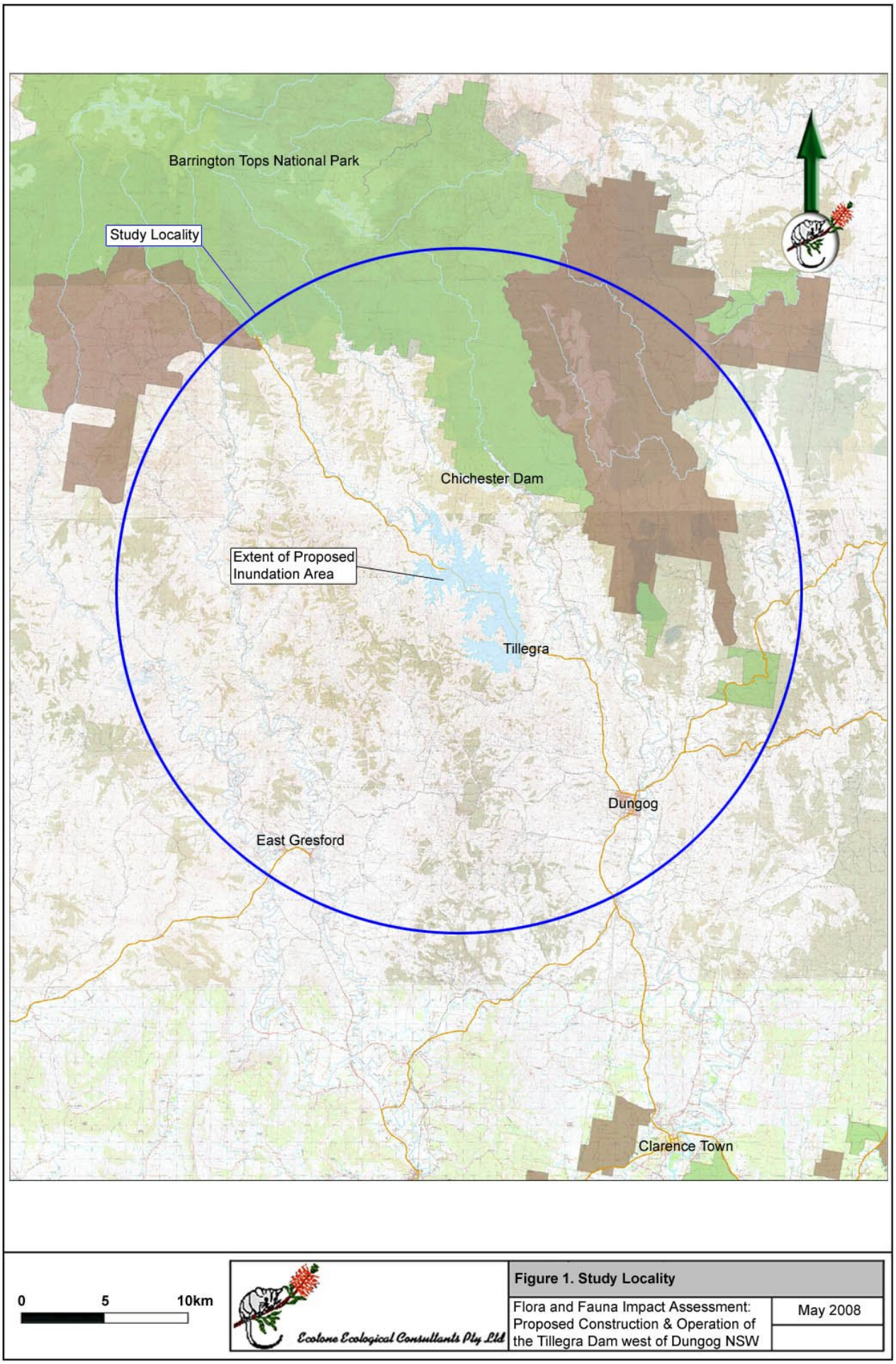
Based on the results of the habitat assessment and field surveys for this study a range of mitigation measures are proposed to be implemented in order to address the habitat loss resulting from the proposal (see **Section 6** for details). It is intended to create a habitat corridor along the eastern edge of the proposed dam which would provide a link to extensive areas of forest to the north of the proposal. Another corridor is proposed to the south-west of the dam wall providing a link to habitat around Mount Butterwicki. A large number of trees will be allowed to regenerate along parts of the shoreline above the full supply level and this would also act as a carbon offset.

Figure 2 illustrates the study area and the Tillegra Dam development proposal.

1.4 Director General's Requirements under Part 3A of the EP&A Act

Key issues relating to terrestrial flora and fauna that may be relevant to this report and need to be addressed according to the Director-General's requirements are:

- Impacts on threatened species, populations, ecological communities and critical habitat which are listed in both State and Federal legislation;
- Impacts on aquatic ecology upstream and downstream of the dam wall (this report only deals with aquatic mammals, the platypus and water rat, which although they are not listed threatened fauna species they are considered to be locally significant).
- Impacts on terrestrial flora and fauna including details on the location, composition, quality and quantity of habitat proposed to be affected.
- The presentation of a framework monitoring program, management and rehabilitation plans and comprehensive compensatory habitat/biodiversity offset packages. Impacts on the terrestrial ecology associated with the project and the amount and type of habitat to be lost are to be taken into account.


Barrington Tops National Park
Study Locality
Chichester Dam
Extent of Proposed Inundation Area
Tillegra
Dungog
East Gresford
Clarence Town
0
5
10km
Ecotone Ecological Consultants Pty Ltd
Figure 1. Study Locality
Flora and Fauna Impact Assessment: Proposed Construction & Operation of the Tillegra Dam west of Dungog NSW
May 2008

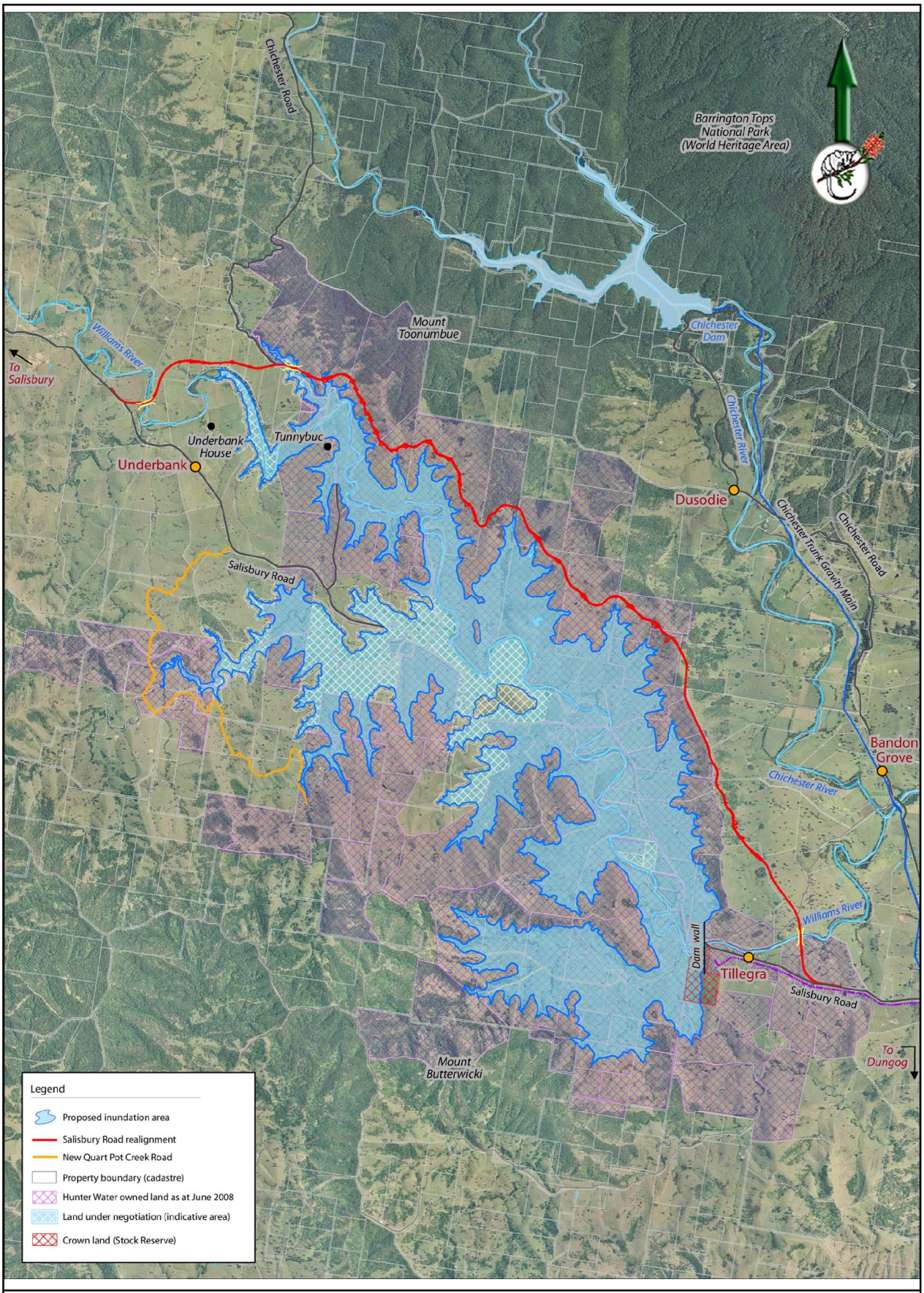


Figure 2. Overview of Tillegra Dam Proposal

Flora and Fauna Impact Assessment: Proposed Construction & Operation of the Tillegra Dam west of Dungog NSW

September 2008

2.0 FIRST STAGE ECOLOGICAL INVESTIGATION – PRELIMINARY ASSESSMENT

This section investigates the potential for threatened flora and fauna species, endangered populations and endangered ecological communities (EEC) to occur within the study area and therefore these could be impacted upon by the Proposal. Identified threatened species are regarded as 'subject species' for the purpose of field survey design, survey effort and the impact assessment process.

Subject species have been determined by a combination of:

1. The previous records of threatened species and endangered populations listed in the NSW TSC Act for the locality held in the DECC Wildlife Atlas (20 km radius around the centre of the Proposal) and other literature (**Tables 2 and 4**). A list of all EECs for the Camberwell and Dungog 1:100,000 map sheets were also provided with the Wildlife Atlas search (**Table 3**).

2. Potential threatened and migratory species and EECs listed in the Commonwealth EPBC Act identified in the Protected Matters Report (**Table 5**) for the locality (**Note:** the species listed in the Protected Matters Report are derived from habitat modelling only rather than actual records).

3. An assessment of the habitat features occurring within the study area (**Table 6**).

4. Determination of whether a species is likely or could potentially occur based on known records, known habitat requirements and the availability of those habitats (**Tables 7 and 8**).

2.1 Review of Local Threatened Species and Other Records

A review of the documented records of the locations of threatened flora and fauna species within the study locality has been undertaken. Threatened species records were accessed from the DECC Atlas of NSW Wildlife Database for the 9133 Camberwell and 9233 Dungog 1:100 000 Map sheets (updated to April 2008).

Whilst no previous comprehensive biodiversity surveys have been undertaken within the study area, the following studies have been carried out within the study locality and were reviewed as part of this assessment:

DUAP 1996. *Williams River Catchment Regional Environmental Study*, Department of Urban Affairs and Planning.

State Forests of NSW, 1995. *Gloucester/Chichester Management Areas – Environmental Impact Statement: Proposed Forestry Operations*, Forestry Commission of NSW, December 1995.

A review of current information for a preliminary environmental assessment has been prepared by Connell Wagner and this report was also accessed (Connell Wagner 2007).

2.1.1 Flora

Threatened species

From the review, a total of 6 threatened and rare flora species are known to occur within the study locality. These are listed in **Table 2**. Two of these species (*Marsdenia longiloba* and *Senna acclinis*) are classified as Endangered on Schedule 1, Part 1 and one species (*Eucalyptus glaucina*) is classified as Vulnerable on Schedule 2 of the NSW *TSC Act*. In terms of national listings, none of the species is listed as Endangered under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* however two are listed as Vulnerable (*Eucalyptus glaucina* and *Marsdenia longiloba*). All six of the species are also listed under the national database known as ROTAP *Rare or Threatened Australian Plants* (Briggs & Leigh 1996). Two of the species *Eucalyptus glaucina* and *Dodonaea megazyga*, have been recorded within 10 km of the site.

Endangered Populations of Plants

No listed endangered populations of flora have been previously recorded within the study locality. The following endangered populations of flora are known from the Hunter catchment generally and may occur in the study area:

- *Acacia pendula* population in the Hunter catchment
- *Eucalyptus camaldulensis* population in the Hunter catchment
- *Cymbidium canaliculatum* in the Hunter Catchment
- *Leionema lamprophyllum* (F. Muell.) Paul G. Wilson subsp. *obovatum* F.M. Anderson in the Hunter Catchment

The study area was assessed for the presence of any of these endangered populations during the field surveys.

Table 2. Threatened Flora previously recorded within the Study Locality

Scientific Name	Status (TSC)	Status (EPBC	ROTAP Risk Code	Earliest / latest record	Number of records within 20 km of site centre	Number of records within 10 km of site centre
Eucalyptus glaucina	V	V	3VCa	1911-1998	12	4
Marsdenia longiloba	E1	V	3RC-	1998	1	0
Senna acclinis	E1	-	3RC-	1998	1	0
ROTAP only species						
Dodonaea megazyga	U	-	C-	1962-1980	5	2
Eucalyptus largeana	U	-	3R	1936	1	0
Marsdenia liisae	U	-	3RC-	1995	4	0

Notes for Table 2:
375000 E and 6426000 N are the approximate co-ordinates of the centre of the study area.
Nomenclature follows Harden (1990-1993; 2002) and Harden & Murray (2000).
Status (TSC): refers to the NSW *Threatened Species Conservation Act* 1995 (TSC)
E1 – Schedule 1, Part 1: Endangered Species E2- Schedule 1, Part 2: Endangered Population
E4 – Schedule 1, Part 4: Species Presumed Extinct V – Schedule 2: Vulnerable Species
P13- Protected Native Plants U – Unprotected Flora and Fauna
Status (EPBC): refers to the Commonwealth *Environment Protection and Biodiversity Conservation Act* 1999 (EPBC)
E - Endangered Species V - Vulnerable Species
ROTAP coding (Briggs and Leigh 1996)

1 Known from one collection only
2 Geographic range in Australia less than 100km
3 Geographic range in Australia greater than 100km
E Endangered Species: at risk of disappearing from the wild within 10-20 years if present land use and other threats continue to operate
V Vulnerable Species: not presently endangered, but possibly at risk in future due to continuing depletion or land-use change
R Rare Species: rare in Australia, but currently without any identifiable threat
K Poorly Known: accurate field distribution information is inadequate
C Reserved: indicates taxon has at least one population within a national park, or other proclaimed conservation reserve or in an area otherwise dedicated for the protection of flora
a indicates that 1000 plants or more are known to occur within a conservation reserve(s)
i indicates that less than 1000 plants are known to occur within a conservation reserve(s)
- reserved population size is not accurately known

Please note: These records are based on information supplied by the Department of Environment and Climate Change and other sources, and may contain errors or omissions.

Endangered Ecological Communities

The literature review indicated that that there was a potential for up to ten endangered ecological communities to occur within the study locality. These EEC's are listed in **Table 3**, together with an assessment of their potential to occur in the study area. The study area was therefore assessed for the presence of these EECs during the field surveys.

Table 3. Potential for EECs to occur within the Study Locality and Study Area

EEC	Comment / Potential to Occur
• Swamp Oak Floodplain Forest of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions	This EEC could occur in limited areas of the study locality, but no areas of swamp oak habitat have been recorded in the study area.
• Freshwater Wetlands on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions • Swamp Sclerophyll Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions	These EECs could occur in limited parts of the study area where impeded drainage and swampy land occurs, although given the generally undulating nature of the study area, they are not considered likely. Dungog is not an LGA from which either EEC is known to occur according to the relevant Final Determinations.
• River-Flat Eucalypt Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions	This EEC could occur on floodplains associated with rivers and creeks, or on low-lying areas subject to flooding. The EEC generally does not occur above 50 m ASL but the Final Determination for the EEC states that it may occur on localised river flats up to 250 m ASL (NSW Scientific Committee 2004a). Dungog is not one of the LGAs specifically listed by the Final Determination in which the EEC is known to occur, but the Final Determination states that it could occur elsewhere in the North Coast bioregion.
• Hunter Lowland Redgum Forest in the Sydney Basin and New South Wales North Coast Bioregions	Although this EEC could technically occur in the study area, Dungog is not one of the LGAs specifically listed by the Final Determination (NSW Scientific Committee 2002) in which the EEC is known to occur. Additionally, the EEC is restricted to Permian sediments whilst all parts of the study area occur on older Carboniferous sediments.

Table 3. continued

• Subtropical Coastal Floodplain Forest of the New South Wales North Coast Bioregion • Lowland Rainforest in the NSW North Coast and Sydney Basin Bioregions • Lowland Rainforest on Floodplain in the New South Wales North Coast Bioregion	One or more of these EECs could occur in limited parts of the study area where there are sheltered moist gullies or moist, low-lying floodplains. The presence of any of these EECs would be determined by the soil type, habitat, community structure and the assemblage of species present. Subtropical Coastal Floodplain Forest is not noted as occurring in the Dungog LGA according to the Final Determination for the EEC (NSW Scientific Committee 2004b), but the Final Determination states that it could occur elsewhere in the North Coast bioregion.
• Lower Hunter Spotted Gum - Ironbark Forest in the Sydney Basin Bioregion	This EEC could occur on drier ridgetops and well-drained slopes. However, in this area the Seaham Spotted Gum – Ironbark Forest, which is not listed as an EEC, is more likely to occur. The species composition and underlying geology of the area would determine which community was present – the EEC is restricted to Permian sediments whilst the Seaham Spotted Gum – Ironbark Forest and related communities occur on older Carboniferous sediments.
• White Box Yellow Box Blakely's Red Gum Woodland	The study area is probably too far east for this EEC. Unless white box, yellow box or Blakeley's red gum or a combination of these occur in the study area, the EEC is unlikely to be present.

2.1.2 Fauna

Threatened Species

A total of 32 threatened terrestrial fauna species have previously been recorded within the study locality according to DECC Wildlife Atlas Records, including 9 bird, 18 mammal, 1 reptile and 4 frog species. Of these, four species are currently regarded as Endangered on Schedule 1, Part 1 of the TSC Act (eastern quoll, brush-tailed rock wallaby, green and golden bell frog and stuttering frog) and the remainder as Vulnerable on Schedule 2 of the Act. Six species are also listed in the Commonwealth EPBC Act, the spotted-tailed quoll as Endangered and the brush-tailed rock-wallaby, long-nosed potoroo, grey-headed flying-fox, green and golden bell frog and stuttering frog listed as Vulnerable. The local threatened fauna species are listed in **Table 4.**

Table 4. Threatened Fauna previously recorded within the Study Locality

Scientific Name	Common Name	Status (TSC)	Status (EPBC)	Earliest / latest record	Number of records within 20km of site centre	Number of records within 10km of site centre
BIRDS						
Atrichornis rufescens	Rufous scrub-bird	V	-	1957-2004	14	0
Calyptorhynchus lathami	Glossy black-cockatoo	V	-	1980-2007	13	5
Ninox connivens	Barking owl	V	-	1980-1982	2	1
Ninox strenua	Powerful owl	V	-	1982-2002	12	2
Pachycephala olivacea	Olive whistler	V	-	1977-1994	3	1
Pomatostomus temporalis temporalis	Grey-crowned babbler (eastern subspecies)	V	-	2004-2005	6	0
Ptilinopus magnificus	Wompoo fruit-dove	V	-	1980-2007	5	1
Tyto novaehollandiae	Masked owl	V	-	1992-2002	2	2
Tyto tenebricosa	Sooty owl	V	-	1992-1998	10	1
NON-FLYING MAMMALS						
Aepyprymnus rufescens	Rufous bettong	V	-	1957-1994	3	0
Dasyurus maculatus	Spotted-tailed quoll	V	E	1967-2006	93	16
Dasyurus viverrinus	Eastern quoll	E1	-	1900-1992	1	0
Macropus parma	Parma wallaby	V	-	1973-2002	11	4
Petaurus australis	Yellow-bellied glider	V	-	1997	1	0
Petaurus norfolcensis	Squirrel glider	V	-	2001	2	0
Petrogale penicillata	Brush-tailed rock-wallaby	E1	V	1994	2	0
Phascogale tapoatafa	Brush-tailed phascogale	V	-	1979-2002	6	2
Phascolarctos cinereus	Koala	V	-	1949-2007	85	17
Potorous tridactylus	Long-nosed potoroo	V	V	1977-2002	4	1
Thylogale stigmatica	Red-legged pademelon	V	-	1980-1993	8	3

Table4, continued

Scientific Name	Common Name	Status (TSC)	Status (EPBC)	Earliest / latest record	Number of records within 20km of site centre	Number of records within 10km of site centre
FLYING MAMMALS						
Falsistrellus tasmaniensis	Eastern false pipistrelle	V	-	1999-2007	87	0
Kerivoula papuensis	Golden-tipped bat	V	-	1992-2007	19	5
Miniopterus schreibersii oceanensis	Eastern bent-wing bat	V	-	1999-2007	14	0
Mormopterus norfolkensis	East-coast freetail-bat	V	-	1996	1	0
Myotis macropus	Southern myotis	V	-	1996-2007	686	1
Pteropus poliocephalus	Grey-headed flying-fox	V	V	1992-2005	10	0
Scoteanax rueppellii	Greater broad-nosed bat	V	-	1978-2007	4	0
REPTILES						
Hoplocephalus stephensii	Stephens' banded snake	V	-	1999-2002	6	2
FROGS						
Litoria aurea	Green and golden bell frog	E1	V	1977	1	0
Litoria daviesae	Davies' tree frog	V	-	1997-2001	4	2
Mixophyes balbus	Stuttering frog	E1	V	2000-2002	4	4
Philoria sphagnicolus	Sphagnum frog	V	-	1970-1980	1	0

Table 3 Notes:
375000 E and 6426000 N are the approximate co-ordinates of the centre of the study area.
Status (TSC): refers to the NSW *Threatened Species Conservation Act* 1995 (TSC)
E1 – Schedule 1, Part 1: Endangered Species
V – Schedule 2: Vulnerable Species
Status (EPBC): refers to the Commonwealth *Environment Protection and Biodiversity Conservation Act* 1999 (EPBC)
E - Endangered Species
V - Vulnerable Species

Please note: These records are based on information supplied by the DECC and other sources, and may contain errors or omissions.

Endangered Fauna Populations

No Endangered Populations of fauna have been previously recorded in the locality.

2.2 EPBC Act Protected Matters Report

The EPBC Act Protected Matters Database Search Tool was accessed 30 April 2008 to identify the Protected Matters under the Commonwealth EPBC Act that occur or may occur within the study locality. This review yielded a report (summarised in **Table 5** and shown in full in **Appendix 1**) listing the matters that could potentially be relevant under the EPBC Act for activities within the study area. Please note that species or other matters identified from the report as occurring, or having potential to occur within the study locality, may not be relevant to the study area or subject site itself. Where specific habitat essential for the presence of a species is obviously absent it can be assumed that the species would not be impacted upon by the Proposal, therefore it has been be excluded from further discussion (see Tables 7 and 8).

Table 5. Protected Matters under the EPBC Act relevant to flora and fauna in the locality

Protected Matter	Details
World Heritage Properties	One: Gondwana Rainforests of NSW
National Heritage Places	One: Gondwana Rainforests of NSW
Wetlands of International Significance (Ramsar sites)	Two Ramsar sites occur within estuaries downstream of the study locality: Hunter Estuary Wetlands and Myall Lakes The Williams River flows into the Hunter River which eventually flows through the Hunter Estuary Wetlands Ramsar site. Thus runoff from the project could potentially flow into the Ramsar site. Whilst the catchment for the Myall Lakes Ramsar site (upper Karuah River) is in the study locality, no part of the proposal area falls within the catchment for this Ramsar site.
Threatened Ecological Communities	One: White box – yellow box – Blakely's red gum grassy woodland and derived native grassland (**CE**)
Threatened Species - Flora	Six species: **Species or species habitat may occur within area according to EPBC modelling.** *Cryptostylis hunteriana* (leafless tongue-orchid) (**V**) **Species or species habitat likely to occur within area according to EPBC modelling.** *Cynanchum elegans* (white-flowered wax plant) (**E**) *Eucalyptus glaucina* (slaty red gum) (**V**) *Pultenaea campbellii* (New England bush-pea) **(V)** *Syzygium paniculatum* (magenta lilly pilly) (**V**) *Thesium australe* (austral toadflax) (V) *Tylophora woollsii* (**E**) The likelihood of any of these species occurring in the study area on the basis of available habitat is assessed in **Table 7**
Threatened Species – Fauna (Terrestrial Species only)	Twelve species: **Species or species habitat may occur within area according to EPBC modelling.** Australian painted snipe (*Rostratula australis*) (**V**) Brush-tailed rock-wallaby (*Petrogale penicillata*) (**V**) Green and golden bell frog (*Litoria aurea*) (**V**) Booroolong frog (*Litoria booroolongensis*) **(E)** Large-eared pied bat (*Chalinolobus dwyeri*) (**V**) Long-nosed potoroo (*Potorous tridactylus tridactylus*) (**V**) Regent honeyeater (*Xanthomyza phrygia*) (**E**) Spotted-tail quoll (*Dasyurus maculatus maculatus* [SE mainland population]) (**E**) Swift parrot (*Lathamus discolor*) (**E, Ma**) **Species or species habitat likely to occur within area according to EPBC modelling.** Hastings River mouse (*Pseudomys oralis*) (**E**) Southern (giant) barred frog (*Mixophyes iteratus*) (**E**) Stuttering frog (*Mixophyes balbus*) (**V**) **Roosting known to occur within area according to EPBC modelling.** Grey-headed flying-fox (*Pteropus poliocephalus*) (**V**) The likelihood of any of these species occurring in the study area on the basis of available habitat is assessed in **Table 8**

Table 5, continued

Protected Matter	Details
Migratory Species (Terrestrial Species Only)	Twelve species : **Species or species habitat likely to occur within area according to EPBC modelling.** White-bellied sea eagle (*Haliaeetus leucogaster*) (**Mi, Ma**) **Species or species habitat may occur within area according to EPBC modelling.** White-throated needletail (*Hirundapus caudacutus*) (**Mi, Ma**) Rainbow bee-eater (*Merops ornatus*) (**Mi, Ma**) Regent honeyeater (*Xanthomyza phrygia*) (**Mi, E**) **Breeding may occur within area according to EPBC modelling.** Black-faced monarch (*Monarcha melanopsis*) (**Mi, Ma**) Rufous fantail (*Rhipidura rufifrons*) (**Mi, Ma**) **Breeding likely to occur within area according to EPBC modelling.** Spectacled monarch (*Monarcha trivirgatus*) (**Mi, Ma**) Satin flycatcher (*Myiagra cyanoleuca*) (**Mi, Ma**) Wetland and Marine Species **Species or species habitat may occur within are according to EPBC modelling.** Latham's snipe (*Gallinago hardwickii*) (**Mi, Ma**) Cattle egret (*Ardea ibis*) (**Mi, Ma**) Great egret (*Ardea alba*) (**Mi, Ma**) Painted snipe (*Rostratula benghalensis s. lat.*) (**Mi, Ma**) Fork-tailed swift (*Apus pacificus*) (**Mi. Ma**) Migratory species are discussed in **Section 4.4**.
State and Territory Reserves	Barrington Tops National Park, NSW Killarney Nature Reserve, NSW Monkerai Nature Reserve, NSW

Notes:
V Species listed as **Vulnerable** under the Commonwealth *EPBC Act*.
E Species listed as **Endangered** under the Commonwealth *EPBC Act*.
CE Species listed as **Critically Endangered** under the Commonwealth *EPBC Act*.
Mi Species listed as **Migratory** under the Commonwealth *EPBC Act*.
Ma Listed **Marine** species (fly over marine areas) under the Commonwealth *EPBC Act*.

2.3 Habitat Assessment of the Study Area

Investigations for the habitat assessment comprised site inspections in November 2007, noting floral and faunal habitat types and features. The possible factors investigated and assessed for the study area included:

Flora: - Type and structure of vegetation
- Dominant species;
- Subjective assessment of floristic diversity;
- Disturbance regime, both past and ongoing
- Extent of weed invasion; and
- Potential of suitable habitat for local threatened and significant flora species.

Fauna: - Presence and frequency of large mature trees, dead trees and hollow-bearing trees;
- Density of shrub and ground cover;
- Presence of fallen timber and rock outcrops;
- Presence of wet areas or water-bodies;
- Assessment of previous and present land use and disturbance regimes;
- Extent of connectivity, movement corridors and refugia;
- Presence of potential key habitat elements for local threatened species;
- Searches for evidence of the presence of threatened species; and
- Fauna species diversity (all fauna observed or signs of fauna were recorded).

From the site assessment it was possible to:

- identify those parts of the study area that contain potentially significant habitats for threatened species and local biodiversity;
- determine the areas of the study area that require detailed field survey;
- identify potential constraints from an ecological perspective within the study area; and
- generate a list of local and regional threatened species regarded as subject species.

Table 6. Habitat Features Recorded in the Study Area

Habitat Feature	Habitat Description
1) Overall Type and Structure of Vegetation	a) Spotted gum - ironbark forest b) Dry slopes forest c) Floodplain forest d) Riparian eucalypt and river oak forest e) Cleared pasture with scattered remnant trees
2) Dominant Species	a) Spotted gum, ironbark b) Grey box, stringybark c) Forest red gum, grey box d) Rough-barked apple, Sydney blue gum, river oak e) Exotic and native grasses, weeds.
3) Density of Shrub and Ground Cover	a) Moderate to dense shrub and ground cover in some areas, grazed or lantana infested in other areas. b) Sparse shrub layer, sparse to moderate ground layer. c) Generally sparse shrub layer with dense, grassy ground cover. d) Sparse shrub cover, moderate to dense ground cover with many weeds, particularly exotic vines e) Almost no shrub layer, generally dense ground cover of introduced and native grasses.

Table 6, continued

Habitat Feature	Habitat Description
4) Soil type	The soil landscape types include alluvial, colluvial, erosional and stagnant alluvial (Connell Wagner 2007).
5) Topography	Varies from gently undulating to steep undulating, with limited areas of flat floodplains.
6) Presence of:	
a) Large Mature Trees (>50cms DBH)	A number of large mature trees occur throughout the subject site, particularly within Tillegra TSR, along riparian areas and roadsides. Also occur as scattered paddock trees.
b) Dead Trees	A number of dead standing trees occur within remnant vegetation and paddocks throughout the site.
c) Hollow-bearing Trees	A number of hollow-bearing trees occur within the subject site, particularly within Tillegra TSR, along riparian areas and roadsides. Also occur as paddock trees.
d) Fallen Timber	The bushland areas contain scattered fallen timber with some large hollow logs. The majority of the cleared land has only a limited amount of fallen timber.
e) Rock Outcrops	Some rock outcrops within the study area, though no large cliff areas were observed except for a section of the Williams River at Underbank.
f) Wet Areas or Water-bodies	Williams River and associated tributaries, also numerous dams/ponds.
7) Extent of Weed Invasion	Some remnant native vegetation within the study area is relatively free of weeds, though many areas have been heavily grazed and are infested with lantana. Areas of cleared pasture are dominated by introduced species.
8) Assessment of previous and present Land Use and Disturbance Regimes	Past and present grazing of cattle has resulted in much of the native vegetation within the study area being cleared and replaced by introduced pasture grasses. In many of the remaining patches of native vegetation the understorey has been greatly modified or replaced by lantana. Tillegra TSR represents the most intact patch of remnant vegetation, although lantana is common.
9) Extent of connectivity, movement corridors and refugia	Much of the remnant native vegetation within the subject site exists as isolated patches and movement between these patches is likely only to be possible for more mobile species (e.g. bats, birds, and large macropods). Reasonably good connectivity exists via riparian vegetation along the Williams River and its tributaries. Patches of vegetation along the ridgeline and hill slopes north of Tillegra bridge may provide some connectivity to larger tracts of bushland towards Chichester Dam and Barrington Tops. Similarly, vegetation south of Tillegra TSR and along Native Dog Creek may provide some connectivity to larger tracts of bushland to the south-east of the study area.

2.4 Determination of Local Threatened Flora and Fauna as Subject Species

Potential subject species are defined as those threatened species considered likely to occur in the habitats present within the study area (DECC 2007a). A list of subject species has been compiled in order to determine those threatened species that could be potentially impacted by the proposal and are therefore assessed in this report.

The factors used to determine whether a species should be included as a subject species are known records from the locality and/or the presence of potential habitat based on the available information on known habitat use by the species.

2.4.1 Threatened Flora

An assessment of the relative likelihood of the threatened flora species previously recorded in the study locality occurring within the study area is provided in **Table 7**. The table also includes species not previously recorded in the locality but predicted to have potential to occur on the basis of habitat modelling by the Department of the Environment, Water, Heritage and the Arts (DEWHA).

Table 7. Assessment of the Potential for Rare and Threatened Flora Species to occur within the Study Area

Scientific Name	Latest Record	Records Within		Preferred Habitat and Comments*	Habitat available on site?	Potential to occur within study area	Subject Species[b]
		20 km	10 km				
Cryptostylis hunteriana (leafless tongue-orchid)	No records in the locality. DEWHA habitat modelling only			Does not appear to have well defined habitat preferences and is known from a range of communities, including swamp-heath and woodland.	Nominally suitable habitat in some areas	**Low**	-
Cynanchum elegans (white-flowered wax plant)	No records in the locality. DEWHA habitat modelling only			Usually occurs on the edge of dry rainforest vegetation, rainforest gullies scrub and scree slopes. Other associated vegetation types include littoral rainforest; coastal tea-tree – coastal banksia scrub; forest red gum aligned open forest and woodland; spotted gum aligned open forest and woodland and bracelet honeymyrtle *Melaleuca armillaris* scrub to open scrub.	Nominally suitable habitat in moist gullies or forest red gum or spotted gum communities	**Low**	-
Eucalyptus glaucina (slaty red gum)	1998	12	4	Grows in grassy woodland and dry eucalypt forest on deep, moderately fertile and well-watered soils.	Probably	**Moderate**	√

Table 7, continued

Scientific Name	Latest Record	Records Within		Preferred Habitat and Comments*	Habitat available on site?	Potential to occur within study area	Subject Species[b]
		20 km	10 km				
Marsdenia longiloba (slender marsdenia)	1998	1	0	Subtropical and warm temperate rainforest, lowland moist eucalypt forest adjoining rainforest and, sometimes, in areas with rock outcrops.	Possibly in moist gullies	**Low to Moderate**	√
Senna acclinis (rainforest cassia)	1998	1	0	Grows in or on the edges of subtropical and dry rainforest.	Possibly in moist gullies	**Low to Moderate**	√
Pultenaea campbellii (New England bush-pea)	No records in the locality. DEWHA habitat modelling only			The species occurs in (or is likely to occur in) dry sclerophyll forest, mainly at medium to high altitudes. Variable geology and sandy, stony soils are favoured.	No, soils are unsuitable and the altitude is probably too low.	**Low**	-
Syzygium paniculatum (magenta lilly pilly)	No records in the locality. DEWHA habitat modelling only			Subtropical and littoral rainforest on sandy soils or stabilised dunes near the sea.	Nominally suitable habitat in moist gullies	**Low**	-
Thesium australe (austral toadflax)	No records in the locality. DEWHA habitat modelling only			Occurs in grassland or grassy woodland. Often found in damp sites in association with Kangaroo Grass.	Nominally suitable habitat in some areas.	**Low**	-
Tylophora woollsii (cryptic forest twiner)	No records in the locality. DEWHA habitat modelling only			Grows in moist eucalypt forest, moist sites in dry eucalypt forest and rainforest margins.	Nominally suitable habitat in moist gullies.	**Low**	-
ROTAP Only Species							
Dodonaea megazyga	1980	5	2	Usually grows in dry sclerophyll forest or on margins of rainforest usually on sandstone.	Possibly	**Moderate**	
Eucalyptus largeana (Craven grey box)	1936	1	0	Restricted and local, in wet forest on sloping sites in subcoastal ranges; confined to Gloucester-Craven district and near Pokolbin.	Nominally suitable habitat	**Low -** record is historic	
Marsdenia liisae (large-flowered milk vine)	1995	4	0	Grows in wet sclerophyll forest and on rainforest margins; headwaters of the Hastings R. to the Nightcap Ra., not common.	Possibly in moist gullies	**Low to Moderate**	

* compiled from: Harden (1991, 1993, 2002); PlantNet; DECC Threatened Species Profiles http://www.threatenedspecies.environment.nsw.gov.au/tsprofile/index.aspx

[b]ROTAP only species do not require formal assessment under legislation, therefore are not eligible to be subject species

Five of the rare and threatened species listed in Table 7; *Eucalyptus glaucina, Marsdenia longiloba, Senna acclinis, Dodonaea megazyga* and *Marsdenia liisae,* are identified as having at least a low to moderate likelihood of occurring. These were considered to have the greatest likelihood of being found within the study area and were noted for special consideration in the ecological fieldwork and assessment.

Eucalyptus glaucina was considered to have moderate potential because of the presence of potentially suitable habitat and records within 10 km. *Marsdenia longiloba* and *Senna acclinis* have potential as they are mesic species that may potentially occur in moist gullies and rainforest areas. These species are considered to be subject species and are subject to formal assessment under legislation.

Of the ROTAP species, only *D. megazyga* and *M. liisae* have some potential to occur, but since they do not require formal assessment under legislation they are not eligible to be subject species and consequently are excluded from further formal consideration. However, any potential impacts on these species could be relevant in relation to the wider biodiveristy implications of the project.

2.4.2 Threatened Fauna

In addition to the DECC Wildlife Atlas records, Connell Wagner (2007) identified the potential for the swift parrot (*Lathamus discolor*), regent honeyeater (*Xanthomyza phrygia*), brown treecreeper (*Climacteris picumnus*), speckled warbler (*Pyrrholaemus sagittatus*) and diamond firetail (*Stagonopleura guttata*) to occur within the area. A number of threatened fauna species have also been recorded from the Gloucester and Chichester State Forests Management Areas to the north of the study area. Three of these species are additional to those shown as occurring within the study locality according to the DECC Wildlife Atlas; these are the glandular frog (*Litoria subglandulosa*), broad-toothed rat (*Mastacomys fuscus*) and little bent-wing bat (*Miniopterus australis*). The glandular frog south of the Hastings River has been renamed Davies' frog (*Litoria daviesae*) and is listed as such in the DECC Wildlife Atlas therefore the glandular frog is not relevant to this study. A review of the *Williams River Catchment Regional Environmental Study* (DUAP 1996) revealed no additional threatened fauna species.

An assessment of the potential for these threatened species to occur within the study area is provided in **Table 8**. A number of additional species have been included for consideration based on either the available habitat within the study area or the results of the EPBC Protected Matters search. These are the turquoise parrot (*Neophema pulchella*), Australian painted snipe (*Rostratula australis*), Hastings River mouse (*Pseudomys oralis*), large-eared pied bat (*Chalinolobus dwyeri*) and giant barred frog (*Mixophyes iteratus*).

Table 8. Assessment of the Potential for Local Threatened Fauna Species to occur within the Study Area

Common Name	Most Recent Record	Closest Records		Preferred Habitat and Comments*	Habitat available on site			Potential to utilise study area	Subject Species
		20 km	10 km		Breeding	Roosting	Foraging		
BIRDS									
Australian painted snipe (*Rostratula australis*)	-	-	-	Permanent and temporary shallow inland and coastal wetlands (can be freshwater or brackish), particularly where there is a cover of vegetation. Individuals have been known to use artificial wetlands (such as sewage ponds, dams and water-logged grasslands.	N	Y	Y	Unlikely limited habitat	-
Barking owl (*Ninox connivens*)	1982	2	1	Inhabits eucalypt woodland, open forest, swamp woodlands and, especially in inland areas, timber along watercourses. Denser vegetation is used occasionally for roosting. During the day they roost along creek lines, usually in tall understorey trees with dense foliage such as acacia and casuarina species, or the dense clumps of canopy leaves in large eucalypts. Feeds on a variety of prey, with invertebrates predominant for most of the year, and birds and mammals such as smaller gliders, possums, rodents and rabbits becoming important during breeding. Live alone or in pairs. Territories range from 30 to 200 hectares and birds are present all year. Three eggs are laid in nests in hollows of large, old eucalypts.	Y	Y	Y	Moderate	√
Booroolong Frog (*Litoria booroolongensis*)	-	-	-	Restricted to rocky streams and headwaters in the tablelands and upper slopes. Mainly in the western flowing streams and the only recent records are from the south-west slopes of NSW.	N	N	N	Nil	-
Brown treecreeper (*Climacteris picumnus*)	-	-	-	Found in eucalypt woodlands (including box-gum woodland) and dry open forest of the inland slopes and plains inland of the Great Dividing Range; mainly inhabits woodlands dominated by stringybark or other rough-barked eucalypts, usually with an open grassy understorey, sometimes with one or more shrub species. Usually not found in woodlands with a dense shrub layer. Fallen timber is an important habitat component for foraging. Sedentary, considered as being resident in many locations throughout its range. Gregarious and usually observed in pairs or small groups of eight to 12 birds. Terrestrial and arboreal in about equal proportions Active, noisy and conspicuous while foraging on trunks and branches of trees and amongst fallen timber; spend much more time foraging on the ground and fallen logs than other treecreepers. Up to 80% of the diet is comprised of ants, with other invertebrates making up the remainder. Hollows in standing dead or live trees and tree stumps are essential for nesting.	Y	Y	Y	Limited based on lack of records	√

Table 8, continued

Common Name	Most Recent Record	Closest Records		Preferred Habitat and Comments*	Habitat available on site			Potential to utilise study area	Subject Species
		20 km	10 km		Breeding	Roosting	Foraging		
BIRDS									
Diamond firetail *Stagonopleura guttata*)	-	-	-	Open forest with a grassy groundcover, woodland, mallee, acacia scrub lands and timber belts along watercourses and roadsides.	Y	Y	Y	Moderate	√
Glossy black-cockatoo (*Calyptorhynchus lathami*)	2007	13	5	Inhabits open forest and woodlands of the coast and the Great Dividing Range up to 1000 m in which stands of she-oak species, particularly black she-oak (*Allocasuarina littoralis*), forest she-oak (*A. torulosa*) or drooping she-oak (*A. verticillata*) occur. In the Riverina area, inhabits open woodlands dominated by belah (*Casuarina cristata*). Feeds almost exclusively on the seeds of several species of she-oak (*Casuarina* and *Allocasuarina* species), shredding the cones with the massive bill. Dependent on large hollow-bearing eucalypts for nest sites.	Y	Y	Y	Moderate	√
Grey-crowned babbler (eastern subspecies) (*Pomatostomus temporalis temporalis*)	2005	6	0	Open eucalypt woodlands with a grassy groundcover and sparse, tall shrub layer. May also be observed along streams in cleared areas and grassy road verges. Conspicuous large communal nests/roosts are constructed out of twigs. Raucous groups of 2-13 individuals foraging for insects in all substrates.	Y	Y	Y	Moderate	√
Masked owl (*Tyto novaehollandiae*)	2002	2	2	Lives in dry eucalypt forests and woodlands from sea level to 1100 m. A forest owl, but often hunts along the edges of forests, including roadsides. The typical diet consists of tree-dwelling and ground mammals, especially rats. Pairs have a large home-range of 500 to 1000 hectares. Roosts and breeds in moist eucalypt forested gullies, using large tree hollows or sometimes caves for nesting.	Y	Y	Y	Moderate	√
Olive whistler (*Pachycephala olivacea*)	1994	3	1	Predominantly found in wet forests above 500m, though may move to lower altitudes in winter. Forages for berries and insects in trees, shrubs and on the ground. Constructs nests of twigs and grass in low forks of shrubs.	N	N	N	Low	-
Regent honeyeater (*Xanthomyza phrygia*)	-	-	-	Box-ironbark eucalypt associations, though uses other woodland types and wet lowland coastal forest in times of food shortage. The wandering nature of this species makes it difficult to assess. Known to frequent areas with densely blossoming winter-flowering trees (e.g. spotted gum, red ironbark, forest red gum and swamp mahogany) on an opportunistic basis along the coast and ranges of NSW.	Y	Y	Y	Potential seasonal visitor, unlikely to breed	√
Rufous scrub-bird (*Atrichornis rufescens*)	2004	14	0	High altitude subtropical, warm temperate, cool temperate forest and moist eucalypt forest with rainforest elements. Inhabits areas with a densely vegetated understorey, deep leaf litter layer and fallen timber.	N	N	N	Unlikely	-

Table 8, continued

Common Name	Most Recent Record	Closest Records		Preferred Habitat and Comments*	Habitat available on site			Potential to utilise study area	Subject Species
		20 km	10 km		Breeding	Roosting	Foraging		
BIRDS									
Powerful owl (*Ninox strenua*)	2002	12	2	The powerful owl inhabits a range of vegetation types, from woodland and open sclerophyll forest to tall open wet forest and rainforest. The powerful owl requires large tracts of forest or woodland habitat but can occur in fragmented landscapes as well. The species breeds and hunts in open or closed sclerophyll forest or woodlands and occasionally hunts in open habitats. It roosts by day in dense vegetation comprising species such as turpentine *Syncarpia glomulifera*, black she-oak *Allocasuarina littoralis*, blackwood *Acacia melanoxylon*, rough-barked apple *Angorphora floribunda*, cherry ballart *Exocarpus cupressiformis* and a number of eucalypt species. The main prey items are medium-sized arboreal marsupials, particularly the greater glider, common ringtail possum and sugar glider. As most prey species require hollows and a shrub layer, these are important habitat components for the owl. Pairs of powerful owls are believed to have high fidelity to a small number of hollow-bearing nest trees and defend a large home range of 400-1450 ha. powerful owls nest in large tree hollows (at least 0.5 m deep), in large eucalypts (diameter at breast height of 80-240 cm) that are at least 150 years old.	Y	Y	Y	Moderate	√
Sooty owl (*Tyto tenebricosa*)	1998	10	1	Large areas of tall open forest and woodland particularly in and around dense creek and gully areas. Nests in large hollows in rainforest trees and eucalypts.	Y	Y	Y	Limited to moist forest	√
Speckled warbler (*Pyrrholaemus sagittatus*)	-	-	-	The speckled warbler lives in a wide range of *Eucalyptus* dominated communities that have a grassy understorey, often on rocky ridges or in gullies. Typical habitat would include scattered native tussock grasses, a sparse shrub layer, some eucalypt regrowth and an open canopy. Large, relatively undisturbed remnants are required for the species to persist in an area. The diet consists of seeds and insects, with most foraging taking place on the ground around tussocks and under bushes and trees. Pairs are sedentary and occupy a breeding territory of about ten hectares, with a slightly larger home-range when not breeding. The rounded, domed, roughly built nest of dry grass and strips of bark is located in a slight hollow in the ground or the base of a low dense plant, often among fallen branches and other litter. A side entrance allows the bird to walk directly inside.	Y	Y	Y	Moderate	√

Table 8, continued

Common Name	Most Recent Record	Closest Records		Preferred Habitat and Comments*	Habitat available on site			Potential to utilise study area	Subject Species
		20 km	10 km		Breeding	Roosting	Foraging		
BIRDS									
Swift parrot (*Lathamus discolor*)	-	-	-	The migratory nature of this species makes them difficult to assess. Known to frequent sclerophyll forest and woodlands with winter flowering trees (e.g. spotted gum, red ironbark, *Eucalyptus crebra* and *E. siderophloia*, forest red gum and swamp mahogany) on an opportunistic basis along the coast and ranges of NSW	N	Y	Y	Potential winter visitor	√
Turquoise parrot (*Neophema pulchella*)	-	-	-	Open eucalypt woodland or forest with a grassy or sparsely shrubby understorey. Favours grasslands on the edge of these habitat types, particularly timbered grassland on mountain slopes and ridges. Feeds on seeds of native and introduced grasses and other herbs. Requires suitable hollows in tree limbs, logs or fence posts for breeding. Usually seen in pairs or small, possibly family groups and have also been reported in flocks of up to thirty individuals.	Y	Y	Y	Moderate	√
Wompoo fruit-dove (*Ptilinopus magnificus*)	2007	5	1	Lowland rainforest, moist eucalypt forest and brush box forest that provides fleshy fruit resources. Rare south of Coffs Harbour.	N	Y	Y	Potential rare visitor	√
MAMMALS									
Broad-toothed rat (*Mastacomys fusca*)	-	-	-	Inhabits dense vegetation in wet alpine and subalpine heaths and woodlands above 1,000 metres altitude in the region. The study area is too low in altitude for this species to occur	N	N	N	Highly unlikely	-
Brush-tailed phascogale (*Phascogale tapoatafa*)	2002	6	2	Found in dry sclerophyll open forests and woodlands, with a preference for sparse ground cover. Also inhabits heath, swamps, rainforest and wet sclerophyll forest. Requires large areas of intact habitat to support a large population. Nests and shelters in tree hollow.	Y	Y	Y	Moderate	√
Brush-tailed rock-wallaby (*Petrogale penicillata*)	1994	2	0	In more recent years this rock-wallaby appears to have become restricted to rock outcrops containing suitable caves and tunnels or very dense undergrowth to provide shelter.	N	N	N	Highly unlikely	-
Eastern quoll (*Dasyurus viverrinus*)	1992?	1	0	Variety of habitats including dry sclerophyll forest, scrub, heathland, and cultivated land. In Tasmania individuals are most commonly found where eucalypt forest and pastures are interspersed. Very rare and possibly now extinct on the mainland.	-	-	-	Highly unlikely	-
Hastings River mouse (*Pseudomys oralis*)	-	-	-	Known from habitat near creeklines within open eucalypt forest with dense ground cover of sedges, grasses and/ or ferns. Within the study area there is mostly grazed, disturbed habitat below the high water level. Potential habitat may occur between Chichester Dam and the study area	N	N	N	Low	-

Table 8, continued

Common Name	Most Recent Record	Closest Records		Preferred Habitat and Comments*	Habitat available on site			Potential to utilise study area	Subject Species
		20 km	10 km		Breeding	Shelter	Foraging		
MAMMALS									
Koala (*Phascolarctos cinereus*)	2007	85	17	Forest and woodland habitats on fertile soils that contain suitable regional eucalypt feed trees. In the locality, the forest red gum and grey gum are known to be important food trees for the koala.	Y	Y	Y	High	√
Long-nosed potoroo (*Potorous tridactylus*)	2002	4	1	Coastal heath and dry and wet sclerophyll forests - relatively thick ground cover is essential and it prefers areas with light, sandy soils. Within the study area there is mostly grazed, disturbed habitat below the high water level. Potential habitat occurs between Chichester Dam and the study area.	N	N	N	Low	-
Parma wallaby (*Macropus parma*)	2002	11	4	Favours wet sclerophyll forest with a thick, shrubby understorey often with nearby grassy patches, rainforest margins and occasionally drier eucalypt forest. Shelters in dense cover at night. Feeds during the day on grasses and herbs in more open eucalypt forest and the edges of nearby grassy areas. Within the study area there is mostly grazed, disturbed habitat below the high water level. Potential habitat occurs between Chichester Dam and the study area.	N	N	N	Low	-
Red-legged pademelon (*Thylogale stigmatica*)	1993	8	3	Inhabits forest with a dense understorey and ground cover, including rainforest, moist eucalypt forest and vine scrub. Shelters in wet gullies with dense shrubby ground cover. Feeds on native grasses and herbs at forest edges. Within the study area there is mostly grazed, disturbed habitat below the high water level. Potential habitat occurs between Chichester Dam and the study area and rainforest gullies above the high water level.	N	Y	N	Low	-
Rufous bettong (*Aepyprymnus rufescens*)	1994	3	0	Found in a variety of habitats from tall, moist eucalypt forest to open woodland, with a tussock grass understorey. Preferred shelter habitat is a dense cover of tall native grasses. Sleeps during the day in a nest constructed of grass and feeds at night on grasses, herbs, seeds, flowers, roots, tubers, fungi and occasionally insects. Within the study area there is mostly grazed, disturbed habitat below the high water level. Potential habitat occurs between Chichester Dam and the study area.	N	N	N	Low	-
Spotted-tailed quoll (*Dasyurus maculatus*)	2006	93	16	Inhabits a variety of habitat types from moist and wet sclerophyll through to dry forests and woodlands on the edge of open grasslands. Requires large hollow logs on the ground for a den and sometimes hollow standing trees. Although individuals could occur, much of the available habitat is probably too disturbed and open to support a resident population.	Y	Y	Y	Moderate	√

Table 8, continued

Common Name	Most Recent Record	Closest Records		Preferred Habitat and Comments*	Habitat available on site			Potential to utilise study area	Subject Species
		20 km	10 km		Breeding	Roosting	Foraging		
MAMMALS									
Squirrel glider (*Petaurus norfolcensis*)	2001	2	0	Usually inhabits dry open sclerophyll forest and woodlands, but has also been observed in moist regenerating forest and moist gullies. Forages on acacia gum, eucalypt sap, nectar, honeydew, manna invertebrates and pollen, utilising areas with an abundance of flowering eucalypts and tall shrubs (e.g. banksias). Acacia species are the preferred sap feeding trees. This species requires an abundance of suitably sized hollow-bearing trees.	Y	Y	Y	High	√
Yellow-bellied glider (*Petaurus australis*)	1997	1	0	Occur in tall mature eucalypt forest generally in areas with high rainfall and nutrient rich soils. Forest type preferences vary with latitude and elevation; mixed coastal forests to dry escarpment forests in the north; moist coastal gullies and creek flats to tall montane forests in the south. Den, often in family groups, in hollows of large trees. Very mobile and occupy a large home range of 20 - 85 ha to encompass dispersed and seasonally variable food resources. Feed primarily on plant and insect exudates, including nectar, sap, honeydew and manna with pollen and insects providing protein. Extract sap by incising (or biting into) the trunks and branches of favoured food trees, often leaving a distinctive 'V'-shaped scar. Although potential habitat occurs in the small remnants below the upper flood level, it is unlikely that they would be large enough to support a local population. Potential habitat occurs between Chichester Dam and the study area although only known from one population on the eastern side of Chichester State Forest despite extensive surveys.	Y	Y	Y	Low	-
FLYING MAMMALS									
East-coast freetail-bat (*Mormopterus norfolkensis*)	1996	1	0	The habitat preference of this species is unclear. It has been predominantly recorded in dry eucalypt forest and woodland, but has been recorded in moist and edge environments. The wing morphology indicates that this species is adapted to the more open habitats. This species primarily roosts in tree hollows, although the roofs of buildings are also used.	Y	Y	Y	Moderate	√
Eastern bent-wing bat (*Miniopterus schreibersii oceanensis*)	2007	14	0	Forages within a variety of habitat types including moist and dry eucalypt forest, woodland, rainforest, heath and open environments, including urban areas. Reliant on suitable roosting/breeding habitat in caves and mine tunnels, although they also roost in storm water channels, road culverts and other comparable structures (including buildings). Estimated nightly foraging range of 20 kilometres. Roost sites are limited within the study area	N	Y	Y	Moderate	√

Table 8, continued

Common Name	Most Recent Record	Closest Records		Preferred Habitat and Comments*	Habitat available on site			Potential to utilise study area	Subject Species
		20 km	10 km		Breeding	Roosting	Foraging		
FLYING MAMMALS									
Eastern false pipistrelle (*Falsistrellus tasmaniensis*)	2007	87	0	Tall forest, woodland or heath/ grassland edges. Roosts in hollow trunk of the largest trees and sometimes buildings. Could forage and roost along the edge of habitat remnants.	Y	Y	Y	Moderate	√
Golden-tipped bat (*Kerivoula papuensis*)	2007	19	5	Rainforest or rainforest gullies in wet sclerophyll forest. Roosts in scrubwren and gerygone nests. Potential habitat could occur in the riparian vegetation and rainforest remnants.	Y	Y	Y	Moderate	√
Greater broad-nosed bat (*Scoteanax rueppellii*)	2007	4	0	Forages for insects over a range of natural and altered habitats, including tall forest, woodland or heath/grassland edges, often along the tree line boundary. Prefers tree hollows in large, often isolated, mature trees for roosting. Usually associated with tall moist open forest.	Y	Y	Y	Moderate	√
Grey-headed flying-fox (*Pteropus poliocephalus*)	2005	10	0	Regularly occurs along the eastern coastal plain through NSW. Roosts in camps, usually in dense riparian habitats. At dusk disperses in search of the preferred food source, mainly eucalypt blossom and rainforest fruits. Long distances are covered (30+km) in search of food. No known camps occur within the study area.	N	N	Y	High	√
Large-eared pied bat (*Chalinolobus dwyeri*)	-	-	-	Range of well-wooded habitats, including dry sclerophyll forests and woodlands of coastal and semi-arid areas. Occasionally in sub-alpine woodlands and at the edge of rainforest and semi-arid areas. Reliant on suitable roosting habitat including caves and mine tunnels (though may use other structures, e.g. abandoned fairy martin nests). No known roosting habitat occurs in the locality.	N	N	Y	Limited	-
Little bent-wing bat (*Miniopterus australis*)	-	-	-	Forages in a range of habitats, including forest, woodland, heath, coastal swamps and rainforest. A nightly foraging range of 20km from roost sites has been reported. Reliant on suitable roosting habitat in caves and mine tunnels, though has been recorded roosting in hollowed out tree bases and dense foliage. No records for the locality but known to occur to the east of Dungog.	N	Y	Y	Moderate	√
Southern myotis (*Myotis macropus*)	2004	686	1	Habitats adjacent to large bodies of water for hunting aquatic insects. Usually forages over or adjacent to water-bodies and associated terrestrial habitats. Roosts in caves, mines, tunnels, bridges, culverts and tree hollows. Likely to roost under the bridges across the Williams River within the study area.	Y	Y	Y	Moderate to High	√

Table 8, continued

Common Name	Most Recent Record	Closest Records		Preferred Habitat and Comments*	Habitat available on site			Potential to utilise study area	Subject Species
		20 km	10 km		Breeding	Roosting	Foraging		
REPTILES									
Stephens' banded snake (*Hoplocephalus stephensii*)	2002	6	2	Partly arboreal in rainforest, wetter sclerophyll forests and rocky areas up to 950m. Shelters during the day under loose bark, among vines, under rock slabs or in hollow trunks, limbs and rock crevices. Hunts for frogs, lizards, birds and small mammals at night. Most likely to occur within the larger riparian and moist forest remnants within the study area, although these may be too small to support a local population.	Y	Y	Y	Limited (forest remnants are small and isolated)	√
AMPHIBIANS									
Davies' tree frog (*Litoria daviesae*)	2001	4	2	Permanently flowing streams above 400m. Inhabits streamside vegetation including rainforest, moist and dry eucalypt forest or heath and tea tree with tussocks and ferns along streams. Breeds in summer and possibly spring. The study area is likely to be too low in altitude for this species to occur.	N	N	N	Highly Unlikely	-
Giant (southern) barred frog (*Mixophyes iteratus*)	-	-	-	Giant barred frogs forage and live amongst deep, damp leaf litter in rainforests, moist eucalypt forest and nearby dry eucalypt forest, at elevations below 1000 m. They breed around shallow, flowing rocky streams from late spring to summer. Females lay eggs onto moist creek banks or rocks above water level, from where tadpoles drop into the water when hatched. Tadpoles grow to a length of 80 mm and take up to 14 months before changing into frogs. When not breeding the frogs disperse hundreds of metres away from streams. They feed primarily on large insects and spiders. The riparian habitat along the banks of the Williams River is considered unsuitable for this species (see **Appendix 8**).	N	N	N	Low	-
Stuttering frog (*Mixophyes balbus*)	2002	4	4	Terrestrial inhabitants of rainforest, Antarctic beech or wet sclerophyll forest along permanent streams. Could occur along the banks of the Williams River where moist/rainforest habitat occurs although adjacent moist forest essential for foraging is absent. Only two potential isolated locations representing < 2 km of riparian habitat have been identified within the inundation area, near Munni Bridge and under the cliffline at Underbank (see **Appendix 8**). Unlikely to occur but cannot be completely discounted so retained as a subject species	Y	Y	Y	Limited	√

Table 8, continued

Common Name	Most Recent Record	Closest Records		Preferred Habitat and Comments*	Habitat available on site			Potential to utilise study area	Subject Species
		20 km	10 km		Breeding	Roosting	Foraging		
AMPHIBIANS									
Sphagnum frog (*Philoria sphagnicolus*)	1980	1	0	Rainforests, including Antarctic Beech forest, moist eucalypt forest and sphagnum moss beds, usually at higher elevations. Burrows in loose, moist soil or moss, under leaf litter often in soaks or seepages, or may use cracks and cavities around waterfalls. The study area is likely to be too low in altitude for this species to occur and the one record from the locality could be dubious.	N	N	N	Highly Unlikely	-
Green and golden bell frog (*Litoria aurea*)	1977	1	0	Inhabits marshes, dams and stream-sides, particularly those containing bullrushes (*Typha* spp.) or spikerushes (*Eleocharis* spp.). Optimum habitat includes water-bodies that are unshaded, free of predatory fish such as plague minnow (*Gambusia holbrooki*), have a grassy area nearby and diurnal sheltering sites available. Some sites, particularly in the Greater Sydney region occur in highly disturbed areas. The species is active by day and usually breeds in summer when conditions are warm and wet. Males call while floating in water and females produce a raft of eggs that initially float before settling to the bottom, often amongst vegetation. Tadpoles feed on algae and other plant-matter; adults eat mainly insects, but also other frogs. Preyed upon by various wading birds and snakes. This species has suffered a major population decline over most of its former range and therefore, based on one old record in the locality, it is considered unlikely to occur. Although habitat may be available within some of the farm dams, further assessment of these habitats by Dr Arthur White suggests that these habitats are unsuitable (see **Appendix 8**).	N	N	N	Low	-

*The following references have been used to compile the habitat descriptions above: Australian Museum Fact Sheets; Churchill, 1998; Cogger, 1995; DECC Threatened Species Profiles; Garnett & Crowley, 2000; NPWS Website; Strahan, 1995.

2.4.3 Subject Species

The following species are considered to be subject species in this assessment on the basis of their likelihood of occurrence in the study area as assessed in **Tables 7 and 8**.

Flora

- *Eucalyptus glaucina* (slaty red gum)
- *Marsdenia longiloba* (slender marsdenia)
- *Senna acclinis* (rainforest cassia)

Fauna

Fauna subject species with the greatest potential to occur as either they are known to occur or are mobile species recorded in the locality and preferred habitat is available:

- Barking owl
- East-coast freetail-bat
- Eastern false pipistrelle
- Grey-crowned babbler
- Koala
- Powerful owl
- Speckled warbler
- Squirrel glider
- Brush-tailed phascogale
- Eastern bent-wing bat
- Greater broad-nosed bat
- Grey-headed flying-fox
- Masked owl
- Southern myotis
- Spotted-tailed quoll
- Turquoise parrot

Fauna subject species with some potential to occur as possible habitat is available:

- Brown treecreeper
- Giant barred frog
- Golden-tipped bat
- Little bent-wing bat
- Sooty owl
- Stuttering frog
- Wompoo fruit-dove
- Diamond firetail
- Glossy black-cockatoo
- Green and golden bell frog
- Regent honeyeater
- Stephen's banded snake
- Swift parrot

Field survey techniques were designed to target these subject species and are discussed in **Section 3**. The potential impacts on these subject species as a result of the proposed development are presented in **Section 4** of this report.

2.4.4 Subject Endangered Flora and Fauna Populations

None of the endangered populations of flora that occur in the Hunter catchment have previously been recorded in the study locality.

Of the endangered populations of flora that could occur in the study locality, *Cymbidium canaliculatum* (tiger orchid) grows in the hollows of trees in dry sclerophyll forest or woodland and there is a small chance that it could occur in the dry sclerophyll forest or woodland communities on ridgetops or drier slopes.

Other populations of endangered flora known to occur in the Hunter catchment are not considered likely to occur in the study area due to a lack of suitable habitat. *Acacia pendula* (weeping myall) usually occurs on heavy clay soils on major river floodplains, *Eucalyptus camaldulensis* (river red

gum) usually occurs adjacent to large permanent water bodies and *Leionema lamprophyllum* (shiny phebalium) grows in heath on exposed ridges at higher altitudes.

No listed endangered populations of fauna are expected to occur within the study area.

2.4.5 Subject Endangered Ecological Communities

Of the EECs identified in **Table 3** as having at least some potential to occur within the study area, the following are considered most likely to occur in the study area on the basis of the habitat assessment carried out:

- River-Flat Eucalypt Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions;
- Subtropical Coastal Floodplain Forest of the New South Wales North Coast Bioregion;
- Lowland Rainforest in the NSW North Coast and Sydney Basin Bioregions; and/or
- Lowland Rainforest on Floodplain in the New South Wales North Coast Bioregion.
- Lower Hunter Spotted Gum – Ironbark Forest in the Sydney Basin Bioregion
- Hunter Lowland Redgum Forest in the Sydney Basin and New South Wales North Coast Bioregions

An assessment of the EECs that were identified as occurring in the study area as a result of the field surveys is provided in **Section 4.**

3.0 SECOND STAGE ECOLOGICAL INVESTIGATION – FIELD SURVEYS

3.1 Floral Investigations

3.1.1 Methodology

Flora field work consisted of a series of surveys of representative parts of the study area encompassing a range of habitat types on 28th November 2007 and 9th - 11th January 2008.

The survey work comprised three components:

- General traverses of selected parts of the study area using the random meander method (Cropper, 1993) to assess the range of floristic variation, vegetation structure, extent of modification, disturbance, weed invasion and condition of the vegetation generally. A small sample of any unknown plant species was obtained for further examination and identification;
- A series of 400 m^2 flora quadrats within areas of remnant natural vegetation along the broad study area for the proposed Salisbury Road deviation in the northern part of the study area; and
- Targeted surveys for threatened flora species considered to be potential subject species (Table 7) in areas of potentially suitable habitat.

3.1.2 Survey Limitations

Given its large size, it was not possible to traverse every part of the study area within the time available. Instead, the aim of the field surveys was to preferentially target priority areas where remnant natural vegetation occurred, particularly remnants of vegetation that could constitute EECs or could contain potentially suitable habitat for threatened flora species. Whilst every patch of remnant vegetation could not be visited, the assessment methodology aimed to ensure that a representative sample of all habitat types in the study area was included during the field survey.

Because of the size of the study area, it is possible that occurrences of rare or threatened flora species in the study area may have been overlooked in spite of the preferential targeting of areas of potentially suitable habitat. This was particularly the case in the proposed road deviation, in which several route options were under consideration for part of the alignment.

The mapping of vegetation was prepared by the interpretation of aerial photographs with ground truthing of approximately 80% of the vegetated areas mapped. Whilst all care was taken in the preparation of the vegetation mapping, as not all areas were visited, some inaccuracies in the interpretation and exact distribution of vegetation may be inherent in the vegetation map produced.

3.1.3 Results

Vegetation Communities

In a review by Connell Wagner (2007) of the vegetation mapping undertaken for the Comprehensive Regional Assessments (NPWS 1999), four broad vegetation community types were considered to occur in the study area:

- Dry Sclerophyll Shrub/Grass Forests;
- Swamp Sclerophyll Forests;
- Wet Sclerophyll Forests; and
- Rainforests.

Being based largely on aerial photo interpretation, the mapping by NPWS (1999) is inaccurate and sometimes misleading at the scale of individual sites or particular local areas. At best it should be used as a guide to the broad vegetation types expected in any area. The mapping presented in this report is largely based on field based survey and aerial photo interpretation in areas not accessed during the surveys. Therefore a more accurate interpretation of the actual vegetation communities within the study area is provided.

From the flora fieldwork carried out, five natural vegetation communities were recognised throughout the study area, plus one artificial community which is highly modified. The natural vegetation communities are shown in **Figure 3**.

Natural Communities

1. Subtropical Rainforest
2. Moist Gully Blue Gum Wet Sclerophyll Forest
3. Spotted Gum – Ironbark Forest
4. Forest Red Gum Moist Slopes Forest
5. Riparian Forest

Highly Modified Community

6. Predominantly cleared open pasture or derived grassland with sporadic remnant paddock trees including small farm dams.

Table 9. Description of the Vegetation Communities within the Study Area

Community 1: SUBTROPICAL RAINFOREST

Stratum	Height (m)	% cover*	Dominant species	Description and Comments
Tall Tree layer (emergent)	25 - 35	30 - 40	*Dendrocnide excelsa, Doryphora sassafras, Melicope micrococca*	Habitat: Moist and deep sheltered gullies on rich, high nutrient soil in more elevated parts of the study area, above the floodplain areas. Often adjoins or intergrades with Community 2 – Moist Blue Gum Forest or Community 3 – Spotted Gum-Ironbark Forest. Structure/Characteristics: Closed Forest with emergent tall rainforest trees, often buttressed, and with a high diversity of small to medium trees with mesophyllous leaves. Ferns, vines and epiphytes are abundant in the ground layer and on trees and large shrubs. No eucalypts or only occasional emergent. Distribution within Study Area: Confined to discrete patches in sheltered gullies along the alignment for the proposed Salisbury Road deviation. Condition & Presence of Weeds: The community is generally in good condition and free of weeds, apart from some infestations of Lantana in patches due to past disturbances such as logging, and minor weeds at the boundaries of disturbed areas. Conservation Status: The habitat of the community together with the particular assemblage of species and structure of the community indicates it qualifies as the EEC 'Lowland Rainforest' under the NSW TSC Act (NSW Scientific Committee 2006).
Sub-canopy layer (small-medium trees)	4 -20	60 - 80	*Sloanea australis, Backhousia myrtifolia, Melia azedarach, Synoum glandulosum, Sarcomelicope simplicifolia, Scolopia braunii, Dysoxylum fraserianum, Ficus coronata, F. rubiginosa, Neolitsea dealbata, N. australiensis, Diospyros australis, Helicia glabriflora, Streblus brunonianus, Acacia maidenii, A. melanoxylon, Hymenosporum flavum, Wilkiea huegeliana*	
Shrub layer	1 – 3	10 - 30	*Pittosporum multiflorum, Sambucus australasica, Alectryon subcinereus, Capparis arborea, Croton verauxii, Hibiscus heterophyllus, Lantana camara.*	
Ground layer	0 – 1	20 - 80	*Lastreopsis decomposita, Rumohra adiantiformis, Calochlaena dubia, Adiantum formosum, Pteris umbrosa, Alpinia caerulea, Pellaea nana, P. falcata, P. paradoxa, Sigesbeckia orientalis, Pollia crispata, Aneilema acuminatum, Solanum prinophyllum, Alocasia brisbanensis, Urtica incisa, Galium binifolium, Asplenium australasicum, Doodia aspera , Dichondra repens, Lomandra longifolia, Oplismenus aemulus, Entolasia marginata, Cyperus tetraphyllus*	
Vines / climbers / epiphytes	*Parsonsia straminea, Pandorea pandorana, Tylophora barbata, Deeringia amaranthoides, Zehneria cunninghamii, Cissus antarctica, C. hypoglauca,C. opaca, Dioscorea transversa, Smilax australis, Stephania japonica, Sarcopetalum harveyanum, Cayratia clematidea, Clematis aristata, Geitonoplesium cymosum, Arhtropteris tenella, Platycerium bifurcatum.*			

*projective canopy foliage cover

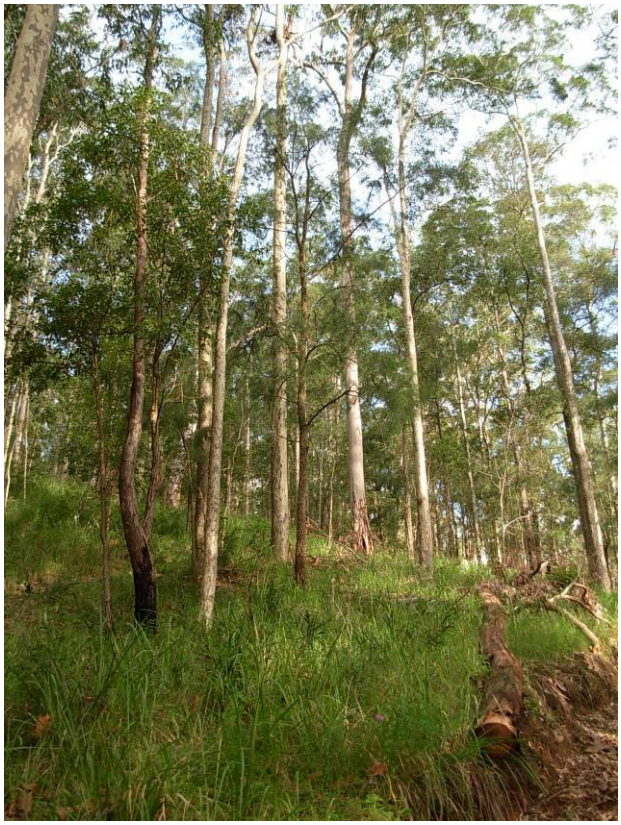
Community 2: MOIST GULLY BLUE GUM WET SCLEROPHYLL FOREST

Stratum	Height (m)	% cover*	Dominant species	Description and Comments
Tree layer	20 - 30	20 - 40	*Eucalyptus saligna, E. microcorys, E. acmenoides, E. umbra, E. canaliculata, Corymbia maculata, Syncarpia glomulifera*	Habitat: Slopes and open moist gullies in more elevated parts of the study area, or minor upper riparian areas. Often intergrades with Community 1 (Subtropical Rainforest) or Community 3 (Spotted-Gum-Ironbark Forest). Structure/Characteristics: Forest or Open Forest dominated by tall eucalypt species with some rainforest elements or moist-adapted species in the understorey. Distribution within Study Area: Occurs in small to medium patches associated with moist open gullies or small riparian areas in the upper reaches of creeks within the study area. Condition & Presence of Weeds: Most areas are in good condition and free from weeds, however large portions of the understorey are heavily invaded by lantana where disturbance is evident from cattle grazing and partial clearing, past logging or under scrubbing. Conservation Status: This community is not a listed EEC and does not have any particular conservation significance locally.
Sub-canopy layer	4 - 12	20 - 30	*Acacia melanoxylon, A. maidenii, Allocasuarina torulosa, Glochidion ferdinandi*	
Shrub layer			*Lantana camara, Clerodendrum tomentosum, Pittosporum revolutum, Maytenus silvestris, Trema tomentosa, Callistemon salignus,*	
Ground layer	0 – 1	40 - 70	*Breynia oblongifolia, Plectrantus parvifolius, Commelina cyanea, Sigesbeckia orientalis, Viola hederacea, Hybanthus stellarioides, Oplismenus aaemulus, Doodia aspera, Pratia purpurascens, Wahlenbergia communis, Adiantum aethiopicum, A. hispidulum, Scaevola albida, Vernonia cinerea, Geranium solanderi, Pseuderanthemum variabile, Dichondra repens, Lomandra longifolia, Imperata cylindrica, Themeda australis, Arthropodium milleflorum, Scutellaria mollis.*	
Vines / climbers / twiners	*Pandorea pandorana, Hardenbergia violacea, Desmodium varians, D. brachypodum,Cayratia clematidea, Geitonoplesium cymosum, Eustrephus latifolius, Clematis aristata, Glycine* spp., *Passiflora herbertiana, Parsonsia straminea, Stephania japonica, Sarcopetalum harveyanum, Smilax australis, Dioscorea transversa, Rubus parvifolius.*			

*projective canopy foliage cover

Community 3: SPOTTED GUM-IRONBARK FOREST

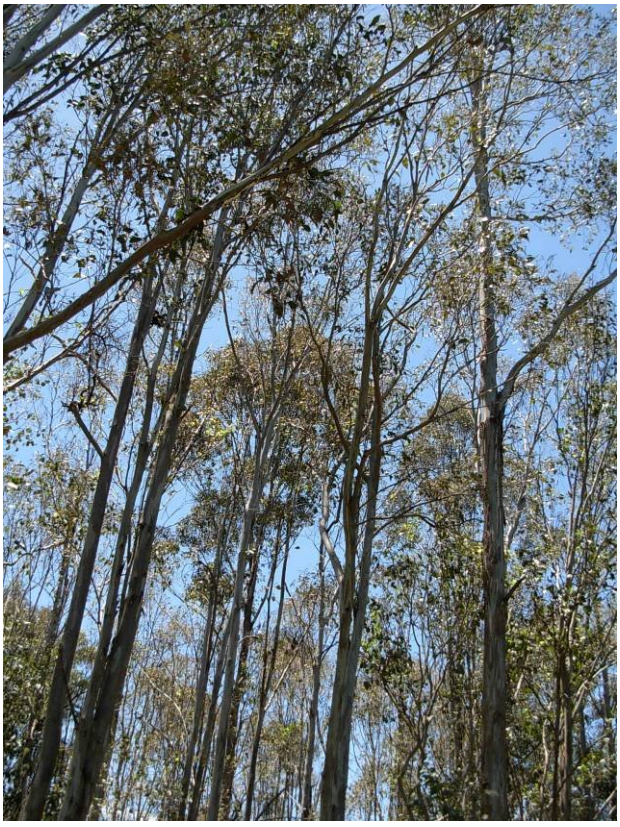
Stratum	Height (m)	% cover*	Dominant species	Description and Comments
Tree layer	18 - 25	20 - 30	*Corymbia maculata, Eucalyptus siderophloia, E. acmenoides, E. canaliculata, E. moluccana, E. umbra.*	Habitat: Well-drained ridgetops and associated slopes, with some remnants on drier lowland areas. Structure/Characteristics: Open Forest dominated by spotted gums, ironbarks, mahoganies and grey gums with a sparse to moderate dry or grassy understorey. The shrub layer is sometimes sparse to absent, but dominated by dense lantana in other patches. The community varies from moist to drier forms, these differences being reflected in species composition and density of the understorey. Distribution within Study Area: Occupies large patches of the study area in the proposed dam wall and spillway area, ridgetop and adjacent slope areas and also some lowland areas. Condition & Presence of Weeds: Most patches of the community are generally in good condition and free of weeds. Some stands that have been disturbed by logging or cattle grazing contain patches of weeds in the understorey, particularly lantana. Many patches in currently grazed areas have been partially cleared, with the understorey removed and the tree layer thinned. Conservation Status: Reference to the Final Determination for Lower Hunter Spotted Gum – Ironbark Forest EEC (NSW Scientific Committee 2005) indicates that this community is not a listed EEC, nor does it carry any particular conservation significance. This is discussed further in the text.
Sub-canopy layer	3 - 12	5 - 20	*Allocasuarina torulosa, Acacia irrorata, A. melanoxylon, A. implexa, Jacksonia scoparia.*	
Shrub layer	1 - 2	0 - 60	*Acacia falcata, Lantana camara, Breynia oblongifolia, Notelaea longifolia, Maytenus silvestris, Daviesia genistifolia, Ozothamnus disomifolius, Cassinia aculeata, Myrsine variabilis*	
Ground layer	0 - 1	40 - 70	*Imperata cylindrica, Themeda australis, Austrostipa scabra, Panicum simile, Poa labillardieri, Eragrostis brownii, E. leptostachya, Echinopogon caespitosus, Cymbopogon refractus, Austrodanthonia* sp.*, Aristida vagans, A. ramosa, Pratia purpurascens, Pomax umbellata, Leucopogon juniperinus, Cheilanthes sieberi, C. distans, Sigesbeckia orientalis, Geranium solanderi, Dichondra repens, Hibbertia diffusa, Dianella caerulea, Lomandra filiformis, L multiflora, Brachyscome microcarpa, Scaevola albida, Chrysocepahlum apiculatum, Lepidosperma laterale, Einadia hastata, Vernonia cinerea, Tricoryne elatior, Pseuderanthemum variabile, Brunoniella australis, Poranthera microphylla, Zornia dictyocarpa*	
Vines / climbers / twiners	*Desmodium rhytidophyllum, D. varians, Glycine tabacina, Eustrephus latifolius, Geitonoplesium cymosum, Kennedia rubicunda, Jasmimum volubile, Billardiera scandens, Clematis aristata.*			



*projective canopy foliage cover

Community 4: FOREST RED GUM MOIST SLOPES FOREST

Stratum	Height (m)	% cover*	Dominant species	Description and Comments
Tree layer	18 - 25	20 - 30	*Eucalyptus tereticornis, E. canaliculata, E. acmonoides, E. moluccana.*	Habitat: Sheltered moist slopes, south/east-facing gullies near ridgetops or moist elevated areas near floodplains. Often intergrading with Community 3: Spotted Gum – Ironbark Forest. Structure/Characteristics: Open Forest dominated byforest red gum, grey gum and white mahogany with a sparse to moderate moist or grassy understorey. The shrub layer is sparse to absent, or dominated by moderate to dense lantana patches in some areas. Distribution within Study Area: Occurs as restricted patches in specific habitat areas, usually where moister (but not waterlogged) and more sheltered conditions than those characterising Community 3 prevail. Mainly on slopes and gullies in the road deviation area, but some remnants occur in riparian areas and on the floodplain. Condition & Presence of Weeds: Most patches of the community are disturbed by past clearing, under scrubbing and current grazing and consequently contain extensive patches of weeds, particularly lantana. Trees in some stands are showing signs of severe defoliation, probably due to Christmas beetle attack. Conservation Status: Although many of the species listed as characterising the EEC Hunter Lowland Redgum Forest are present in the study area, the underlying geology, topography and habitat do not match the description given in the Final Determination for the EEC (NSW Scientific Committee 2002) indicating that this community is not a listed EEC as discussed further in the text. The community does not carry any particular local conservation significance.
Shrub layer	1 - 2	0 - 20	*Lantana camara, Breynia oblongifolia, Notelaea longifolia, Pittosporum multiflorum, Maytenus silvestris, Acacia maidenii, Myrsine variabilis*	
Ground layer	0 - 1	40 - 70	*Imperata cylindrica, Oplismenus aemulus, Microlaena stipoides, Themeda australis, , Panicum simile, Pratia purpurascens, Viola hederacea, Commelina cyanea, Cheilanthes sieberi, Centella asiatica, Hybanthus stellarioides, Verbena rigida, Carex longebrachiata, Rubus parvifolius, Fimbristylis dichotoma, Ranunculus plebeia, Pellaea falcata, Hydrocotyle tripartita, Cymbonotus lawsonianus, Dichondra repens, Scaevola albida, Vernonia cinerea, Tricoryne elatior, Zornia dictyocarpa*	
Vines / climbers / twiners	*Parsonsia straminea, Desmodium rhytidophyllum, D. varians, Glycine tabacina, G. microphylla, Pandorea pandorana, Eustrephus latifolius, Geitonoplesium cymosum, Clematis aristata.*			



*projective canopy foliage cover

Community 5: RIPARIAN FOREST

Stratum	Height (m)	% cover*	Dominant species	Description and Comments
Tree layer	20 - 30	30 - 50	*Casuarina cunninghamiana, Angophora floribunda, Eucalyptus saligna, E. tereticornis, E. moluccana*	Habitat: Bank and immediate low-lying floodplain of river and major creeks and tributaries. Structure/Characteristics: Riparian Forest or Open Forest dominated by river oaks, moisture- and flood-tolerant eucalypts, clumps of paperbarks and usually with a mesic understorey and a high proportion of weedy species (including trees such as willows etc.) spread by floodwaters. Distribution within Study Area: Occupies the flat, low-lying areas in a narrow band (broadening in some places across the floodplain) along the Williams River and its major tributaries in the study area. Condition & Presence of Weeds: Almost all parts of the community are affected by herbaceous and/or woody weeds to some degree due to transport of propagules by floodwater. Common noxious or environmental weeds are Cat's claw creeper, willows Conservation Status: The habitat of the community together with the particular assemblage of species according to the Final Determination indicates that the community qualifies as the EEC 'River-flat Eucalypt Forest' (NSW Scientific Committee 2004a) under the NSW TSC Act with some elements, including a couple of larger patches, of Subtropical Coastal Floodplain Forest (NSW Scientific Committee 2004b) usually in sheltered creek gullies with narrow floodplains where rainforest species tend to be more common.
Sub-canopy layer	10 - 15	0 - 60	*Melaleuca styphelioides, Tristaniopsis laurina, Melia azedarach, Callistemon salignus, Backhousia myrtifolia, Streblus brunonianus*	
Shrub layer	1 - 5	0 - 70	*Lantana camara, Ficus coronata, Maytenus silvestris, Acacia melanoxylon, Hibiscus heterophyllus, Clerodendrum tomentosum, Breynia oblongifolia.*	
Ground layer	0 – 1	50 - 90	*Oplismenus aemulus, Ehrhardta erecta, Imperata cylindrica, Entolasia marginata, Viola hederacea, Ageratina riparia, Juncus usitatus, Pteridium esculentum, Sigesbeckia orientalis, Paspalum* spp., *Commelina cyanea, Carex appressa, Phyllanthus gunnii, Cheilanthes sieberi, Urtica incisa, Adiantum formosum, Plectranthus parvifolius, Christella dentata, Doodia aspera, Zieria smithii*	
Vines, climbers, scramblers			*Rubus parvifolius, Macfadyena unguis-cati, Rubus fruticosus, Cayratia clematidea, Pandorea pandorana, Glycine* spp., *Clematis aristata, Eustrephus latifolius, Geitonoplesium cymosum, Hibbertia scandens, Stephania japonica, Cissus antarcticus.*	

*projective canopy foliage cover

Floral Diversity

From the flora surveys, a total of 315 flora species from 100 families have been identified. This total includes 21 ferns, 220 dicotyledons and 73 monocotyledons. Of the total species recorded, 78 species of exotic flora were identified, representing approximately 25% of the total species.

A list of all flora species so far recorded and identified from within the study area is included as **Appendix 2.**

Condition of the Vegetation and Presence of Weeds

The condition of the vegetation varies throughout the parts of the study area. The areas of heaviest weed infestation occurred along the river and creekline riparian areas and some gully areas, and to a lesser extent in the pasture and grazing areas. Grazing in the open pasture tends to keep the abundance of noxious and environmental weeds relatively low. A moderate infestation of lantana was present in patches of the spotted-gum – ironbark forest and rainforest areas.

Five of the species recorded in the study area are declared noxious weeds pursuant to the *Noxious Weeds Act 1993* in the Dungog Council Control Area. These, together with their relevant control classes, are:

- Blackberry (*Rubus fruticosus* sp. aggr.) – Class 4
- Black willow (*Salix nigra*) – Class 5
- Lantana (*Lantana camara*) – Class 5
- Noogoora burr (*Xanthium occidentale*) – Class 4
- Shamrock oxalis (*Oxalis articulata*) – Class 5

Explanations of the relevant control categories are as follows:

Class 4 – Locally Controlled Weeds: The growth and spread of the plant must be controlled according to the measures specified in a management plan published by the local control authority. Further details are available from the Dungog Council website: http://www.dungog.nsw.gov.au/environment.html

Class 5 – Restricted Plants: The requirements in the Noxious Weeds Act 1993 for a notifiable weed must be complied with. See **Appendix 3** for further details.

Since many of these weeds occur in areas that would be inundated, the usual control provisions may not apply in the relevant areas. Areas where the control provisions would be most relevant include the dam wall and spillway area, road deviation area and retained vegetation and pasture areas.

Apart from declared noxious species, major or more serious environmental weed species recorded within the site include cat's claw creeper, moth plant, creeping crofton weed, fire weed, small-leaved privet, wild tobacco tree, trad and giant reed. Common minor or less serious environmental weeds include slender celery, cobblers pegs, cape ivy, stinking Roger, common sowthistle, hedge mustard, common chickweed, burr medic, lucerne, Texas sage, redflower mallow, Paddy's lucerne, Mexican poppy, curly dock, sweet briar, twiggy mullein, purpletop and some exotic grasses.

As with the noxious weeds, many of these species occur in areas that will be inundated and therefore no special treatment would be necessary. Otherwise, control or management of any of these species in areas adjacent to affected areas would be highly desirable.

Threatened or Significant Flora Species or Endangered populations of flora

No threatened flora species listed by legislation or by ROTAP were recorded within the study area during the field surveys. Since potentially suitable habitat for some threatened flora species could be present within particular parts of the study area not surveyed, the small possibility of rare or threatened species occurring in the study area remains open.

In terms of endangered populations of flora, the presence of *Cymbidium canaliculatum* is also a minor possibility.

Threatened Ecological Communities

Three Endangered Ecological Communities (EECs) listed by the NSW TSC Act are considered to occur in the study area (one in intergrade form only) on the basis of the field investigations. These are:

- River-flat Eucalypt Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions
  Most of the riparian vegetation along watercourses (Community 5) appears to qualify as the EEC *River-flat Eucalypt Forest on Coastal Floodplains*. Although the Final Determination for the EEC states that it generally occurs below 50 m ASL, the EEC 'may occur on localised river flats up to 250 m above sea level' (NSW Scientific Committee 2004a). Of the 88 species listed in the Final Determination for the EEC as characterising the EEC, 62 (about 69%) are present in the study area. Although not all of these species were recorded within the riparian area itself (Community 5), the majority were and most that were only recorded in other communities are highly likley to also occur in some parts of the riparian community. The Final Determination states that the EEC has a tall open tree layer of eucalypts. The tree layer in some sections of riparian vegetation along the rivers and creeks consists entirely of river oak (*Casuarina cunninghamiana*) with eucalypts absent. This form is regarded as a variant of the EEC, since *C. cunninghamiana* is stated as being characteristic of the small tree layer, even though stands of this species are quite tall (at least as tall as the eucalypts) in the study area. Dungog LGA is not among the list of LGAs in which the EEC is known to occur according to the Final Determination (NSW Scientific Committee 2004a), but it is stated that the EEC 'could occur elsewhere' in the North Coast bioregion. The EEC is stated as occurring on periodically inundated alluvial flats, drainage lines and river terraces associated with coastal floodplains. Floodplains are defined in the Final Determination as 'level landform patterns on which there may be active erosion and aggradation by channelled and overbank stream flow with an average recurrence interval of 100 years or less' (NSW Scientific Committee 2004a). It could be argued that riparian zone disturbance since European settlement may have reduced the frequency of flooding of the upper Williams River to less than once in 100 years, as postulated in studies cited by Gippel and Anderson (2008). This being the case, the community would not be on a true floodplain according to and required by the definition in the Final Determination.

  Hydraulic modelling of the Williams River channel would be required to definitely determine the specific extent and frequency of flooding within this community to ensure that it met all of the diagnostic criteria in the determination, however, such hydraulic analysis is beyond the scope of our assessment. We have observed recent flood debris in branches well above the normal water level in the riparian community within the proposal area, suggesting that at least parts of it flood regularly and is therefore on a true floodplain. Consequently, we conclude that the riparian community as identified in the study area does

peioridically flood and accordingly meets the NSW Scientific Committee's criteria for identification. Regardless of the exact frequency of flooding, we also consider that the community does occur on substrate that is consistent with the definition of a floodplain as intended by the Final Determination. The identification guidelines for the EEC (DECC 2008) acknowledge that flooding regimes may have been been changed since European settlement and that certain floodplain areas 'rarely flood anymore due to deepening or widening of streams' or other human-induced changes.

- Lowland Rainforest in the NSW North Coast and Sydney Basin Bioregions
  Many deep, sheltered and particularly south-facing gullies in elevated areas on rich soil contain moist closed forest characterised by trees with mesophyllous leaves and a general lack of eucalypts or sclerophyllous shrubs. This vegetation type (Community 1) is classified as subtropical rainforest and qualifies as the EEC *Lowland Rainforest.* Of the 108 species listed in the Final Determination for the EEC as characterising the EEC (NSW Scientific Committee 2006), 43 (about 40%) are present in the relevant areas. The patches of this EEC within the study area are fairly small, and mainly occur in the road deviation section of the study area.

- Subtropical coastal Floodplain Forest in the NSW North Coast and Sydney Basin Bioregions (intergrade form with River-flat Eucalypt Forest)
  Small parts of the riparian forest (Community 5) where the watercourse runs through a deeper gully with steep banks and a very narrow floodplain or no flat floodplain contain rainforest elements in the form of small mesophyllous trees, shrubs and ferns. However, these tend to soon intergrade with the River-flat eucalypt forest EEC (as identified and described above), and it is considered that this EEC occurs in an intergrade form, with no part of the riparian community constituting the 'pure' form of the EEC, apart from possibly a couple of slightly larger patches. Although not listed as occurring in the Dungog LGA according to the Final Determination for the EEC (NSW Scientific Committee 2004b), the Final Determination states that it 'could occur elsewhere' in the North Coast bioregion.

Endangered Ecological Communities that were considered as having a potential presence in the study area, but subsequently rejected as being present following field surveys and data analysis include:

- Lower Hunter Spotted Gum – Ironbark Forest in the Sydney Basin Bioregion
  Several medium to large patches of a spotted gum – ironbark forest vegetation association (Community 3) occur within the study area, mainly in drier ridgetop or well-drained slopes and some lower areas. This community is not considered to constitute *Lower Hunter Spotted Gum -Ironbark Forest* (LHSGIF), but another form of spotted-gum ironbark forest which is specifically excluded from the EEC by the Final Determination (NSW Scientific Committee 2005). The reasons for this are firstly that the community in the study area occurs on Carboniferous sediments rather than the younger Permian sediments that support LHSGIF. Secondly, the species composition of the community in the study area is more indicative of either *Seaham Spotted Gum – Ironbark Forest* (in particular the greater frequency of *Eucalyptus moluccana* and *E. siderophloia* in the tree layer; and of *Acacia falcata, Leucopogon juniperinus* and *Aristida vagans* in the understorey) or another distinct assemblage dominated by spotted gums and ironbarks on Carboniferous sediments of the footslopes of the Barrington plateau (NSW Scientific Committee 2005). Both assemblages are explicitly excluded from the EEC by the Final Determination. Although the Final Determination for LHSGIF states that the EEC is known to occur in Dungog

LGA, the full title for the EEC effectively restricts the distribution of this EEC to the Sydney Basin bioregion.

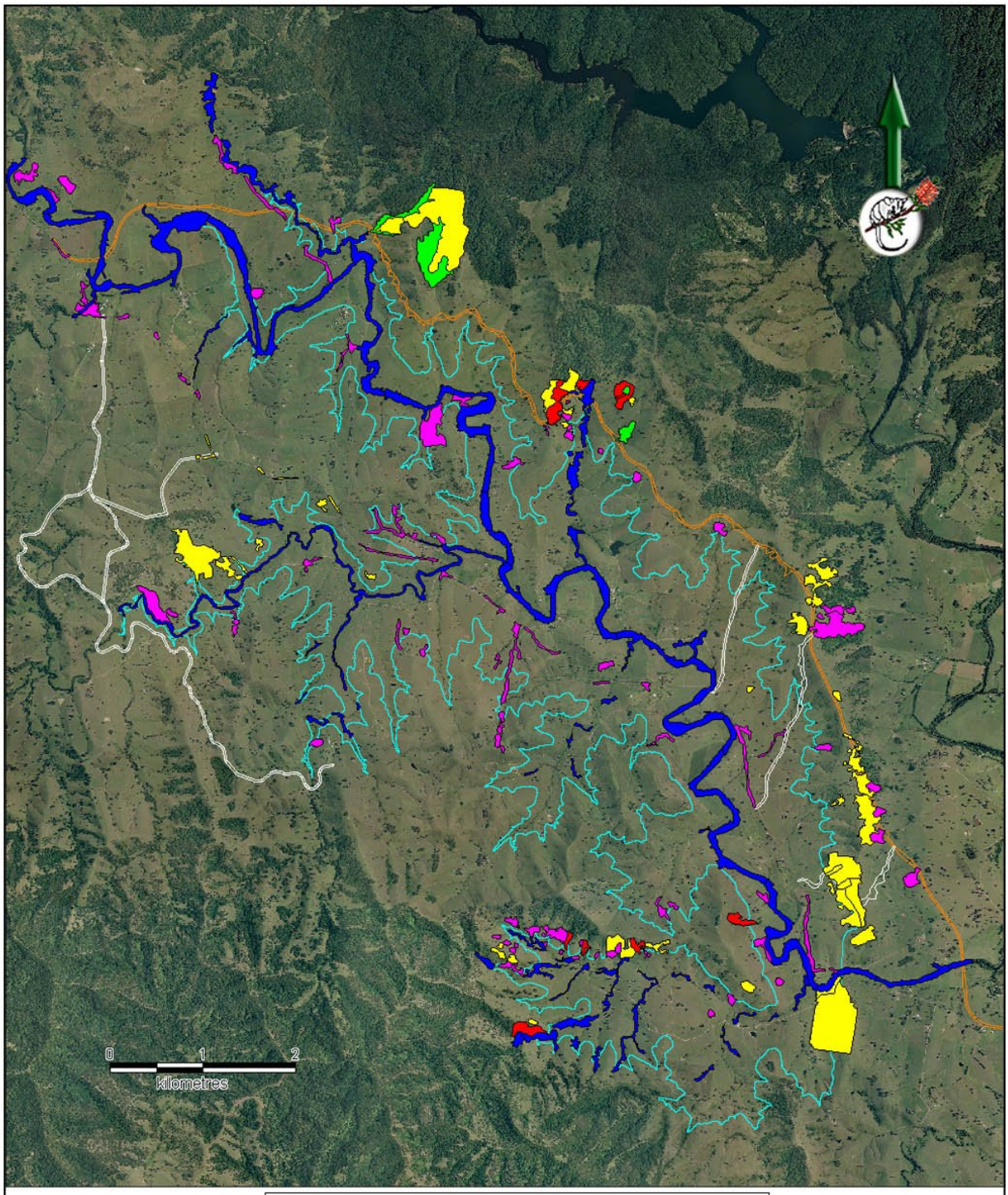
- Hunter Lowland Redgum Forest in the Sydney Basin and New South Wales North Coast Bioregions
  Although a large proportion of species characteristic of this EEC are present in the study area (NSW Scientific Committee 2002), most of these are widespread species common to many communities. Many areas dominated by forest red gums (*Eucalyptus tereticornis*) occur within the study area (Community 4). These typically occur on sheltered, slightly moister gullies and lower slopes or flatter areas originating from some riparian areas at the lower end and extending upslope to and intergrading with the drier spotted gum – ironbark community (Community 3). The Final Determination for the EEC (NSW Scientific Committee 2002) states that the community occurs on Permian sediments, whereas the geology of the study area is predominantly Carboniferous. In addition, the EEC is not known to occur in the Dungog LGA according to the Final Determination, although other EECs not stated as occurring in Dungog LGA are considered to be present. Finally, some of the most common canopy tree species according to the Final Determination are absent, including *Angophora costata, Eucalyptus crebra* and *E. punctata*. Overall, it is concluded that this EEC does not occur in the study area.

No threatened ecological communities listed by the Commonwealth EPBC Act are considered to occur within the study area. The white box, yellow box, Blakely's red gum grassy woodland and derived native grassland is listed in the Protected Matters report as possibly occurring within the area. However the field surveys failed to record any of the key indicator tree layer species and no remnants have been mapped in the locality. Therefore this vegetation community is considered unlikely to occur.

Overall Significance of the Vegetation

The vegetation of the study area has significance in that it includes three EECs, provides habitat for documented threatened fauna species and has potential habitat for threatened flora species and rare non-listed flora species.

The main ecological function of the remnant vegetation in the study area is as part of a corridor that provides connectivity both for movement of fauna and for exchange of genetic material between native flora species locally. This would tend to reduce the risk of local flora populations becoming isolated.



Key

- Community 1 - Subtropical Rainforest (EEC)
- Community 2 - Moist Gully Blue Gum Wet Sclerophyll Forest
- Community 3 - Spotted Gum-Ironbark Forest
- Community 4 - Forest Red Gum Moist Slopes Forest
- Community 5 - Riparian Forest (EEC)

Ecotone Ecological Consultants Pty Ltd

Figure 3. Vegetation Communities

Flora and Fauna Impact Assessment: Proposed Construction & Operation of the Tillegra Dam west of Dungog, NSW

May 2008

3.2 Faunal Investigations

An initial habitat assessment was conducted on the 2nd of November 2007. Fauna survey investigations took place between the 26th-30th November 2007 and 9th-11th January 2008. The main purpose of the initial week-long survey was to target arboreal and terrestrial mammals by undertaking trapping techniques within those areas of more intact bushland identified during the field habitat assessment. The second field trip was designed to cover areas that had not been investigated during the first trip, though no additional trapping was undertaken.

A list of all fauna recorded within the study area during the survey period is included as **Appendix 4**.

3.2.1 Methodology

The initial field trip concentrated on the south-east half of the study area, with the primary aim to undertake trapping within the two larger patches of more intact native vegetation that were identified during the field habitat assessment. These two patches of vegetation are located north and south of the proposed dam wall area and include the Tillegra Travelling Stock Reserve (TSR). Surveys for the second field trip were conducted mainly along the proposed road route along the ridgeline and hill slopes east of the Williams River.

The survey methodologies used are in general accordance with the DEWHA Guidelines for Biological Survey Data, DECC Threatened Biodiversity Survey and Assessment: Guidelines for Developments and Activities (working draft 2004) and Lower Hunter and Central Coast Regional Environmental Management Strategy (LHCCREMS) flora & fauna survey guidelines (2002). The field survey methodologies are as follows:

- Tree and terrestrial live trapping transects
- Tree and terrestrial hair tube transects
- Bridge watch
- Stag watch
- Spotlight survey
- Nocturnal call playback
- Ultrasonic bat call detection
- Harp trapping for insectivorous bats
- Diurnal bird census
- Diurnal reptile census
- Targeted searches for frogs
- Koala scat search
- Opportunistic observations

A summary table showing the total survey effort is included as **Appendix 5**. The locations of the fauna survey sites are included in **Table 10** and shown in **Figure 4**.

Table 10. Locations of Fauna Survey Sites

Site	Location	Grid Reference (WGS84)	
		Easting	Northing
1	Along Chichester Rd - north of Salisbury Rd and south of the Williams River	371228	6429730
2	Along Heatherbrae Rd from Munni Bridge	375141	6426533
3	Tillegra Dam – Trap Line A - Vegetated patch along slopes and ridge north of bridge at Tillegra	376690	6424172
4	Tillegra Dam – Trap Lines B, C & D - Tillegra TSR & vegetated patch along river south of bridge at Tillegra	376553	6422978
5	Near Munni House	374593	6426528
6	Along Quartpot Rd from Salisbury Rd	370727	6427841
7	Along Salisbury Rd either side of Bullee Coggee Creek crossing	368412	6430638
8	Tillegra Bridge (Williams River)	376490	6423431
9	Along Tillegra TSR Rd (west of Salisbury Rd and Tillegra TSR)	374829	6422721
10	Riparian strip along Williams River on Moore's property - north of junction with Quartpot Creek	372899	6428059
11	Along Chichester Rd - north of Salisbury Rd and north of the Williams River	370434	6431677
12	Property No. 272 (Lot 7 DP 5937) NE of Williams River and Chichester Rd	371970	6431453
13	Dam north of Heatherbrae Road (Lot 1 DP 829408)	374051	6427932
14	Property No. 114 (Lot 50 DP 753201) North of Heatherbrae Rd	373854	6429724
15	Along ridge north of Line A (Lot 142 DP 617159 & Lot 12 DP 825979)	376661	6425352

Live trapping transects

Live trapping targeting arboreal and terrestrial mammals was carried out during the initial survey week, with four trap lines set out along 200-400m transects in remnant vegetation at the south-eastern end of the study area. Trap lines A, B and C were set out within the study area on the 26th of November 2007 for four nights. Trap line D was set out on the 27th of November 2007 for three nights. Details of the number of traps in each line are given below:

Line A
- Tree traps - 10 “B” Elliott traps (measuring 46cm x 15cm x 15cm)
- Ground traps - 25 “A” Elliott traps (measuring 33cm x 10cm x 9cm)
- 3 cage traps

Line B
- Tree traps - 10 “B” Elliott traps
- Ground traps - 25 “A” Elliott traps
- 3 cage traps

Line C
- Tree traps - 5 “B” Elliott traps
- Ground traps - 13 “A” Elliott traps
- 2 cage traps

Line D
- Tree traps - 5 “B” Elliott traps
- Ground traps - 12 “A” Elliott traps
- 1 cage trap

In order to target arboreal mammals, each tree trap was mounted on a platform attached to a selected tree at a height of approximately three metres with the aid of a ladder. Tree traps were baited with standard peanut butter and rolled oat mixture and candied honey wrapped in paper towel. The tree trunk above the trap was sprayed each day with a honey/water mixture via a spray bottle.

In order to target terrestrial mammals, ground traps were positioned near obvious animal runways, fallen logs or suitable dense vegetation. Each Elliott trap was baited with standard peanut butter and rolled oat mixture. Each cage trap was baited with two raw chicken wings.

All traps were positioned so as to avoid the morning sun and were covered with a plastic bag to reduce the risk of exposure (due to rain) to any captured animal. Ground traps were either positioned within dense vegetation or covered with leaves or bark for shade. Bedding material, usually dry leaves gathered on site, was added to each Elliott trap.

All traps were inspected early each morning for captures, with captured animals either released immediately or kept until evening and then released at the point of capture.

Hair Tube Transects

Hair tube lines targeting arboreal and terrestrial mammals were set out during the initial survey week, with small, medium and large hair tubes set up along the four trap lines in remnant vegetation at the south-eastern end of the study area. Hair tubes along lines A, B and C were set out on the 26th of November, 2007, for eleven nights. Hair tubes along trap line D were set out on the 27th of November, 2007, for ten nights. Details of the number of hair tubes in each line are given below:

Line A	- Tree	- 10 small hair tubes
	- Ground	- 3 large hair tubes
		- 10 medium hair tubes
		- 10 small hair tubes
Line B	- Tree	- 10 small hair tubes
	- Ground	- 3 large hair tubes
		- 10 medium hair tubes
		- 10 small hair tubes
Line C	- Tree	- 5 small hair tubes
	- Ground	- 1 large hair tubes
		- 5 medium hair tubes
		- 5 small hair tubes
Line D	- Tree	- 5 small hair tubes
	- Ground	- 2 large hair tubes
		- 5 medium hair tubes
		- 5 small hair tubes

At each tree trap location, a small hair tube was attached to the trunk of a selected tree at a height of approximately two metres. Ground hair tubes were positioned near obvious animal runways, fallen logs or suitable dense vegetation. Small hair tubes were baited with peanut butter while the medium and large hair tubes were baited with a peanut butter, rolled oats and tinned fish mixture. Double-sided tape was affixed to the roof of each hair tube in order to collect hairs from any mammal that might investigate the bait.

Hair tubes were left in place for either ten or eleven nights and collected on the 7th of December, 2007. All hair tubes were inspected carefully following collection and any hairs found were sent to Barbara Triggs, a recognised expert in hair and fur analysis, for identification.

Bridge Watch

A daytime search for roosting bats was conducted at Tillegra Bridge (Site 8) on the 10th January 2008. This was followed by a dusk bridge watch in order to determine approximate numbers and species of bats that may be roosting under the bridge. The bridge watch was undertaken by two observers for a period of 30 minutes starting just before sunset, followed by a short period of spotlighting in the vicinity. A hand-held CFZCAIM unit was utilised during the entire period in order to record the calls of any bats leaving roost sites or foraging within the vicinity. Any faunal activity observed during that period was recorded, in particular any signs of bats leaving or entering roost sites under the bridge.

Stag Watch

A 'stag watch' of hollow-bearing trees at Site 4 was undertaken on the 28th of November 2007 (near trap lines B and D). The stag watch was undertaken by two observers (at different locations) for a period of approximately 30 minutes starting just before sunset, followed by a short period of spotlighting in the vicinity. Any faunal activity observed during that period was recorded, in particular any signs of owls, bats or arboreal mammals leaving or entering hollows.

Spotlight Survey

During the initial survey period evening spotlight surveys for nocturnal fauna were conducted on the 27th, 28th & 29th of November 2007 along the four trap lines (Sites 3 and 4) and along Heatherbrae Road (Site 2). During the second survey period spotlight surveys were conducted on the 9th and 10th of January 2008 at Sites 12 and 14. Spotlighting was conducted on foot by one or two observers for a period of between 30 minutes to 1.25 hours using Makita 14-volt hand-held torches and 50-Watt hand-held spotlights powered by 12-volt batteries. Both arboreal and terrestrial nocturnal animals were targeted during the spotlighting surveys and any fauna species positively identified either by sight or characteristic vocalisation were recorded.

Nocturnal Call Playback

During the initial survey the playback of pre-recorded calls of threatened nocturnal species was carried out on the 28th and 29th of November, 2007, at trap lines A and B (Sites 3 and 4). During the second survey period call playback surveys were conducted on the 9th and 10th of January 2008 at Sites 12 and 14. After an initial listening period of ten minutes, each call was played (amplified by the use of a loud hailer) for a total of five minutes, followed by a five minute listening period, with the last listening period followed by ten minutes of spotlighting. Any fauna were identified either by characteristic call or direct observation using spotlights.

Ultrasonic Bat Call Detection

During the initial survey period insectivorous bats were surveyed on the 26th-29th of November 2007 at Sites 2, 3, 4, 5, 8 and 10 using CFZCAIM detectors to collect ultrasonic calls of insectivorous bat species within the area. During the second survey period ultrasonic bat call detection was undertaken on the 9th and 10th of January 2008 at Sites 1, 8, 10, 12 and 14. The CFZCAIM units were either handheld during other survey activities or left in a stationary position overnight.

Bats emit ultrasonic calls as a method of navigating and searching for food. These calls are often at a higher frequency than calls audible to the human ear. In order to make the calls audible, bat detectors convert the call to a lower frequency. These calls are recorded and later analysed with a computer package (Anabat), to identify the species recorded. Ultrasonic call detectors have proven useful for recording species that are difficult to capture. However, owing to variations in call strength and frequency within and between species and the difficulty in identifying short or poor quality calls, the identity of species recorded by a bat detector cannot always be guaranteed. Some bats are difficult to detect due to their quiet calls (e.g. *Nyctophilus* sp., *Kerivoula papuensis*) and bats with extremely similar calls are sometimes difficult to differentiate (e.g. *Miniopterus schreibersii oceanensis* and *Vespadelus darlingtoni*). Therefore, bat detectors cannot always provide positive species identification.

Harp Trapping for Insectivorous Bats

Harp trapping for insectivorous bats was carried out at Sites 3 and 5 during the initial field survey week. One harp trap was set up at Site 3 for two nights (26th and 28th of November) and two harp traps were set up at Site 5 for two nights (28th and 29th of November). In order to maximise capture success, suitable harp trap sites were chosen along potential flyways (e.g. vehicle tracks). All harp traps were inspected for captures early in the morning and also checked at night if possible. Captured bats were identified to species level and either released immediately or kept until evening.

Diurnal Bird Census

Surveys for diurnal birds were carried out at Sites 3 and 4 (along trap lines A, B, C and D) on the 29th of November, 2007. Each bird survey was completed early in the morning by one observer for a period of 20 minutes. All birds positively identified either by direct visual observation or by their characteristic call during this period were recorded.

Diurnal Reptile Census

Reptile surveys were carried out at Sites 3 and 4 on the 29th of November, 2007. Each reptile survey was undertaken by one observer for a period of approximately one hour when temperatures were suitable for reptile activity. All reptiles positively identified during this period were recorded.

Targeted Searches for Frogs

Targeted searches for frogs were carried out at two locations within the study area during the initial field survey week. The first search was carried out on the 28th of November, 2007, at a dam on the ridgeline at Site 4. The second search took place along the Williams River near Tillegra Bridge (Site 8) on the 29th of November, 2007. Both frog searches were undertaken by two people for approximately 45 minutes at night. All frogs positively identified either by direct visual observation or by their characteristic call were recorded.

Following the completion of the fauna surveys it was still unclear as to whether some of the threatened frog species identified as possibly frequenting the riparian habitats would actually occur. In order to address this issue an additional habitat assessment was carried out by frog expert Dr Arthur White (Biosphere Environmental Consultants Pty Ltd) in July 2008. A report of his findings is given in **Appendix 8** of this report.

Koala Scat Search

Two koala scat searches were undertaken on the 29th of November 2007 in the vicinity of a shallow gully at the end of Line A (Site 3). This area was chosen due to the number of grey gums observed. The grey gum (*Eucalyptus punctata*) is listed in SEPP44 as a preferred koala food tree. Each search was undertaken by one person and involved searching for koala scats in leaf litter at the base of 20 trees. For each tree searched, a record was made of the tree species, diameter at breast height, any scats found and any other evidence of koala activity. Koalas were also targeted using call playback and spotlighting techniques.

Opportunistic Observations

All fauna opportunistically identified while on site were recorded and are included in **Appendix 4**.

3.2.2 Survey Limitations

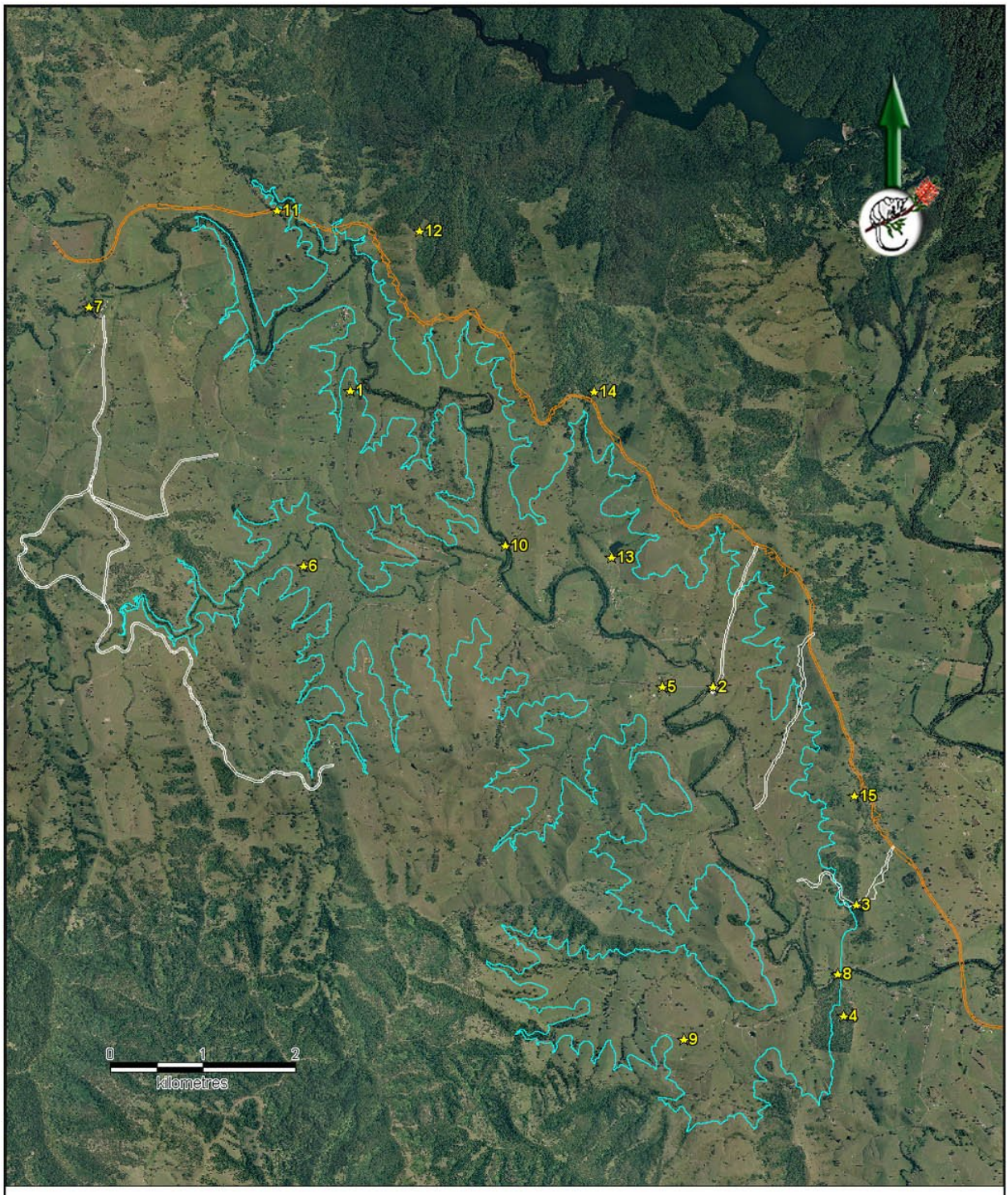
Field surveys for a large study area such as the proposed Tillegra Dam site are inevitably based on targeted sampling of representative habitats within the study area, aimed at maximising the likelihood of detecting threatened fauna species. A number of limitations have been identified, most associated more generally with any short-term fauna survey.

Few good harp trap sites were found within the study area and one of the CFZCAIM detectors malfunctioned during the first field trip. Despite these problems at least 13 insectivorous bat species were positively recorded during the field surveys. Migratory or nomadic species such as the threatened swift parrot and regent honeyeater may only visit the study area on a seasonal basis depending on weather conditions and the availability of food resources, and thus may not have been detected during the field surveys. As field surveys were carried out in late spring and summer, winter-breeding species such as the threatened powerful owl are less likely to have been detected than if surveys were carried out at the height of the breeding season. Some species are difficult to detect using currently available survey methods due to their general nature, for example the Stephen's banded snake, a shy, predominantly arboreal, nocturnal snake. A number of insectivorous bats such as the threatened golden-tipped bat, eastern false pipistrelle and greater broad-nosed bat are sometimes difficult to identify using ultrasonic call analysis due to the nature of their calls.

As a result of these limitations it is likely that some species that would be expected to occur may not have been detected.

Weather Conditions

The weather conditions encountered during the survey period allowed for adequate survey conditions for all the targeted fauna groups (see **Appendix 6.1** for details of the weather conditions). Temperatures were warm to hot during the day (23.8 – 29.5^{0}C maximum) and mild during the night (13.7 - 18.5 ^{0}C minimum). Cloud cover and moonlight varied throughout the survey and the wind strength was generally light. Rainfall was restricted to a heavy storm on the afternoon of the 29/11/2007 and light showers on the morning of the 30/11/07 and 09/01/08. This was enough to stimulate increased frog activity over these periods.



Key

☆ Fauna Survey Site

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Figure 4. Locations of Fauna Survey Sites

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3.2.3 Results

Fauna Diversity

A total of 157 fauna species were positively identified during the field surveys (comprising 95 bird, 32 mammal, 16 frog and 14 reptile species). A further five species of insectivorous bat were given a probable identification and two species given a tentative (possible) identification based on ultrasonic call analysis. Six of the species recorded, the black rat, brown hare, common myna, dog, house mouse and rabbit, are introduced species. All fauna species recorded within the study area during the survey period are listed in **Appendix 4**. Survey weather conditions, trapping and bat call analysis results tables are included as **Appendix 6**.

Birds

Ninety-five bird species were recorded during the survey period, most of them relatively common and widespread species expected to be found in the environs represented within the study area. The majority of species were recorded during specific diurnal bird surveys or opportunistically within the study area, with some nocturnal birds recorded during evening call playback and spotlight surveys. One threatened bird species listed as vulnerable in the TSC Act, the speckled warbler (*Pyrrholaemus sagittatus*), was recorded during the survey period. Five migratory species listed in the EPBC Act, the white-bellied sea-eagle (*Haliaeetus leucogaster*), white-throated needletail (*Hirundapus caudacutus*), rainbow bee-eater (*Merops ornatus*), black-faced monarch (*Monarcha melanopsis*) and rufous fantail (*Rhipidura rufifrons*), were also recorded.

Mammals

Thirty-two mammal species were positively identified during the survey period, with an additional five insectivorous bat species given a probable identification and two species given a tentative (possible) identification based on ultrasonic call analysis. Bats made up over half of the total with twenty species possibly recorded. Considering the fragmented nature of the available habitat, arboreal mammals were well represented with six species recorded.

At least six threatened mammal species were recorded, the east-coast freetail-bat, southern myotis, squirrel glider, brush-tailed phascogale, koala and grey-headed flying fox. In addition to those threatened species positively identified, the greater broad-nosed bat and eastern false pipistrelle were given a probable identification and the golden-tipped bat was given a tentative (possible) identification based on ultrasonic call analysis.

Trapping within the study area yielded good results during the initial survey week. Five mammal species were captured using the live trapping transects, including the threatened squirrel glider and brush-tailed phascogale. Five species of insectivorous bat were captured in harp traps, including species that cannot be differentiated using ultrasonic call analysis. In addition to those caught in harp traps, eight species of insectivorous bat were given a definite identification, five were given a probable identification and two were tentatively identified using ultrasonic call analysis. Detailed results of the ultrasonic bat call analysis are included in **Appendix 6.2**.

The remainder of the mammal species were recorded during evening spotlighting and call playback activities or opportunistically during the survey period.

Reptiles

Fourteen reptile species were recorded during the survey period, all relatively common and widespread species. All fourteen species were recorded either during specific diurnal reptile searches or opportunistically during other daytime survey activities. No snake species were recorded, though an unidentified snake skin was found near a pile of rocks next to Quartpot Road. Several other common reptiles are expected to occur within the study area, including the wall skink (*Cryptoblepharus virgatus*), barred-sided skink (*Eulamprus tenuis*) and eastern brown snake (*Pseudonaja textilis*). No threatened reptile species were recorded.

Frogs

Sixteen species of frog were recorded within the survey period. Frogs were recorded during specific frog searches, evening spotlighting surveys or opportunistically within the study area. Most were recorded along the Williams River or at the dam near line B. No threatened frog species were recorded during the survey period.

Significant Fauna Species

Eight threatened species, the speckled warbler, eastern bent-wing bat, east-coast freetail-bat, southern myotis, squirrel glider, brush-tailed phascogale, koala and grey-headed flying-fox, were positively identified within the subject site during the survey period. In addition, calls of the eastern false pipistrelle and greater broad-nosed bat were given a probable identification and calls of the golden-tipped bat were given a tentative (possible) identification based on ultrasonic call analysis. All eleven species are listed as vulnerable on the TSC Act and the grey-headed flying-fox is also listed as vulnerable on the EBPC Act. The locations of threatened fauna species recorded during the field surveys are shown in **Figure 5**.

Given the sedentary nature of the speckled warbler, squirrel glider and brush-tailed phascogale, it is expected that permanent breeding populations of these species occur in remnant vegetation in the south-east of the study area north and south of the proposed dam wall area. The koala is also likely to be a permanent resident and given the habitat available within the study area, a breeding population of this species may also occur. While the areas of remnant vegetation north and south of Tillegra Bridge represent the largest and best quality patches of native vegetation, additional suitable potential habitat for these threatened species exists elsewhere within the study area.

The diversity of habitats within the study area provides foraging habitat for a variety of threatened insectivorous bat species, including those identified during the field survey. Numerous hollow-bearing trees occur throughout the study area and these provide potential roosting and breeding habitat for hollow-reliant bat species, including the east-coast freetail-bat, eastern false pipistrelle and greater broad-nosed bat.

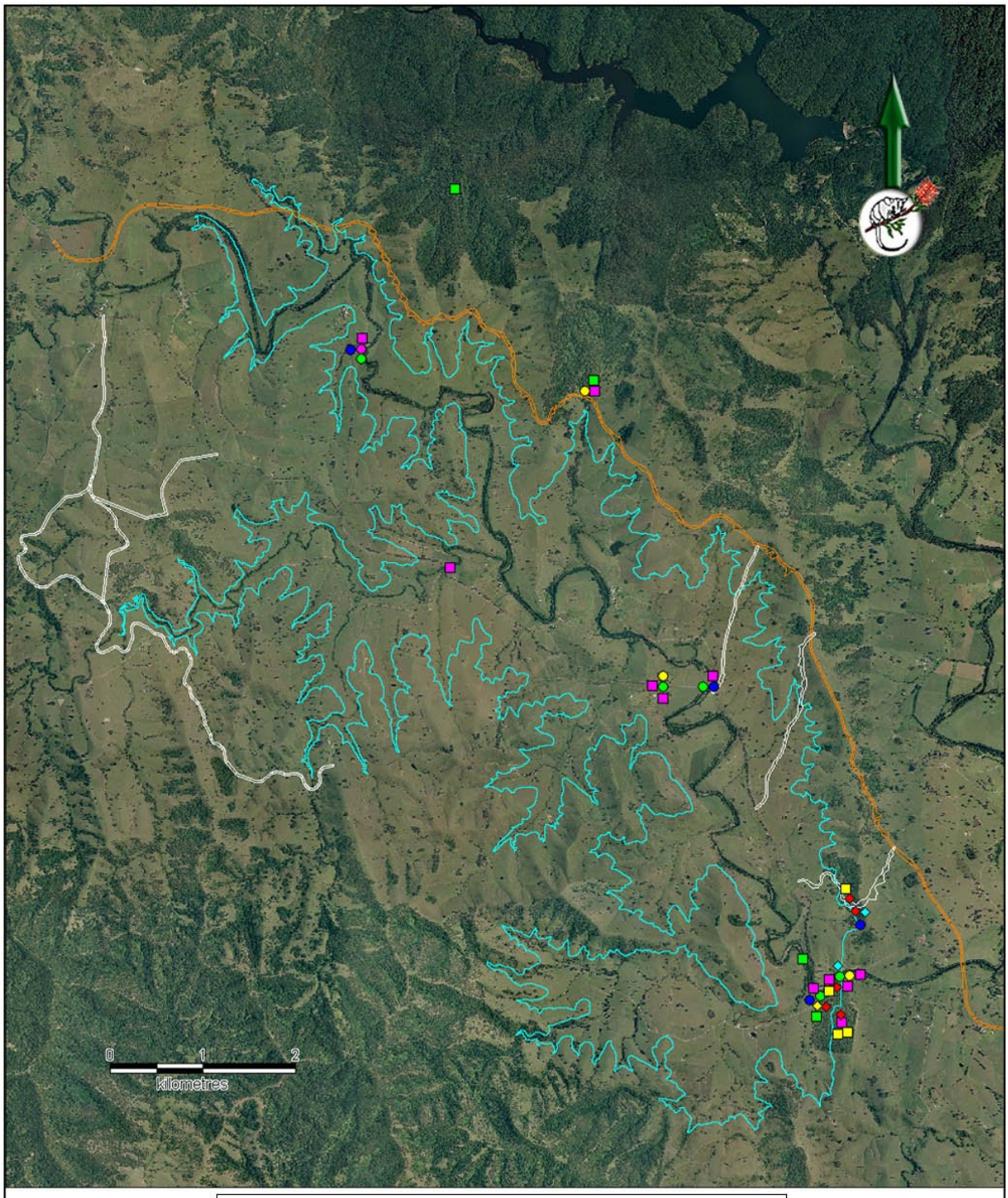
The southern myotis is likely to roost under bridges within the study area and there is potential for a breeding colony to occur (particularly under the Tillegra Bridge). The eastern bent-wing bat could also potentially roost in hollowed timber under bridges within the study area, though this species generally roosts in caves. While some rock outcrops were observed from a distance during the field survey, these are unlikely to contain suitable roosting habitat for the eastern bent-wing bat.

While calls of the golden-tipped bat were only tentatively identified, potential roosting and breeding habitat for this species occurs in scattered rainforest pockets and some areas of riparian vegetation within the study area.

No known roost for the grey-headed flying-fox occurs within the study area however this species is expected to be a regular seasonal or opportunistic visitor, particularly during peak flowering of the spotted gum. The grey-headed flying-fox could potentially utilise riparian and rainforest habitat within the study area to establish temporary camps during peak flowering or fruiting periods.

Based on the initial habitat assessment it was thought that potential habitat could possibly occur for threatened frog species, including the giant barred frog (*Mixophyes iteratus*), stuttering frog (*Mixophyes balbus*) and the green and golden bell frog (*Litoria aurea*). In order to address this issue a supplementary habitat assessment has been conducted by a recognised frog expert, Dr Arthur White of Biosphere Environmental Consultants Pty Ltd (**Appendix 7**). Dr White concluded that only the stuttering frog had some potential to occur in remnant rainforest pockets along the Williams River and within side creeks of the catchment. Within the inundation area only two sites were identified, one is a small isolated patch of moist riparian vegetation near Munni Bridge (Heatherbrae Road) and the other a more extensive 1.5 km stretch of moist riparian vegetation verging on rainforest below the cliff at 'Underbank'. Approximately 500 metres of potential habitat was also identified along Moolee Creek, just outside of the inundation area. The Munni Bridge site and to a lesser extent the Underbank remnant are thought to be too small and isolated for the stuttering frog to occur and any population that may occur would be small and already at risk of local extinction as a result of natural changes to habitat, such as impacts from drought and flooding.

The potential impacts of the proposed dam on these species and on other species with potential to occur within the subject site are discussed in **Section 4**.



NB: Only definite or probable records have been included in this figure

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Figure 5. Threatened Fauna Species

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4.0 ASSESSMENT OF THE PROPOSAL

4.1 Part 3A of the Environmental Planning & Assessment Act 1979 (EP&A Act)

This proposal is to be assessed under Part 3A of the Environmental Planning & Assessment Act 1979. Part 3A was introduced by the NSW government in July, 2005. This allows the Minister for Planning to call in 'major projects' or anything deemed as 'critical infrastructure'. A new *State Environmental Planning Policy (Major Projects) 2005* defines what projects are subject to Part 3A and require ministerial approval. The proposed construction of the Tillegra Dam has been specifically called in under a Section 75B declaration.

Under Part 3A, the Department of Planning prepares the matters that the Hunter Water Corporation must address in the environmental assessment for the Proposal, known as the Director-General's requirements for environmental assessment. The requirements are developed in consultation with State agencies such as the Department of Environment and Climate Change and other relevant authorities including local councils. Under Part 3A, the proponent would be required to include a written impact assessment including a statement of commitments to demonstrate how the project's likely environmental impacts would be minimised or managed. If the project is approved, the proponent would be required to honour these commitments as part of the conditions of approval. Following preparation of the impact assessment, the Director-General prepares a statement to the Minister as to whether the assessment is considered to have met the Director-General's requirements. The Minister must take this statement into account when deciding whether to approve the proposed development, but is not obliged to be bound by it.

The Director-General's requirements for environmental assessment of the Proposal (Section 75F of the EP&A Act) includes the preparation of a comprehensive ecological impact assessment for both terrestrial and aquatic ecosystems. Although this report only deals with terrestrial flora and fauna, aquatic mammals, the platypus (*Ornithorhynchus anatinus*) and water rat (*Hydromys chrysogaster*) are included in the discussion of impacts. A seperate aquatic report is in preparation however this does not cover the aquatic mammals. The report has been written to comply with the draft guidelines for threatened species assessment (DEC 2005) prepared for use in assessing major infrastructure applications submitted for assessment under Part 3A of the EP&A Act. Threatened species, endangered populations and endangered ecological communities are defined as those listed in the Schedules of the NSW TSC Act 1995 and the Commonwealth EPBC Act 1999.

The Director-General's requirements for the environmental assessment for the proposed construction of the Tillegra Dam include a number of requirements specifically relating to terrestrial flora and fauna that are relevant to this report.

The Director-General's requirements include a specification that if the proposal includes any actions that could have a significant impact on matters of National Environmental Significance (see **Table 4**) then approval would be required under the Commonwealth EPBC Act. This is additional to any approvals required under NSW legislation.

Key issues relating to terrestrial flora and fauna that may be relevant to this report and need to be addressed according to the Director-General's requirements are:

- Impacts on threatened species, populations, ecological communities and critical habitat which are listed in both State and Federal legislation;

- Impacts on aquatic ecology upstream and downstream of the dam wall (this report only deals with the platypus and water rat, which although they are not listed threatened fauna species they are considered to be locally significant).
- Impacts on terrestrial flora and fauna including details on the location, composition, quality and quantity of habitat proposed to be affected
- The presentation of a framework monitoring program, management and rehabilitation plans and comprehensive compensatory habitat/biodiversity offset packages. Impacts on the terrestrial ecology associated with the project and the amount and type of habitat to be lost will need to be taken into account.

These issues are addressed in the following sections.

4.1.1 Threatened Flora and Endangered Ecological Community Assessment

This assessment addresses the potential effects of the proposal on threatened flora species or their habitats according to Appendix 3 of the *Draft Guidelines for Threatened Species Assessment* under Part 3A of the Environmental Planning and Assessment Act 1979 (DEC & DPI 2005). The factors relevant to threatened flora and given in Appendix 3 of the Part 3A guidelines are discussed for the subject species. The subject species have been determined by a combination of the literature review, habitat assessment and field survey.

Flora subject species with the greatest potential to occur:

- *Eucalyptus glaucina* (slaty red gum)
- *Marsdenia longiloba* (slender marsdenia)
- *Senna acclinis* (rainforest cassia)

a) How is the proposal likely to affect the lifecycle of a threatened species and/or endangered population?

No threatened flora species or endangered flora populations listed by legislation were recorded in any part of the study area during field surveys and therefore no impact is expected on threatened flora species or endangered populations of flora. Targeted surveys were undertaken within key areas considered to contain suitable habitat for threatened species that were considered to be subject species as listed above. However, because of the large size of the subject site, it is acknowledged in the survey limitations section that there is a small possibility that individuals or very small populations of one or more of these species could occur in specific areas of the subject site not covered during the field surveys. In the event that this was the case, the possible effect on the lifecycle of the subject threatened flora species or endangered population is discussed as follows:

Eucalyptus glaucina (slaty red gum)
The habitat for this species is grassy woodland and dry eucalypt forest on deep, moderately fertile and well-watered soils. If any undetected occurrences of the species did occur, they would be most likely on the flats and gentle slopes upslope from the immediate riparian area and could occur as remnant isolated paddock trees in Community 6 – cleared pasture. No fewer than 12 records of the species occur within 20 km of the centre of the subject site, including four records within 10 kilometres (see Table 2). Therefore, in the unlikely event that individuals of the species were removed by the proposal due to inundation, the lifecycle of any population remaining in the study locality would be unaffected as it is expected that viable populations within the region would remain.

Marsdenia longiloba (slender marsdenia)
Senna acclinis (rainforest cassia)
Both these species grow in subtropical rainforest or in adjoining moist forest areas. The areas where they are most likely to occur are the rainforest patches and adjoining moist gully forest (Communities 1 and 2) which mainly occur in the area potentially affected by construction of the proposed deviation of Salisbury Road. Recent refinements to the preferred alignment of this road deviation have effectively avoided the identified patches of rainforest and moist gully eucalypt forest. Therefore, it is concluded that in the unlikely event that either species were present in the study area, neither are likely to be impacted by the proposal.

Endangered Population - *Cymbidium canaliculatum* (tiger orchid) in the Hunter Catchment
This orchid grows in the hollows of trees in dry sclerophyll forest or woodland. If present in the study area, it would be most likely to occur in the spotted gum – ironbark or forest red gum communities on the ridgetops and slopes, most of which would be unaffected by the proposal.

b) How is the proposal likely to affect the habitat of a threatened species, endangered population or endangered ecological community?

The proposal is unlikely to affect the habitat of any threatened flora species or endangered populations, as concluded in (a) above.

However, habitat areas for two endangered ecological communities (EECs) plus small areas of one intergrade EEC would be directly removed by the proposal. **Table 11** shows the areas of each EEC that would be lost due to the proposal, based on the 152.3ahd full supply level.

Table 11. Extent of potential habitat loss for each EEC associated with the Proposal (based on RL 152.3 top water level)

Vegetation Community	Corresponding EEC	Predicted Impact Area (hectares)
1-Subtropical Rainforest	Lowland Rainforest	0.2
5-Riparian Forest	Mainly River-flat Eucalypt Forest on Coastal Floodplains, plus small areas of intergrade Subtropical Coastal Floodplain Forest	145*

* Mapping in figure 3 includes river channel – calculated area excludes the river channel to obtain a true estimate of vegetated area.

As the table shows, only a minor area of Lowland Rainforest (LR) would be impacted due to the alignment of the proposed deviation of Salisbury Road. Only edge areas of Community 1 may be affected. This minor amount equates to only 1.1% of the total mapped area of Lowland Rainforest (Community 1) in the study area.

In relation to the River-flat Eucalypt Forest on Coastal Floodplains (RFEFCF) including a minor component of intergrade Subtropical Coastal Floodplain Forest (SCFF) a significant amount will be completely removed due to inundation. This is due to the proposal covering a long stretch (approximately 19.2 kilometres) of the Williams River, plus a number of its tributaries, most of which support riparian vegetation along their floodplains.

In order to place the extent of each EEC that would be impacted by the proposal into a regional context, data from the vegetation mapping of the Comprehensive Regional Assessment of north eastern NSW (NPWS 1999) was consulted. The area covered by this regional study broadly corresponds to the North Coast Bioregion of Thackway & Creswell (1995). This area is defined as the region for the purposes of this assessment. The relevant map units from the regional study that are included within or best match each EEC according to the relevant Final Determinations, together with their remaining area as of 1999 and conservation status within the region are given in **Table 12**.

Table 12. Vegetation Communities from NPWS (1999) that correspond to Endangered Ecological Communities in the Subject Site

EEC	Corresponding Vegetation Communities (NPWS 1999)		Current Extent (ha)	Cleared Estimate	Status (NPWS 1999)*
	Map Unit No.	Community Name			
River-flat Eucalypt Forest on Coastal Floodplain	47	Escarpment Red Gums	20,498	73%	P
	120	River Oak	922	41%	V, H, P
Lowland Rainforest	168	Rainforest	256,326	N/A	E, P

*Status
E – Endangered
V – Vulnerable
H – Highly Inadequately Reserved
P – Private Land Priority

A number of qualifications need to be made in the interpretation of Table 12. Firstly, River Oak (Map Unit 120) is not explicitly stated as forming part of the *River-flat Eucalypt Forest on Coastal Floodplains* EEC according to the Final Determination (NSW Scientific Committee 2004a), however it forms a major component of the riparian community in the subject site, therefore it is considered appropriate to include it. Secondly, Map Unit No. 168 (Rainforest) of NPWS (1999) is a broad map unit and probably includes additional categories of rainforest, such as temperate rainforest, that are not included in the Final Determination for *Lowland Rainforest*. Therefore, the area of rainforest shown for the region is likely to represent an overestimate of the area of the EEC *Lowland Rainforest* in the region. Finally, *Subtropical Coastal Floodplain Forest* is not addressed specifically as a distinct EEC because it occurs as an intergrade form only in the study area where it and is difficult to differentiate from RFEFCF on the ground within which it tends to be embedded as small, intergrading patches.

From Table 12, it can be inferred that both EECs are of high conservation significance in the region covered by NPWS (1999) according to the current status of the communities that make them up and the estimated extent of habitat that has been cleared from each. It is difficult to rank the conservation priorities of the EECs on the basis of the status of the communities that make them up, but the map units that are either noted as 'Endangered' (such as Rainforest) or whose current extent is low, cleared estimate high and is 'highly inadequately reserved' (such as River Oak)) are probably most sensitive to loss of habitat. The proportions of the remaining area of each EEC within a 20 km radius of the centre of the subject site and within the entire region (North Coast Bioregion) that would be affected by the proposal is given in **Table 13**.

Table 13. Proportion of the Total Area of Endangered Ecological Communities in the Region that would be affected by the Proposal

EEC	Total Extent of EEC in Region (NPWS 1999) (ha)	Area of EEC in a 20 km radius (NPWS 1999) (ha)	Area of EEC Impacted by Proposal (ha)	Percentage of EEC Impacted	
				within a 20 km radius of subject site centre	in entire Region
River-flat Eucalypt Forest	21,420	643	145	22.5%	0.7%
Lowland Rainforest	256,326	4,758	0.2	0.004%	0.00008%

As the table shows, a very small proportion of *Lowland Rainforest* would be affected at either the local (20 km radius) or regional levels. Whilst a substantial proportion of *River-flat Eucalypt Forest on Coastal Floodplain* would be removed at the local level, the mapping of NPWS (1999) is likely to have underestimated the abundance of the River Oak community (Map unit 120) locally, since none of this map unit showed up as occurring within 20 km of the subject site, which is clearly incorrect. No more than 0.7% of the total area of either EEC in the region would be removed or modified by the proposal.

As discussed above the proportion of the *Lowland Rainforest* EEC affected could be somewhat higher because it is made up of a more restricted set of vegetation alliance types. Nevertheless, the area of EEC affected within the study area is minimal. The total area of each EEC indirectly affected by hydrological changes, edge effects, weed invasion and other degrading processes may also slightly increase these proportions, but not to the extent that a significant proportion of each EEC would be affected regionally.

Overall, the major impact on habitat for EECs locally would be on the *River-flat Eucalypt Forest on Coastal Floodplains*. However, the regional impact is insignificant, with the possible exception of the River Oak component of the EEC. The impact on habitat for the *Lowland Rainforest* EEC is considered to be insignificant.

c) Does the proposal affect any threatened species or endangered population that are at the limit of its known distribution?

According to BioNET, of the flora species considered most likely to occur in the study area,

- *Eucalyptus glaucina* would be approaching but not at the western limit of its known distribution
- *Marsdenia longiloba* would be at or near the southern limit of its known distribution
- *Senna acclinis* would be approaching but not at the western limit of its known distribution
- *Cymbidium canaliculatum* would be approaching but not at the southern limit of its known distribution

Therefore, only *Marsdenia longiloba* could be at the limit of its known distribution but, if present, would be unlikely to be affected by the proposal because it is only likely to occur in the subtropical rainforest or moist gully communities that would be practically unaffected by the proposal.

d) How is the proposal likely to affect current disturbance regimes?

Current disturbance regimes include:

- grazing;
- agricultural activities;
- roadside disturbance;
- disturbance of riparian habitat;
- stream bank erosion;
- runoff from pasture and roads into waterways;
- noxious and environmental weeds;
- feral animals

The proposal would result in the clearing of vegetation within the subject site and the inundation of 2100 hectares of land. The level of disturbance associated with the proposed dam is much higher than those factors currently operating within the study area.

e) How is the proposal likely to affect habitat connectivity?

The inundation due to the proposal would isolate a currently continuous stretch of riparian forest EEC from the proposed dam wall to the upper reaches of the Williams River 19 km upstream and its associated tributaries where the new inundation level would occur. Whilst this particular stretch of the Williams River would remain unconnected following inundation, the proposed tree regeneration and/or planting around the edge of the full supply level of the dam would improve connectivity and replace habitat for most of the fauna species found in the study area. However it is unlikely that the vegetation type that would develope above full supply level would be the same as the current riparian habitat, therefore there would not be a 'like for like' replacement of habitat.

f) How is the proposal likely to affect critical habitat?

No critical habitat is currently listed in the NSW TSC Act or Commonwealth EPBC Act for the subject species within the study area.

In conclusion, the proposal is unlikely to significantly impact on any threatened flora species or endangered populations of flora.

An insignificant impact on the EEC *Lowland Rainforest* would occur at both the local and regional level. The impact on the EEC *River-flat Eucalypt Forest on Coastal Floodplains* would be substantial at the local level, but minor in the regional context. However, the apparent level of local impact should be qualified by the apparent underestimation of the abundance of riparian vegetation at the local level by the available regional mapping (NPWS 1999).

4.1.2 Threatened Fauna Assessment

This assessment addresses the potential effects of the proposal on threatened fauna species or their habitats according to Appendix 3 of the *Draft Guidelines for Threatened Species Assessment* under Part 3A of the Environmental Planning and Assessment Act 1979 (DEC & DPI 2005). The draft guidelines include a list of factors to be considered when identifying potential impacts on threatened species, endangered populations or endangered ecological communities as a result of a proposal. In the case of this proposal, the following threatened fauna species could potentially be impacted by the proposal to some degree.

Fauna subject species with the greatest potential to occur based on the field survey and habitat assessment results:

- Brush-tailed phascogale*
- Eastern bent-wing bat*
- Golden-tipped bat#
- Grey-crowned babbler
- Koala*
- Powerful owl
- Speckled warbler*
- Turquoise parrot
- East-coast freetail-bat*
- Eastern false pipistrelle?
- Greater broad-nosed bat?
- Grey-headed flying-fox*
- Masked owl
- Southern myotis*
- Squirrel glider*

* - recorded during the current survey;
? - probable record based on ultrasonic call
- possible record based on ultrasonic call

Fauna subject species with some potential to occur as habitat is available:

- Barking owl
- Diamond firetail
- Little bent-wing bat
- Sooty owl
- Stephen's banded snake
- Swift parrot
- Brown treecreeper
- Glossy black-cockatoo
- Regent honeyeater
- Spotted-tailed quoll
- Stuttering frog
- Wompoo fruit-dove

The factors relevant to threatened fauna and given in Appendix 3 of the Part 3A guidelines are discussed for the above species;

a) How is the proposal likely to affect the lifecycle of a threatened species and/or endangered population?

Brush-tailed Phascogale (*Phascogale tapoatafa*) – vulnerable under the NSW TSC Act

> The brush-tailed phascogale is a nocturnal, semi-arboreal, carnivorous dasyurid and preys on invertebrates and small vertebrates. The eastern distribution of the brush-tailed phascogale is along the coast and adjacent ranges from southern Queensland to south-eastern South Australia. This species appears to prefer dry open forest types with sparse ground cover though it has also been recorded in moist forest and cool temperate rainforest (Soderquist, 1995).

Considered to be the most arboreal of the dasyurids, individuals have been reported using up to 20 nests in a single year, which include hollow tree limbs, rotted stumps and globular bird nests, although breeding nests are usually situated in tree hollows. Studies have reported a home range of 37.05 ha for females and 86.53 ha for males outside the breeding season (Traill & Coates, 1993; Soderquist, 1995). Female home ranges do not overlap with other unrelated females however male home ranges can overlap with those of other males and females. The brush-tailed phascogale has a very restricted breeding season, which occurs in the winter with annual male die-off occurring after mating. Births tend to occur during July and August, with the female having up to eight young. Females can live beyond their second year though tend not to breed after this time.

Given the large home range, small population sizes and the reproductive strategy of male die-off, this species is considered to be particularly vulnerable to fragmentation of suitable habitats and local extinctions. Widespread logging and activities resulting in the loss of actual and potential nest hollows are also a significant threat to this species, as are activities that open up habitat to allow access by introduced predators. The brush-tailed phascogale is vulnerable to road mortality, particularly males during the breeding season or during juvenile dispersal in late spring or early summer.

The brush-tailed phascogale was recorded within the Tillegra TSR (Site 4) during field survey work. One lactating female was caught in a tree trap at Line D on the 28th of November 2007 and one individual (probably the same female) was observed during spotlighting that evening. Given the large home ranges required by this species, Tillegra TSR is likely to be the most suitable habitat available to the brush-tailed phascogale within the subject site. Other patches of remnant vegetation within the subject site tend to be smaller, more fragmented and in generally poorer condition. The brush-tailed phascogale could potentially utilise some of these areas, particularly as a movement corridor for males during the breeding season or during dispersal of young animals. In particular, the remnants to the east of the proposed impoundment provide some links to large areas of forest to the north of the study area. Potentially suitable habitat remnants also occur to the south and south-west of the proposal in the vicinity of Mount Butterwicki.

Due to a combination of inundation and clearing for the proposed dam wall and overflow areas, the proposal is expected to result in the loss of most of the available habitat for the brush-tailed phascogale within Tillegra TSR. Given the large home range of this species, the remaining patch of vegetation is unlikely to support a viable population of the brush-tailed phascogale. Therefore it is considered that the proposal would result in the disturbance of this species and would displace the brush-tailed phascogale from much of the subject site, in particular the Tillegra TSR area.

Given the extent of clearing involved, there is a possibility that the proposal may disrupt the breeding cycle of the brush-tailed phascogale, especially if a hollow tree or log containing a pregnant female or female with young is removed. This is of particular concern in Tillegra TSR where a breeding female was recorded during field survey work. The breeding cycle of the brush-tailed phascogale may also be impacted by the barrier the proposed dam would present to movement. While the movement and dispersal patterns of this species within the study area are unknown, the proposed inundation area would represent a large, impassable barrier to this species. This may affect the ability of young animals to disperse and could potentially prevent the exchange of genetic material between currently interbreeding sub-populations.

In summary, impacts associated with the proposal include the potential loss of roosting and breeding hollows, the loss of foraging habitat and the further fragmentation of habitat. As a result of these disturbances, it is considered that the proposal could potentially affect the life-cycle of the brush-tailed phascogale.

Ameliorative measures such as supplementary plantings, rehabilitation of currently cleared or degraded habitat may also assist in mitigating long-term impacts on the brush-tailed phascogale. Of particular importance to this species is the establishment, rehabilitation and maintenance of fauna movement corridors.

Cave-roosting bats – eastern bent-wing bat (*Miniopterus schreibersii oceanensis*) and little bent-wing bat (*Miniopterus australis*) – both vulnerable under the NSW TSC Act

Both of these threatened cave-roosting bats occur along the coast and ranges of eastern Australia, extending from Cape York, through to the central coast of NSW for the little bent-wing bat and Victoria for the eastern bent-wing bat. Both species are relatively widespread and can be locally common where suitable caves or tunnels are available as roost sites. While caves represent their natural roosting habitat, both species would also utilise old mines, stormwater channels, road culverts and other similar structures. The little bent-wing bat is known to occasionally roost in large hollowed-out tree bases or dense foliage (Schulz, 1997). The major threat to these cave-roosting bat species is the loss of roost sites, particularly breeding caves. Their dependence upon relatively few nursery caves suggests that threats to the existence or structural integrity of these may place widespread populations in jeopardy (Dwyer, 1995). Habitat loss through clearing for development or agriculture and subsequent reductions in insect prey availability may also adversely affect these species.

The little bent-wing bat forages for insects beneath the canopy in well timbered forest and is also known to forage within coastal swamps and rainforest. A nightly foraging range of 20 kilometres from the roost site has been reported for the little bent-wing bat. Mating takes place in July and August, with births occurring in December. This species was not recorded during field survey work and no records exist for the locality. However potential foraging habitat occurs within the study area and individuals of this species could potentially roost seasonally under bridges and culverts within the study area.

The eastern bent-wing bat is known to forage within a variety of habitat types including rainforest, moist and dry eucalypt forest, swamp sclerophyll forest and heath. Dwyer (1995) regards typical habitat as well-timbered valleys, though this species has been reported utilising bushland remnants in urban areas. The eastern bent-wing bat is known to feed on moths, cockroaches, grasshoppers and ants and forages above the tree canopy (AMBS, 1995). Like the little bent-wing bat, the eastern bent-wing bat is a mobile species and is estimated to forage within a 20 km radius in a single night. The eastern bent-wing bat was recorded at Sites 1, 2, 3 and 4 during the field surveys. Potential foraging habitat for this species occurs throughout the subject site and individuals of this species could potentially roost seasonally under bridges and culverts within the study area.

Given the lack of records, the subject site is unlikely to represent important habitat for the little bent-wing bat. For the eastern bent-wing bat, while this species is often recorded in open habitats and is likely to be able to forage on the edges of the proposed dam, the clearing and inundation of land associated with the proposal would result in the modification of an extensive area of known foraging habitat.

No suitable breeding habitat for either the eastern bent-wing bat or little bent-wing bat occurs within the study area and none is expected to be impacted as a result of the proposal. However as both species may utilise bridges and culverts within the study area for roosting on a seasonal or occasional basis, there is potential for individuals of both species to be killed if a bridge or culvert containing roosting bats is destroyed or removed. This is particularly relevant as the existing Tillegra Bridge is to be removed during the dam wall construction phase. However three new bridges are to be constructed for the Salisbury Road deviation and these have the potential to provide new roosting sites.

Forest owls – powerful owl (*Ninox strenua*), barking owl (*Ninox connivens*), masked owl (*Tyto novaehollandiae*) and sooty owl (*Tyto tenebricosa*) – all vulnerable under the NSW TSC Act

All the large forest owl species are known to occupy large territories, particularly in fragmented areas, which is a reflection of their high mobility and the diversity of prey species they take. The barking owl is thought to have the smallest home range of between 30 to 200 hectares while home ranges of up to 1000 hectares have been recorded for the masked owl (Kavanagh & Murray, 1996). While these four owl species have different habitat requirements, all are reliant upon mature trees containing large hollows for breeding purposes. These forest owls are generally known to roost in dense foliage or large tree hollows, although the masked owl and sooty owl also roost in caves.

None of these threatened owls were recorded within the study area during the field survey and no records occur within two kilometres. Potential foraging and roosting habitat for these species occurs in larger patches of remnant vegetation within the study area, though potential habitat for the sooty owl is limited to moist forest in gullies and riparian zones within the study area.

The proposal is expected to result in the loss of some potential foraging habitat for these four threatened owl species, though given the fragmented and degraded nature of that potential habitat it is considered unlikely to displace any of these species from their home territories. However, while native vegetation within the subject site is unlikely to represent significant habitat for any of these species, the loss of that habitat and prey does contribute to the cumulative loss affecting these threatened owl species.

The proposal is expected to result in the loss of trees containing potential breeding hollows for threatened forest owl species particularly the masked owl and barking owl. While no nest hollows were recorded during field survey work, the removal of hollow-bearing trees could potentially disrupt the breeding cycle of one or more of these threatened owl species, particularly if a tree containing a nest hollow is removed during the breeding season. Given the relatively large home ranges of all four species, the loss of one or two individuals could potentially have a greater impact on the local population.

A recovery plan for the powerful owl, sooty owl and masked owl (DEC, 2006) and a draft recovery plan for the barking owl (NPWS, 2003a) have been prepared. The proposal may be inconsistent with these plans as it is expected to result in the loss of potential foraging and breeding habitat for these species, particularly the masked owl and barking owl.

Glossy black cockatoo (*Calyptorhyncus lathami*) – vulnerable under the NSW TSC Act

The glossy black cockatoo occupies forests of south-eastern Australia, from Shoalwater Bay in central Queensland to the Victorian border region. Preferred habitat for this species generally consists of moist and dry eucalypt forest types with a she-oak understorey. In areas where she-oaks are abundant, this species is sedentary, however, in other areas glossy black cockatoos can be nomadic, moving from one food source to another. (DECC threatened species profile)

The breeding season is between March and August with eggs usually being laid between April and June. The nests are located in large hollow limbs or trunks, often in tall dead trees standing in clearings. The nests are usually between 13 and 22 metres above the ground. The glossy black-cockatoo relies almost entirely on the seeds of a few species of she-oak for food and any factor that reduces the quantity, quality or availability of the seed crop of these trees must have a direct impact on local populations, through starvation or reduced fecundity. (DECC threatened species profile)

The glossy black-cockatoo was not recorded within the study area during the field surveys and no records occur within two kilometres, though a number exist for the locality. Potential habitat for the glossy black-cockatoo occurs in patches of remnant vegetation, particularly those areas containing *Allocasuarina torulosa* (forest oak), a preferred food tree that was recorded within the proposed inundation area. While no nest sites were observed, potential breeding habitat for the glossy black-cockatoo occurs within the study area in trees containing large hollows although the forest remnants available may be too small in area. The main potential impacts associated with the proposal include the loss of potential nest trees and the loss of potential foraging habitat.

Given the lack of records and the degraded, fragmented nature of potential habitat, the subject site is not expected to represent vital habitat for the glossy black-cockatoo. However, while the loss of potential habitat associated with the proposal is not expected to greatly affect the life-cycle of the glossy black-cockatoo in the short term, it could contribute to the cumulative loss of habitat affecting this species. The proposal is also expected to result in the loss of a large number of hollow-bearing trees, including those containing potentially suitable nest hollows for the glossy black-cockatoo. While no nest trees were recorded within the study area during field survey work, the loss of a nest hollow could potentially disrupt the breeding cycle of the glossy black-cockatoo, particularly if it is removed during the breeding season.

Golden-tipped bat (*Kerivoula papuensis*) – vulnerable under the NSW TSC Act

The golden-tipped bat has been recorded in a narrow band in coastal areas and the sub-coastal slopes and ranges from Cape York Peninsula in Queensland south to the New South Wales/ Victorian border. Moist closed lowland forest appears to provide the most favoured habitat type for this species (Woodside, 1995). The majority of captures of the golden-tipped bat have been made in coastal forests, near to where wet and dry forest ecotones occur, and often in the vicinity or over creeks. The species is known to occur in areas where dense or tangled vegetation is present, and along creeks, suggesting that the flight habits are suited to foraging in dense vegetation and in ecotonal habitats.

It is expected that this species feeds by gleaning, flying slowly in dense vegetation and hovering to collect insects and spiders from vegetation or out of webs while on the wing (Schulz, 2000). Golden-tipped bats have been located roosting in abandoned gerygone and scrubwren nests. These are dome-shaped nests made of bark fibre, moss and lichen and hang from vines and twigs (Churchill, 1998). Little is known of the reproductive biology of this species in Australia, though it is considered likely that in southern Australia the golden-tipped bat breeds in early spring (Woodside, 1995).

One possible call of the golden-tipped bat was tentatively identified based on ultrasonic call detection at Site 4 during the November 2007 field survey. Only one record of this species exists for the locality, though suitable potential habitat occurs in patches of rainforest and moist gullies within the study area. The proposal is would result in the loss of potential foraging, roosting and breeding habitat for the golden-tipped bat if it is present. Much of this potential habitat is degraded and not considered ideal for the golden-tipped bat, however the loss of these areas does contribute to the cumulative loss of habitat affecting this species. In the event that a population of the golden-tipped bat does occur within the proposed inundation area or any of the areas to be cleared, the loss of that habitat could displace or result in the loss of that population, particularly if a breeding colony is destroyed.

Grey-headed flying-fox (*Pteropus poliocephalus*) – vulnerable under the NSW TSC Act and Commonwealth EPBC Act

The grey-headed flying-fox is endemic to Australia and presently occurs along the east coast from Bundaberg in Queensland to Melbourne, Victoria (NPWS, 1999). This species utilises subtropical and temperate rainforests, tall sclerophyll forests and woodlands, heaths, swamps and mangroves, as well as urban gardens and fruit crops for foraging (Churchill, 1998; NPWS, 1999). The grey-headed flying-fox has been recorded to forage on more than 80 plant species of which eucalypt blossom is considered the major food source, with figs the most common fruit consumed (Churchill, 1998). These bats would disperse and commute up to 50km daily to foraging areas from their day roost (Strahan, 2002).

The grey-headed flying-fox roosts in large colonies of up to tens of thousands and often shares camps with the little red flying-fox and black flying-fox (Churchill, 1998; NPWS, 1999). Colonies are usually formed in gullies with a dense vegetation canopy and a water source nearby. Camps have also been formed in modified vegetation in urban areas (NPWS, 2001). Site fidelity is high, with some camps in NSW used for over a century. Bats usually return annually in October/November to particular camps for rearing young (NPWS, 2001).

The grey-headed flying-fox may migrate hundreds of kilometres to where a suitable food source is available. The population concentrates in May and June in northern NSW and Queensland where animals exploit winter-flowering trees such as swamp mahogany, forest red gum and paperbark, dispersing south during the summer (NPWS, 2001). When migration occurs they do not move as a colony, but as individuals or small groups resulting in the intermixing of sub-populations (Churchill, 1998).

The grey-headed flying-fox was recorded at Sites 3 and 8 during the field surveys and this species could forage seasonally in flowering or fruiting vegetation anywhere within the subject site. The nearest known flying-fox camps are at Main Creek and Mt Richardson. These camps lie 10-12 kilometres from the study area, well within flying range for the grey-headed flying-fox. There is some potential for small temporary camps to form in riparian habitat along the Williams River, particularly during peak flowering or fruiting periods.

The proposal is expected to result in the loss of potential foraging habitat for the grey-headed flying-fox. While this is unlikely to significantly impact the lifecycle of the grey-headed flying-fox, the loss of this vegetation would contribute to the cumulative loss of habitat affecting this species. No known flying-fox camps would be disturbed as a result of the proposal and it is unlikely that the Proposal would disrupt the breeding cycle of the grey-headed flying-fox. However the loss of riparian vegetation along the Williams River would prevent the grey-headed flying-fox from establishing temporary camps within this area.

Hollow-roosting bats – eastern false pipistrelle (*Falsistrellus tasmaniensis*), east-coast freetail-bat (*Mormopterus norfolkensis*) and greater broad-nosed bat (*Scoteanax rueppellii*) – all vulnerable under the NSW TSC Act

All three of these threatened bat species are reliant upon hollow-bearing trees for roosting and breeding purposes. They would also roost behind loose bark and occasionally in buildings.

The eastern false pipistrelle prefers moist forest, occurring predominantly in higher rainfall areas. This species forages for flying insects above or just below the tree canopy (DECC Threatened Species Profile). Young are born in December and lactation continues until February (Churchill, 1988). The east-coast freetail-bat has been reported from dry eucalypt forest, woodland, riparian vegetation and wet sclerophyll forest. This species prefers more open habitats for foraging, including woodland, cleared forest edges, tracks and above the forest canopy (AMBS, 1995). Little is known about the reproductive cycle of the east-coast freetail-bat, though it is likely that the breeding period occurs during late spring and summer (Ray Williams, pers. comm.). The greater broad-nosed bat has been recorded in a variety of habitat types including rainforest, moist and dry eucalypt forest and woodland. Favoured foraging areas for this species appear to be tree-lined creeks and the junction of woodland/forest with cleared paddocks. The reproductive cycle is poorly known, but a single young is produced in January and prior to birth, females congregate at maternity sites, which are located in suitable trees (DECC Threatened Species Profile).

The east-coast freetail-bat was recorded at Sites 1, 2, 3, 4 and 8 during the field surveys using ultrasonic call analysis. Probable calls of the eastern false pipistrelle were recorded at Site 1 and probable calls of the greater broad-nosed bat were recorded at Sites 5, 8 and 14. Potential foraging habitat for all three species occurs throughout the subject site. Potential roosting and breeding habitat occurs in forested areas within the study area and other areas where suitable hollow-bearing trees are located (e.g. paddock trees).

The main potential impacts associated with the proposal are expected to be the loss of roosting/breeding hollows and a large area of potential foraging habitat. Given the results of the field surveys and availability of suitable habitat, it is likely that one or more of these species roosts within the subject site and would therefore be displaced as a result of the proposal. In addition, the removal of a roost tree during the day may result in the death of a number of bats, particularly if a tree containing a maternity roost is removed during the breeding season. Given the extent of clearing and area of land expected to be inundated, the proposal could adversely affect the lifecycle of the local population of one or more of these threatened hollow-roosting bat species at least in the short term. It is expected that populations of these species would be able to move to roost sites in hollow trees situated above the high water level.

Koala (*Phascolarctos cinereus*) – vulnerable under the NSW TSC Act

Distributed from about Townsville, Queensland to the Victorian / South Australian border, from the coast to the western slopes and plains in New South Wales, this species is rare in the north and south of its range and nowhere can it be considered abundant. The koala is a foliovore, feeding on preferred eucalypt species and is found in a variety of habitats where suitable food trees occur. (DECC threatened species profile)

Koalas are generally solitary except during the mating season and have a home range of about 3 ha, though long movements in search of a mate or new food source are possible (Phillips 1990). The breeding season begins about September, when males commence calling and searching for reproductive females, and ends about April.

The koala was recorded at Sites 3, 4, 12 and 14 during the field surveys and could occur in any vegetated areas within the subject site, particularly where preferred food trees are found. The proposal is expected to result in the loss of a large area of koala habitat, including the loss of koala food and shelter trees. The main areas where habitat would be lost are in Tillegra TSR, riparian habitat on the Williams River, along the existing Salisbury Road easement and where the road realignment passes through remnant vegetation. In addition, the koala could potentially utilise stands of vegetation or isolated trees anywhere within the subject site. The loss of habitat associated with the proposal is expected to displace the koala from the subject site. This has the potential to result in an overall reduction in the size of the local population.

As the koala is likely to inhabit areas of bushland to the north and south of the subject site, the proposed dam would present a barrier to movement for this species. In order to move between these two areas after the dam is filled with water, koalas would have to travel a long way to the north-west or south-east ends of the dam in order to cross the Williams River. An existing potential corridor through remnants to the east of the dam would be retained. However, the proposed road realignment passes through or near to these remnants and increased road deaths or injuries could occur.

A draft recovery plan for the koala has been prepared (NPWS, 2003b). The overall objectives of this draft recovery plan are to reverse the decline of the koala in NSW, to ensure adequate protection, management and restoration of koala habitat and to maintain healthy breeding populations of koalas throughout their current range. As the Proposal is expected to result in the loss and further fragmentation of koala habitat, it is considered inconsistent with the objectives of this plan.

Regent honeyeater (*Xanthomyza phrygia*) and swift parrot (*Lathamus discolor*) – both endangered under the NSW TSC Act and Commonwealth EPBC Act; the swift parrot is also listed as migratory under the Commonwealth EPBC Act.

The regent honeyeater is known to breed on the western slopes of the Great Dividing Range and recently near Kurri Kurri in the Hunter Valley. The swift parrot only breeds in Tasmania and migrates to the mainland during winter. Both are seasonal or opportunistic visitors to coastal NSW and forage in areas containing winter-flowering trees (e.g. the swamp mahogany and spotted gum). Neither of these species was recorded during the field survey, though both have some potential to occur, particularly during peak winter flowering periods. Potential nest sites for the regent honeyeater occur in the river oaks within the riparian habitat of the Williams River.

The proposal is considered unlikely to greatly affect the lifecycle of either the regent honeyeater or swift parrot. However it is expected to result in the loss of potential foraging habitat, including important winter-flowering trees, which would contribute to the cumulative loss of habitat affecting these species. The clearing of potential regent honeyeater and swift parrot habitat is inconsistent with the aims of the recovery plans for these species (Swift Parrot Recovery Team, 2001; Regent Honeyeater Recovery Team, 1999), though given that no records of either species exist for the study locality, the habitat to be cleared is highly unlikely to be critically important to the survival of either species.

Southern myotis (*Myotis macropus*) – vulnerable under the NSW TSC Act

The southern myotis is apparently widespread but uncommon in northern New South Wales (AMBS, 1995) and considered comparatively rare over its limited national range (Richards, 1983). A variety of foraging habitats are used by this species although it is usually found near large bodies of water, including estuaries, lakes, reservoirs, rivers and large streams, often in close proximity to the roost site. The southern myotis forages for flying insects predominantly just above the surface of open water bodies but also rakes the surface of the water with the recurved claws of its large feet in order to catch aquatic insects and small fish. It sometimes uses its tail membrane as a scoop (Menkhorst, 1995).

The southern myotis appears to have specific roost requirements and only a small percentage of available caves, bridges, mines, tunnels and culverts are used. It has also been recorded utilising large tree hollows near water. Colonies usually number between 10 and 15 individuals, but colonies of up to several hundred individuals have been reported in a single roost (Richards, 1983). In New South Wales breeding occurs between October and February with two distinct birthing times occurring in October and early February when a single young is produced. Whether individual females give birth twice in a breeding season is unclear however banding studies indicate that succesive births do not occur (Ray Williams, Ecotone pers. obs.).

Loss of foraging habitat and roost sites are considered the major threats to this species. The specific nature of its foraging habits suggest that this species is adversely impacted by habitat degradation through water pollution, and foraging habitat is likely to have been lost through nutrient enrichment, oil spills and pollutant rich run-off entering waterways. Disturbance of colonies, especially during the breeding season or in colder months when the bat is in torpor, may cause populations to desert roost sites and can result in heavy mortality (Ayers, 1995).

The southern myotis was recorded at Sites 1, 2, 3, 4, 5, 8, 10 and 14 during the field surveys. This species was mostly recorded using ultrasonic call detection, though an adult female was caught in a harp trap at Munni House (Site 5) on the 28th November 2007 and two individuals were observed foraging over water near Tillegra Bridge (Site 8). No evidence of roosting bats was observed during an inspection and dusk watch of Tillegra Bridge however potential roost sites occur in hollow wooden beams under the bridge. Potential foraging habitat for this species occurs at dams and waterways within the study area. Potential roosting habitat occurs at bridges, drainage culverts and possibly large hollow-bearing trees overlooking water within the study area.

For the southern myotis, the main potential impact associated with the proposal is the likely loss of roosting habitat. Existing foraging habitat is also likely to be lost, though this species would still be able to forage over open water along the edges of the proposed dam.

Although no maternity roosts were observed during the field surveys, such colonies are likely to occur, particularly at Tillegra Bridge. As the southern myotis is known to roost under bridges and culverts, the removal of these structures could result in the deaths of roosting individuals, particularly if non-flying young are present or during winter months when bats enter periods of torpor. If a bridge containing a maternity roost was destroyed, this could potentially result in the loss or displacement of an entire colony.

Spotted-tailed quoll (*Dasyurus maculatus*) – vulnerable under the NSW TSC Act; eastern mainland subspecies endangered under the Commonwealth EPBC Act

The current distribution of the spotted-tailed quoll is along the coast and ranges of eastern Australia from southern Queensland to the Victorian/South Australian border and Tasmania. The mainland range of this species has been much fragmented and significantly reduced and is now disjunct over much of its former range. The spotted-tailed quoll utilises a wide range of habitat types including rainforest, wet and dry sclerophyll forest, woodland, coastal heathland and inland riparian forest (Edgar & Belcher, 1995). A solitary, nocturnal and semi-arboreal species, the spotted-tailed quoll preys on a variety of species ranging in size from small wallabies to insects, as well as plants. The spotted-tailed quoll utilises an extensive home range, estimated to be between 500 - 1000 hectares (AMBS, 1995).

This species was not recorded within the study area during field survey work within the study area and no nearby records occur, however a large number of records exist for the locality. Some potential habitat for the spotted-tailed quoll occurs in larger patches of remnant vegetation within the subject site. Given the large home range of this species, it is more likely to occur in larger tracts of bushland north and south of the subject site (including Barrington Tops National Park) though may forage within the study area. The main potential impact for the spotted-tailed quoll is likely to be the further fragmentation of habitat as the proposed dam would make movement between vegetation to the north and south of the Williams River more difficult. The proposal would also result in the loss of some potential foraging habitat for this species.

In addition, as the spotted-tailed quoll utilises large hollow logs and hollow-bearing trees for breeding and shelter purposes, there is the potential for the proposal to result in the loss of some of these important habitat features due to clearing or flooding within the subject site. As the spotted-tailed quoll utilises a number of den sites within its territory, it is unlikely that the loss of one den site would greatly affect the spotted-tailed quoll. However, if an occupied den site is destroyed, particularly one containing a female with young, this could affect the local population.

Squirrel glider (*Petaurus norfolcensis*) – vulnerable under the NSW TSC Act

The squirrel glider is distributed along the coast and ranges of eastern Australia from about Cairns in north Queensland to the Victorian/ South Australian border, extending to the western slopes and plains. This species usually inhabits dry open sclerophyll forest and woodland but there have been observations in moist regenerating forest and moist gullies. Although requiring nesting/den hollows, this species is not dependent on mature forest as sightings have been made in eucalyptus plantations and forest remnants (Ray Williams, Ecotone Ecological Consultants, pers. obs.). It is possible that disused common ringtail possum dreys and birds nests are used in the absence of an abundance of suitable hollows. The diet includes acacia gum, eucalyptus sap, nectar, honeydew, manna, invertebrates and pollen (Quin, 1995).

Survey work indicates a home range of about 13ha and a population density of 0.4 - 1 per hectare in a Victorian population (Traill & Coates, 1993) and 3.0 - 3.5ha with a density of 0.89 - 1.54 per hectare in a mid north coast population (Quin, 1995). The breeding season varies between localities and may be tied to the availability of food resources (Williams 1990; Quin 1995).

The squirrel glider was recorded at Sites 3 and 4 during the field surveys and is likely to occur in other patches of vegetation within the study area, particularly along the existing and proposed road routes.

This species is reliant upon hollow-bearing trees for roosting and breeding purposes and requires a reasonable level of vegetation connectivity in order to move freely from one area to another. Potential impacts associated with the proposal include the loss of roosting and breeding hollows, the loss of foraging habitat and the further fragmentation of habitat.

The proposal is expected to displace one or more family groups from their current territories, particularly within Tillegra TSR. A large number of hollow-bearing trees are expected to be lost as a result of the proposal, some of which were noted to contain potentially suitable roosting and breeding hollows for the squirrel glider. If a roost tree containing one or more squirrel gliders is removed, this could result in the direct deaths of those gliders.

As the squirrel glider is likely to inhabit areas of bushland to the north and south of the subject site, the proposed dam would present a barrier to movement for this species. However, the existing potential north-south corridor through remnants to the east of the proposed dam would be retained.

Stephens' banded snake (*Hoplocephalus stephensii*) – vulnerable under the NSW TSC Act

Stephens' banded snake is an arboreal, nocturnal snake largely restricted to remnant forests in eastern Australia (Fitzgerald et al, 2005) and is usually associated with moist hardwood forest or rainforest (Klippel, 1992). The species has also been recorded in rock outcrops, coastal open forest and dry forest types. Key elements of the preferred habitat of this species include a large (greater than 9000ha) area of forest with a large number of hollow bearing trees. In terms of conservation for this species, appropriate management of large areas of forest with abundant hollow trees is necessary, including maintaining the interconnectivity of forest patches. The species mostly forages in arboreal habitats and the tree canopy, where the snakes prey on a range of species including lizards, birds and small mammals including bats (Cogger, 1992; DECC Threatened Species Profile).

Stephens' banded snake was not recorded during field survey work and no nearby records occur. Some marginal potential habitat occurs in remnant vegetation within the study area, particularly patches of rainforest and adjacent eucalypt forest. Stephen's banded snake is known to occur in large tracts of bushland to the north-west of the study area, however given that this species requires large areas of forest (greater than 9000ha) it seems unlikely that it would occur within the subject site. If Stephen's banded snake does occur, potential impacts associated with the proposal include the fragmentation of habitat, loss of hollow-bearing trees and loss of foraging habitat.

Stuttering frog (*Mixophyes balbus*) – endangered under the NSW TSC Act and vulnerable under the Commonwealth EPBC Act.

The stuttering frog has a preference for riparian habitats and is usually associated with wet sclerophyll forest or rainforest for foraging and clean, flowing streams as breeding sites (Robinson, 1993; White, 1994; AMBS, 1995). In NSW the stuttering frog is found at mid to low altitudes. The species is reported to avoid sites devoid of vegetation and still water-bodies (Robinson, 1993). Specifically it is reported to be affected by the loss or modification of riparian vegetation from suitable sites and is likely to be very susceptible to declining water quality, including sedimentation and increasing turbidity.

The stuttering frog was not recorded during the field surveys however potential, albeit limited habitat occurs within the study area where the riparian vegetation consists of moist forest/rainforest along the Williams River. Within the inundation area such habitat is limited to a very small remnant near Munni Bridge and approximately a 1.5 km section of river below the cliffline at Underbank. While there is only a limited possibility that this species occurs, the proposal would result in a minor loss of potential habitat along the Williams River.

If a population of this species occurs it would be unable to exist within the inundation area of the proposed dam therefore it would result in the loss of that local population. However given the isolation and small area of potential habitat, any population would be small and already vulnerable to potential negative impacts resulting from drought, floods and land management issues.

Wompoo fruit-dove (*Ptilinopus magnificus*) – vulnerable under the NSW TSC Act

The wompoo fruit-dove was once distributed from about Illawarra in the south, north to Cape York and New Guinea, however this species has become increasingly rare in the south of its range, and now reaches its usual southern limit at the Hunter River. This species can be either sedentary or locally nomadic and prefers lowland and foot-hill subtropical forest, including littoral rainforest (AMBS, 1995). The wompoo fruit-dove feeds on a variety of rainforest fruits, including those of palms, figs, laurels, lilly-pilly, white cedar and lawyer vine. Most feeding is done high in the forest canopy. In north-eastern New South Wales, nesting extends from late winter to midsummer. The nest is a simple platform of sticks, between five and 20 metres from the ground but often less than 10 metres, and a single egg is laid.

The wompoo fruit-dove was not recorded during the field surveys and no nearby records occur. This species has some potential to opportunistically visit patches of remnant rainforest or moist forest within the study area. Some marginal potential habitat for the wompoo fruit-dove is likely to be lost as a result of the proposal. However given that this species is likely to be only an opportunistic visitor to the study area, it is considered highly unlikely that the lifecycle of the wompoo fruit-dove would be greatly affected by the Proposal.

Woodland birds - grey-crowned babbler (*Pomatostomus temporalis temporalis*), speckled warbler (*Pyrrholaemus sagittatus*), brown treecreeper (*Climacteris picumnus victoriae*), turquoise parrot (*Neophema pulchella*) and diamond firetail (*Stagonopleura guttata*) – all vulnerable under the NSW TSC Act

These five threatened species are all reliant on woodland areas, though each has slightly different habitat requirements.

The grey-crowned babbler inhabits open eucalypt woodlands with a grassy groundcover and sparse, tall shrub layer (DECC Threatened Species Profile). This sedentary species lives in groups of 5-12 within a home territory of approximately 12 hectares and builds a large, domed, communal nest 4-7 metres off the ground (Readers Digest, 1979, Morcombe, 2000).

The speckled warbler occupies eucalypt and cypress woodlands and appears to require contiguous areas of habitat larger than 100 hectares (DECC Threatened Species Profile). This species occupies a home range of between 6-12 hectares and prefers areas where the ground cover consists of grass, fallen leaves and bark (Hoskin, 1991). The speckled warbler congregates in small family groups of two or three and breeds from September to March (Readers Digest, 1979). Dome shaped nests are constructed of dried grasses and bark strips and are camouflaged under a tuft of grass usually beneath fallen branches or at the base of a small shrub (Hoskin, 1991; Readers Digest, 1979).

The eastern form of the brown treecreeper prefers dry open woodland habitats, mainly on the western slopes of the Great Dividing Range, with a patchy distribution to the east of the Divide. The brown treecreeper is a sedentary species, with a pair or small family group frequenting a permanent territory. This species is reliant upon tree hollows for nesting and viable populations are thought to require a minimum patch size of 200ha of suitable habitat (DECC Threatened Species Profile).

The turquoise parrot appears to prefer grassland on the edge of open woodland or open forest. Timbered grassland on mountain slopes, ridges and grasslands constitute favoured habitat for this partly nomadic species. The turquoise parrot is usually seen in pairs or small groups, although flocks of up to thirty birds have been reported. Breeding occurs between August and December, with a nest formed in a suitable hollow of a tree limb, log or fence post.

The diamond firetail mainly inhabits eucalypt woodlands, forests and mallee with a grassy understorey. Usually in flocks of 20-30 individuals, they may form larger flocks in autumn and winter (Morcombe, 2000). Diamond firetail populations appear to require native vegetation remnants of greater than 200ha to persist in an area (NPWS, 2003). This species constructs a horizontal bottle shaped nest in the dense foliage of a tree or shrub up to ten metres high and the breeding season is generally from August through to January.

The grey-crowned babbler, brown treecreeper, turquoise parrot and diamond firetail were not recorded during the field surveys and no nearby records of these species occur. The speckled warbler was recorded at Sites 3 and 4 during the field surveys. Suitable habitat for all five species occurs in remnant vegetation within the subject site and the turquoise parrot and diamond firetail have some potential to utilise more open areas with a suitable cover of grass.

For these five threatened woodland bird species, the main potential impact associated with the proposal is the loss of foraging and breeding habitat. While the proposal could potentially impact all five species, only the speckled warbler was recorded during the surveys and therefore is discussed in more detail below.

The proposal is expected to displace at least one known population of the speckled warbler. The patch of vegetation at the Tillegra TSR currently covers an area of approximately 31 hectares. The combination of the proposed dam wall, spillway and inundation area would result in the loss of most of this vegetation and it is estimated that a patch of eight hectares would remain in the south-east corner. Given that this patch would be isolated from other areas of

vegetation, it is unlikely that it would be large enough on its own to support a population of the speckled warbler.

Habitat for the speckled warbler is also expected to be lost along the proposed road route and potentially other vegetated areas within the subject site. As this species is likely to occur in larger patches of vegetation north and south of the subject site, the proposed dam could present a barrier to movement and may affect the dispersal ability of this species or isolate currently interbreeding populations. However, the existing potential north-south corridor through remnants to the east of the proposed dam would be retained.

b) How is the proposal likely to affect the habitat of a threatened species, endangered population or endangered ecological community?

The proposal is mainly expected to affect threatened fauna habitat within the study area through the inundation of 2100 hectares of land.

The proposal would result in some clearing of native vegetation in the proposed dam wall area, riparian habitat along the Williams River, along the existing road easement, scattered paddock trees and along the proposed new road routes. Given the area of land likely to be affected by the proposal, a large number of hollow-bearing trees are expected to be lost.

A number of water bodies are expected be impacted by the proposal, including a long stretch (approximately 19.2 kilometres) of the Williams River. Additional waterbodies expected to be affected are Moolee Creek, Quartpot Creek, Black Camp Creek, Bullee Coggee Creek, Native Dog Creek, Taylors Creek, numerous dams and smaller tributaries within the subject site.

The southern myotis is known or likely to forage over waterbodies within the study area, although as this species would be able to forage over water along the edges of the proposed dam, the loss of these areas is unlikely to reduce the extent of foraging habitat available to this species.

No other threatened species are likely to be impacted as a result of the loss of the existing dams. However, a long stretch (approximately 19.2 kilometres) of riparian habitat along the Williams River would be lost as result of the proposal, as well as the loss of riparian habitat along a number of smaller creeks and watercourses within the study area. These watercourses provide potential but limited habitat for the stuttering frog where moist forest or rainforest occurs. A supplementary habitat assessment carried out for threatened frog species (White in **Appendix 8**) found that suitable habitat for the stuttering frog only occurred at two locations within the inundation area, near Munni Bridge and at Underbank. The Munni Bridge site and to a lesser extent the Underbank remnant are thought to be too small and isolated for the stuttering frog to occur and any population that may occur would be small and already at risk of local extinction as a result of natural changes to habitat, such as impacts from drought and flooding.

Due to the large area of land likely to be affected, the proposal is expected to result in the loss of known or potential habitat for a number of threatened fauna species. Table 14 shows the extent of each native vegetation community likely to be affected as a result of the proposal and the threatened fauna species with potential to occur in each community. It has been calculated that approximately 223 hectares of remnant vegetation would be lost, however it should be noted that this does not include the scattered hollow bearing paddock trees that occur across the inundation area.

The loss of vegetation within the study area associated with the proposal would include the loss of particular tree species that provide important foraging habitat for a number of threatened fauna species. These include preferred food tree species for the koala and glossy black-cockatoo as well as important winter-flowering trees (e.g. spotted gum) that provide an important seasonal food resource for a range of species including the grey-headed flying-fox, swift parrot and regent honeyeater.

Table 14. Extent of Potential Threatened Fauna Habitat Loss associated with the Proposal (based on RL152.3 full capacity level)

Vegetation Community	Threatened Fauna with Potential to Occur	Predicted Impact Area (hectares)
1-Subtropical Rainforest	Owls, giant barred frog, stuttering frog, golden-tipped bat, grey-headed flying-fox, spotted-tailed quoll, Stephens' banded snake, wompoo fruit-dove	0.2
2-Moist Gully Blue Gum Wet Sclerophyll Forest	Brush-tailed phascogale, insectivorous bats, owls, giant barred frog, stuttering frog, grey-headed flying-fox, koala, spotted-tailed quoll, squirrel glider, Stephens' banded snake, wompoo fruit-dove	2.5
3-Spotted Gum-Ironbark Forest	Brush-tailed phascogale, insectivorous bats, owls, glossy black-cockatoo, grey-headed flying-fox, koala, regent honeyeater, swift parrot, spotted-tailed quoll, squirrel glider, woodland birds	32.2
4-Forest Red Gum Moist Slopes Forest	Brush-tailed phascogale, insectivorous bats, owls, glossy black-cockatoo, grey-headed flying-fox, koala, regent honeyeater, swift parrot, spotted-tailed quoll, squirrel glider, woodland birds	43.7
5-Riparian Forest	Brush-tailed phascogale, insectivorous bats, owls, giant barred frog, stuttering frog, glossy black-cockatoo, grey-headed flying-fox, koala, regent honeyeater, swift parrot, southern myotis, spotted-tailed quoll, squirrel glider, wompoo fruit-dove	145

In addition to the loss of foraging habitat for the species in the above table, the clearing of vegetation associated with the proposal is also expected to result in the loss of sheltering and breeding habitat for a number of these species, particularly due to the loss of hollow-bearing trees. While hollow-bearing trees were generally sparsely distributed throughout the study area, the large clearing footprint of the proposal would result in the overall loss of a large number of hollow-bearing trees. Hollow bearing trees were noted to be common along the existing road easement and as scattered paddock trees. Threatened species that utilise hollow-bearing trees for sheltering and/or breeding purposes include the brown treecreeper, brush-tailed phascogale, glossy black-cockatoo, hollow-roosting bats, owls, southern myotis, spotted-tailed quoll, squirrel glider, Stephens' banded snake and turquoise parrot.

On the ground, hollow logs and fallen timber provide potential habitat for a number of threatened fauna species, including the brush-tailed phascogale and spotted-tailed quoll. Most areas of native vegetation within the study area contained some degree of fallen timber however these habitat features were most prevalent within Tillegra TSR and in larger patches of more intact bushland to the north of the proposed inundation area. Large hollow logs also occur within areas of cleared pasture, though it is unlikely that these would be used by any threatened fauna species.

The Tillegra TSR remnant will be substantially reduced in size as a result of the construction of the dam wall and subsequent inundation. The resulting remnant is likely to be too small to support the known populations of threatened fauna species (koala, squirrel glider and brush-tailed phascogale). The proposed revegetation for habitat corridors would help to alleviate impacts resulting from dispersal to and from the remnant, particularly if some regeneration is allowed to take place prior to the start of construction works.

As the proposal would remove bridges within the study area, bat species that roost under such structures may be affected by the proposal, including the eastern bent-wing bat, little bent-wing bat and southern myotis. The southern myotis and eastern bent-wing bat are most likely to be affected by bridge removal, particularly at Tillegra Bridge, as both species were recorded foraging under the bridge. Although no roost sites were identified during the survey period potential sites were identified. The southern myotis is known to form maternity roosts under old bridges where suitable hollows occur therefore a maternity colony may occur at Tillegra Bridge during the breeding season (October – March). The bent-wing bats would only roost in small numbers under bridges and culverts within the study area, although if these structures are removed while bats are roosting, then individual deaths may occur if ameliorative measures are not put in place (see tne Bat Management Plan in **Appendix 7**).

c) Does the proposal affect any threatened species or endangered population that are at the limit of its known distribution?

The study area is nearing the western limit for six threatened fauna species with potential to occur. These are the golden-tipped bat, little bent-wing bat, sooty owl, Stephens' banded snake, stuttering frog and wompoo fruit-dove. All of these species are more frequently recorded closer to the coast and all except the sooty owl are more common further north. With the exception of the little bent-wing bat, the remaining species have preference for moist eucalypt forest or rainforest. Of these species, the golden-tipped bat, sooty owl, Stephens' banded snake, stuttering frog and wompoo fruit-dove have all been recorded in one or more of the State Forests and National Parks that lie to the north and east of the study area.

None of these species were positively identified during the field surveys, though a call of the golden-tipped bat was given a tentative (possible) identification based on ultrasonic call analysis. The proposal is expected to result in the loss of about 2 km of potential riparian habitat for five of these threatened fauna species however this would not result in a significant range reduction. The little bent-wing bat may not occur in the study area however if it does, there would be some loss/modification of foraging habitat and a loss of potential roost sites under the existing bridges. It is proposed to replace such roost sites under the new bridges for the Salisbury Road realignment (see Bat Management Plan in **Appendix 7**).

d) How is the proposal likely to affect current disturbance regimes?

Current disturbance regimes include:

- grazing;
- agricultural activities;
- roadside disturbance;
- disturbance of riparian habitat;
- stream bank erosion;
- runoff from pasture and roads into waterways;
- weeds; and
- feral animals

The proposal would result in the clearing of vegetation within the subject site and the inundation of 2100 hectares of land. The level of disturbance associated with the proposed dam is much higher than those factors currently operating within the study area.

e) How is the proposal likely to affect habitat connectivity?

No mapped wildlife corridors or areas of key habitat would be affected by the proposal. However the proposed dam would represent a barrier to fauna movement, particularly along the Williams River and between large areas of bushland to the north and south of the subject site. However, the existing potential north-south corridor through remnants to the east of the proposed dam would be retained, although the proposed new road route would pass through or close to some of the remnants. The proposal to allow regeneration and conduct revegetation above the high water mark will alleviate habitat connectivity in general. However in denuded areas it could take many years for adequate regeneration to take place.

While mobile flying species would be able to travel over or around the proposed dam, for less mobile species the presence of the dam would present a major obstacle to movement between areas currently linked by the riparian habitat, road easement and scattered paddock trees. Those species most likely to be affected include the brush-tailed phascogale, koala, spotted-tailed quoll and squirrel glider. The proposal could potentially separate currently interbreeding populations and affect the dispersal ability of these species, although some movement for the above species would be possible via the proposed eastern corridor and links to Mount Butterwicki.

Although it is unlikely that the stuttering frog occurs, potential, albeit limited, habitat is available in isolated moist riparian habitat pockets within the study area. Potential habitat has been identified upstream and downstream of the propsed inundation area however the isolated remnants are seperated by long stretches of unsuitable habitat and movement through the riparian habitat is considered to be an unlikely occerrence, except possibly in times of flood.

The proposed roads are unlikely to greatly affect habitat connectivity within the study area, though less mobile species (particularly the koala and brush-tailed phascogale) would be at risk of vehicle strike while crossing the road. Koalas are known to occur in the vicinity of the new road and would not be familiar with the risk posed by vehicle traffic if crossing between forest remnants on either side of the road.

f) How is the proposal likely to affect critical habitat?

No critical habitat is currently listed in the NSW TSC Act or Commonwealth EPBC Act for the subject species within the study area.

4.2 Key Threatening Processes

The following key threatening processes that are listed as Final Determinations in Schedule 3 of the NSW TSC Act could be initiated or intensified within the study area by the proposed action:

a. *Alteration to the natural flow regimes of rivers and streams and their floodplains and wetlands*

Construction of the dam wall will alter the natural flow regime of rivers and streams, both within the inundation area and downstream of the dam wall. Whilst the release of environmental flows downstream from the dam may temper the effect of this key threatening

process, the flow regime post dam will be significantly different from that currently in existence.

b. Clearing of native vegetation

Based on the concept design impact area, the proposal is expected to result in the clearing of approximately 223 hectares of native vegetation and an additional area of approximately 1877 hectares of predominantly cleared land, parts of which include scattered trees. Therefore the proposal is expected to contribute to this key threatening process.

c. Competition and grazing by the feral European rabbit

The proposal is unlikely to result in increasing numbers of the feral European rabbit within the study area and therefore would not contribute to this key threatening process. However control measures would still need to be put in place as part of the plan of management for the proposal.

d. Competition from feral honeybees

The proposal is unlikely to result in increasing numbers of the feral honeybee within the study area and therefore would not contribute to this key threatening process.

e. High frequency fire

The proposal is unlikely to increase the frequency of fire within the study area and therefore would not contribute to this key threatening process. A fire regime may need to be implemented as part of the plan of management for the proposal in order to protect regenerating vegetation.

f. Human-caused climate change

Emissions from rotting vegetation, machinery, vehicles and clearing associated with the proposal are expected to contribute to this key threatening process. However a large number of trees are expected to be planted or allowed to regenerate in order to offset this impact. In addition a hydro electric generator is proposed for power production and this will assist in addressing or reducing the projects contribution to this key threatening process.

g. Infection of frogs by amphibian chytrid causing the disease chytridiomycosis

While it is unlikely that the proposal would lead to an increase in the incidence of chytridiomycosis in frog populations within the study area, this disease is known to affect the stuttering frog and other frog species with potential to occur within the study area. Chytrid fungus is a water borne pathogen and can be spread through water or mud on vehicles, machinery, footwear and other equipment. In order to prevent the spread of chytrid fungus, appropriate cleaning and disinfection protocols would need to be followed when moving between wet-area work sites (including creek crossings, dams, wetlands and swampy areas). The NSW National Parks and Wildlife Service has produced a booklet that should be used as a guide, *Hygiene protocol for the control of disease in frogs* (NPWS, 2001).

h. Infection of native plants by Phytophthora cinnamomi

There is a very real risk of this fungus being introduced on machinery, clothing and in soil/fill during construction of the project. It is recommended that protocols be established during construction to minimise the risk of this happening.

i. Invasion, establishment and spread of lantana (Lantana camara L. sens. lat)

Lantana was found to be common and abundant within most communities in the study area. Most of it would be removed from the riparian community by inundation, but where it occurs in dryland or moist gully communities not subject to direct inundation its invasion, establishment and spread would need to be managed during both construction and operation of the project to prevent impacts on adjoining retained habitat. Weed control prior to commencement of earthworks is recommended.

j. Invasion and establishment of exotic vines and scramblers

Particular parts of the study area were found to contain established populations of exotic vines and scramblers. As with lantana, their invasion and establishment in areas not subject to inundation would need to be managed during both construction and operation of the project as part of a general weed management strategy to prevent impacts on adjoining retained habitat.

k. Invasion of native plant communities by exotic perennial grasses

Numerous species of exotic perennial grasses were recorded in the study area during field surveys, some of which are highly invasive in natural vegetation communities. Their spread in areas not subject to inundation would need to be managed during both construction and operation of the project as part of a general weed management strategy to prevent impacts on adjoining retained habitat.

l. Predation by the European red fox (Vulpes vulpes)

The proposal is unlikely to increase the population of this introduced predator, however, if native fauna is forced to travel over open ground between habitat remnants then an increase in predation levels could occur. Control measures would still need to be put in place as part of the plan of management for the proposal.

m. Predation by the feral cat (Felis catus)

The proposal is unlikely to increase the population of this introduced predator, however, if native fauna is forced to travel over open ground between habitat remnants then an increase in predation levels could occur. Control measures would still need to be put in place as part of the plan of management for the proposal.

*n. Predation by the plague minnow (*Gambusia holbrooki*)*

The plague minnow has been identified as a major predator of the tadpoles of a number of frog species, including the endangered green and golden bell frog (NSW NP&WS 2003). Although the plague minnow already occurs in low numbers in the Williams River (The Ecology Lab 2008), the proposal has the potential to increase population numbers of the plague minnow due to an increase in shallow still waters around the edge of the dam (NSW NP&WS 2003). Therefore the Proposal could contribute to this key threatening process.

o. Removal of dead wood and dead trees

While large logs and dead standing trees were generally found to be sparsely scattered throughout the study area, given the large area of land likely to be affected, the proposal is expected to result in the removal of large amounts of dead wood and dead trees from within the construction and inundation area, therefore contributing to this key-threatening process.

p. Loss of hollow-bearing trees

While hollow-bearing trees were generally noted to be sparsely distributed throughout the study area, some areas contained numerous hollow-bearing trees that could provide good fauna habitat for hollow-reliant species. Many of the scattered paddock and roadside trees were large trees observed to contain numerous hollows. Given the large area of land likely to be affected, the proposal is expected to result in the loss of a large number of hollow-bearing trees from within the study area and would therefore contribute to this key threatening process.

4.3 Relevant Recovery Plans or Threat Abatement Plans

Final Recovery Plans have been prepared for the following threatened species recorded or with potential to occur within the study area:

- Large forest owls (powerful owl, sooty owl and masked owl)
- Regent honeyeater
- Swift parrot

Draft Recovery Plans have been prepared for the following threatened species recorded or with potential to occur within the study area:

- Barking owl
- Koala

A final Threat Abatement Plan has been prepared for the following key threatening process considered to have potential to operate in the study area:

- Predation by the red fox
- Predation by *Gambusia holbrooki* – plague minnow

The relevant Recovery Plans have been referred to in the Part 3A assessments above.

4.4 Summary of the Part 3A Threatened Species, Population and Ecological Community Assessment

Threatened Species

No threatened flora species are expected to be significantly impacted upon by the proposal.

The following ten threatened fauna species were definitely or probably recorded within the study area. A further species, the golden-tipped bat (*Kerivoula papuensis*), was possibly recorded by ultrasonic call.

- Brush-tailed phascogale (*Phascogale tapoatafa*)
- East-coast freetail-bat (*Mormopterus norfolkensis*)
- Eastern bent-wing bat (*Miniopterus schreibersii oceanensis*)
- Eastern false pipistrelle (*Falsistrellus tasmaniensis*) – probable call only
- Greater broad-nosed bat (*Scoteanax rueppellii*) – probable call only
- Grey-headed flying-fox (*Pteropus poliocephalus*)
- Koala (*Phascolarctos cinereus*)
- Southern myotis (*Myotis macropus*)
- Speckled warbler (*Pyrrholaemus sagittatus*)
- Squirrel glider (*Petaurus norfolcensis*)

Nine of these species were recorded within the Tillegra TSR however most of this forest remnant will be removed for the construction of the dam wall and the subsequent inundation of the area. However all of these, except the brush-tailed phascogale, were recorded at other sites, including seven species above or near the high water level. Most likely to be impacted are the less mobile species (koala, brush-tailed phascogale and squirrel glider) as the remaining remnant in the dam wall area is expected to be too small to support viable populations and individuals would need to disperse across open ground to adjoining remnants. Some dispersal would be possible along the riparian habitat of the Williams River prior to its removal for the filling of the dam. The proposed revegetation of a habitat corridor to the east of the dam and to the Mount Butterwicki remnants in the south-west will help to alleviate impacts on fauna movements in the long term.

The endangered stuttering frog was not recorded during surveys and the probability of the species occuring is considered to be low given the isolation of the habitat remnant, the clearing of much of the vegetation for agriculture and past riverbank and snag removal works (Biosphere 2008 in **Appendix 8**). However the loss or modification of approximately 2 km of moist riparian vegetation along the Williams River has some potential to impact on the stuttering frog should a population actually occur.

A large number of hollow bearing trees are expected to be removed from the inundation area. Such trees are likely to be used by hollow dependent fauna species, particularly as bird nest sites and insectivorous bat day and maternity roosts. Although it is expected that these mobile species will find alternative nest/roost sites above the high water level there will be a significant overall loss of tree hollows within the local area. In addition, competition for the remaining roost sites above the high water level could result in a reduction of population numbers for some of the subject species.

With regards to the insectivorous bats there will be a reduction of foraging areas for some species, particularly those that forage within vegetation. Although some species are likely to forage over the

dam, particularly along the edge of any fringing vegetation, the insect prey diversity and availability is likely to change, disadvantaging some species and advantaging others.

The demolition of Tillegra Bridge and eventual flooding of Munni and Quart Pot Creek Bridges has the potential to remove roost sites for the southern myotis and to a lesser extent the eastern and little bent-wing bat. The southern myotis may also breed in these structures and therefore the loss of a maternity site would be significant. The provision of artificial roost sites under the replacement bridge structures would help to alleviate any impacts.

In summary, impacts on threatened species are predicted to be low as within the context of the total inundation area, suitable habitat for the various species is limited. Where habitat exists, key areas include the Tillegra TSR and surrounding area for koalas, brush tailed phascogale and the squirrel glider, as well as at least two isolated pockets of moist riparian vegetation in the inundation area that, on a precautionary basis, is assumed to contain the stuttering frog.

Some individuals of threatened fauna species may be lost or displaced as a result of the proposal however it is likely that local populations of many of the species will continue to inhabit the existing remnants above the full supply level. It should be cautioned that new habitat created by the dam will be unsuitable for some species. For example, should a limited number of the stuttering frog actually occur in the area, it will not be able to adjust to living within the reservoir as it is dependant on moist riparian floodplain forest habitat for survival.

The loss of hollow bearing trees throughout the entire inundation area is of significant concern given the large number of old paddock trees scattered throughout the landscape. The creation of the habitat corridor will not be able to mitigate this loss in the short to medium term, until new trees are sufficiently mature to recreate nesting and roosting sites. The provision of artificial nest and roost sites for use by hollow dependent species should be considered to ameliorate this issue.

Endangered Populations

No endangered population of flora and fauna have been recorded within the study area and none are expected to occur.

Endangered Ecological Communities

The riparian habitat along a 19.2 km stretch of the Williams River will be lost. This habitat has been identified as an EEC *River-flat Eucalypt Forest on Coastal Floodplains* intergrading with small isolated pockets of *Subtropical Coastal Floodplain Forest*. On a local scale it has been estimated that 22.5% of this habitat within the locality would be lost. On a regional scale this loss represents 0.7% of the total area of the EEC. Therefore, on a local scale, the loss of this habitat is considered to be significant, although regionally the loss appears to be insignificant.

The potential loss of 0.2 ha of the EEC *Lowland Rainforest* is considered to be insignificant on both a local (0.004%) and regional (0.0008%) scale.

4.5 Environment Protection & Biodiversity Conservation Act 1999 (EPBC Act)

The EPBC Act was gazetted in 2000 and replaced several earlier Commonwealth statutes. This Act focuses Commonwealth interests on matters of national environmental significance (NES) including integrated biodiversity conservation and the management of important protected areas. The Act also establishes a streamlined environmental assessment and approvals process.

The matters of NES as identified in the Act which require assessment and approval to be addressed by the Commonwealth include:

- World Heritage properties
- National Heritage places
- RAMSAR wetlands
- Nationally threatened species and ecological communities (Part 13, Division 1, Subdivision A of the EPBC Act)
- Migratory species
- Commonwealth Marine areas
- Nuclear actions (including uranium mining)

The assessment and approval process applies to any action that has, would have or is likely to have a significant impact on a matter of NES. An 'action' is defined as a project, development, undertaking or an activity or series of activities. As of 18 January 2007, a bilateral agreement has been signed between the Commonwealth and the state of NSW which essentially accredits the NSW assessment process of environmental impact for the purposes of the EPBC Act, provided that the assessment has been done in accordance with the bilateral agreement. This has effectively removed the need for duplication of assessment effort by both the Commonwealth and state.

With regard to flora and fauna, the only matters of NES relevant to the study area are nationally threatened species and migratory species, although the Williams River is part of the Hunter River system that flows into the Hunter Estuary Wetland RAMSAR Site situated outside of the study locality. The relevant criteria given in the administrative guidelines for the Act to determine whether the action is likely to have a significant impact on a nationally threatened species are shown in **Table 15.**

Table 15. Assessment of Relevant Significant Impact Criteria under the EPBC Act

Significant Impact Criteria and Assessment	
Critically Endangered and Endangered Ecological Communities - none of those listed in the EPBC Act recorded within the study area	
Critically endangered and endangered species **Flora** – nil **Fauna** – potential habitat for the regent honeyeater, spotted-tailed quoll and swift parrot (all endangered)	
An action has, will have, or is likely to have a significant impact on a critically endangered or endangered species if it does, will, or is likely to:	*a) lead to a long-term decrease in the size of a population, or* Comment: None of these species were recorded within the study area. The proposal is unlikely to reduce the population size of the three potential species being assessed.
	b) reduce the area of occupancy of the species, or Comment: Potential habitat for all three species would be lost as a result of the proposal. Habitat restoration and revegetation above the high water level has the potential to increase the area of habitat over time for the three species being assessed.
	c) fragment an existing population into two or more populations, or Comment: No known populations of these species occur within the study area.
	d) adversely affect habitat critical to the survival of a species, or Comment: The available habitat currently occurring within the study area is not critical to the survival of the three potentially occurring endangered species.
	e) disrupt the breeding cycle of a population, or Comment: The regent honeyeater is known to nest in riparian habitat, particularly in river oaks (*Casuarina cunninghamiana*). No breeding sites are known for the locality and given the apparent lack of records it is considered unlikely that the breeding cycle would be disrupted. The breeding cycle of the spotted tailed quoll and swift parrot would not be affected.
	f) modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline, or Comment: All habitats within the inundation area would be lost however the remaining forested areas, particularly to the north and east would support local populations of these species. Therefore it is unlikely that populations of the three species bein g assessed would decline as a result of the proposal.
	g) result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species' habitat,* Comment: No invasive species other than those already occurring in the study area are likely to become established. Foxes, cats and rabbits are known to occur and increases in populations are not expected to occur as a result of the proposal.
	h) interfere with the recovery of the species. Comment: No known habitat occurs for these endangered species within the study area and better quality known habitat occurs outside of the inundation area, particularly to the north (World Heritage Area) and east of the study area. Therefore it is considered unlikely that the proposal would interfere with the recovery of these endangered species.

Table 15, continued

Vulnerable species **Flora** – potential habitat for *Eucalyptus glaucina* and *Marsdenia longiloba* **Fauna** – known habitat for the grey-headed flying-fox Potential limited habitat for the Australian painted snipe, large-eared pied bat and stuttering frog	
An action has, will have, or is likely to have a significant impact on a vulnerable species if it does, will, or is likely to:	*a) lead to a long-term decrease in the size of an important population of a species, or* Comment: Of the flora species, *Eucalyptus glaucina* is most likely to occur as several records occur for the locality. Whilst not recorded during the field surveys, should this species occur as an isolated individual or small group of trees it is unlikely that it would be classed as an important population based on the definitions given for this criterion. With the exception of the grey-headed flying-fox, no known populations of the remaining species of flora or fauna species were identified within the study area. Based on the survey results, it is considered unlikely that an important population of any of the subject species would decrease as a result of the proposal. The stuttering frog was not recorded and given that the habitat remnants are small and isolated, any population that may occur is expected to be small and already under threat of local extinction. (Biosphere 2008 in **Appendix 8**). Known and more secure populations of the stuttering frog occur in the extensive forests to the north and east of the study area.
	b) reduce the area of occupancy of an important population[**]*, or* Comment: No known important populations of vulnerable species have been identified in the study area. Should a sub-population of the stuttering frog actually occur within the inundation area then there would be a reduction of occupancy resulting from the loss of about 2 km of fragmented moist riparian habitat. This reduction in habitat will not have significant and notable impact as the habitat areas identified are already considered to be compromised (Biosphere 2008, refer **Appendix 8**).
	c) fragment an existing important population into two or more populations, or Comment: No existing important populations for the subject species are known to occur.
	d) adversely affect habitat critical to the survival of a species, or Comment: No existing important populations for the subject species are known to occur reflective of the fact that the majority of the project area is cleared agricultural land. Habitat remnants identified as having some limited potential for supporting the stuttering frog are considered to be small, fragmented and isolated. On this basis, the available habitat is not considered to be critical for the overall survival of the species in the region. Critical habitat for other subject flora and fauna species will not be affected.
	e) disrupt the breeding cycle of an important population, or Comment: No important populations of the subject vulnerable species are known to occur in the study area; accordingly their breeding cycles would not be disrupted.
	f) modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline, or Comment: The transformation of the project area from a terrestrial habitat to an aquatic habitat is unlikely to modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that a subject species is likely to decline. This conclusion is made on the basis that the majority of the existing habitat within or affected by the proposal is cleared agricultural land. Any remnant habitat within the project area, although valuable for terrestrial species in general, is unlikely to support a significant number of Commonwealth subject threatened species, to the extent that its removal would cause a species to decline.

Table 15, continued

Vulnerable species - continued **Flora** – potential habitat for *Eucalyptus glaucina* and *Marsdenia longiloba* **Fauna** – known habitat for the grey-headed flying-fox Potential limited habitat for the Australian painted snipe, large-eared pied bat and stuttering frog	
	*g) result in invasive species that are harmful a vulnerable species becoming established in the vulnerable species' habitat***, or* Comment: No invasive species other than those already occurring in the study area are likely to become established. Foxes, cats and rabbits are known to occur and increases in populations are not expected to occur as a result of the proposal. Control measures would need to be implemented in the plan of management for the proposal. An increase in mosquito fish would not impact on the stuttering frog as it is unlikely that this frog would survive or breed in the confines of the dam.
	h) interferes substantially with the recovery of the species. Comment: No known habitat occurs for these vulnerable species and better quality known habitat occurs outside of the inundation area, particularly to the north (World Heritage Area) and east of the study area. In the case of the Australian painted snipe preferred habitat occurs in the Hunter Estuary Wetland within the Hunter/Williams River catchment.
Migratory Species **Known** habitat for the black-faced monarch, rainbow bee-eater, rufous fantail, white-bellied sea-eagle and white-throated needletail **Potential** habitat for the cattle egret, great egret, painted snipe, Latham's snipe, regent honeyeater, satin flycatcher and spectacled monarch	
(Note that some migratory species are also listed as threatened species. These criteria are relevant to migratory species that are not threatened). ***An action is likely to have a significant impact on a migratory species if there is a real chance or possibility that it will:***	*a) substantially modify (including by fragmenting, altering fire regimes, altering nutrient cycles or altering hydrological cycles), destroy or isolate an area of important habitat[#] for a migratory species;* Comment: No areas of **important** habitat for migratory species, as defined in the notes below, were identified within the study area. However known habitat for the subject forest/woodland birds would be lost within the inundation and construction areas.
	b) result in an invasive species that is harmful to the migratory species becoming established in an area of important habitat for the migratory species; or Comment: No invasive species other than those already occurring in the study area are likely to become established. Foxes, cats and rabbits are known to occur and increases in populations are not expected to occur as a result of the proposal. No areas of **important** habitat for migratory species were identified within the study area.
	c) seriously disrupt the lifecycle (breeding, feeding, migration or resting behaviour) of an ecologically significant proportion[##] of the population[###] of a migratory species. Comment: The proposal would not disrupt the lifecycle of an ecologically significant proportion of the population of a migratory species. The proposed revegetation of land above the high water level has the potential to increase and/or improve habitat for most of the subject migratory species.

Table 15, continued

Wetlands of International Importance The Hunter Estuary Wetland RAMSAR site occurs downstream from the proposal	
An action is likely to have a significance impact on the ecological character of a declared Ramsar wetland if there is a real chance or possibility that it will result in:	*a) areas of the wetland being destroyed or substantially modified.* Comment: No
	b) a substantial and measurable change in the hydrological regime of the wetland, for example, a substantial change to the volume, timing, duration and frequency of ground and surface water flows to and within the wetland. Comment: It has been estimated that the Williams River at the point of the proposed dam wall contributes about 30% of the water flows in the lower Williams River. It is predicted that the proposed dam will change the frequency, duration and timing of flows below the dam wall (Gippel and Anderson, 2008). However a release strategy is being developed for environmental flows and bulk water transfer and in times of drought, when more frequent larger flows of water are most likely to be released. Freshwater would be held by the Seaham weir and pumped into Grahamstown Dam for human consumption. Downstream of the weir the river is tidal and joins the Hunter River at Raymond Terrace. As the Hunter Estuary Wetlands are a considerable distance from the proposed dam and subjected to daily fluctuations in water levels and flows, it is considered unlikely that there would be substantial change to the hydrology of the wetland.
	c) the habitat or lifecycle of native species, including invertebrate fauna and fish species, dependent upon the wetland being seriously affected. Comment: Given the reasons above it is unlikely that there would be a significant change to the habitat or lifecycle of the existing wetland species.
	d) a substantial and measurable change in the water quality of the wetland – for example, a substantial change in the level of salinity, pollutants, or nutrients in the wetland, or water temperature which may adversely impact on biodiversity, ecological integrity, social amenity or human health. Comment: It is unlikely that there would be a substantial change to the water quality in the wetlands as releases of water for human consumption are likely to be held at Seaham Weir. Natural freshwater flows through flooding are unlikely to be significantly reduced as the upper Williams River represents only 30% of the total flow of the Williams River and much less when compared with the combined flows of the Hunter, Williams and Chichester Rivers. However it is intended that the water release strategy will take this factor into account.
	e) an invasive species that is harmful to the ecological character of the wetland being established (or an existing invasive species being spread) in the wetland. Comment: Invasive aquatic water plants (e. g. salvinia, water hyacinth and alligator weed) are known to occur in the Williams/Hunter River catchments however the proposal is unlikely to increase the potential for these species to spread within the RAMSAR wetlands.

Notes:

^ *'Habitat critical to the survival of a species or ecological community' refers to areas that are necessary:*

- *for activities such as foraging, breeding, roosting or dispersal*
- *for the long-term maintenance of the species or ecological community (including the maintenance of species essential to the survival of the species or ecological community, such as pollinators)*
- *to maintain genetic diversity and long term evolutionary development*
- *for the reintroduction of populations or recovery of the species or ecological community*

Such habitat may be, but is not limited to: habitat identified in a recovery plan for the species or ecological community as habitat critical for that species or ecological community; and/or habitat listed on the Register of Critical Habitat maintained by the Minister under the EPBC Act.

A 'population of a species' is defined under the EPBC Act as an occurrence of the species in a particular area. In relation to critically endangered, endangered or vulnerable threatened species, occurrences include but are not limited to:

- *a geographically distinct regional population, or collection of local populations or*

- *a population, or collection of local populations, that occurs within a particular bioregion.*

** Introducing an invasive species into the habitat may result in that species becoming established. An invasive species may harm a critically endangered or endangered species by direct competition, modification of habitat, or predation.*

***An important population is one that is necessary for a species' long-term survival and recovery. This may include populations that are:*

- *key source populations either for breeding or dispersal,*
- *populations that are necessary for maintaining genetic diversity, and/or*
- *populations that are near the limit of the species range.*

****Introducing an invasive species into the habitat may result in that species becoming established. An invasive species may harm a vulnerable species by direct competition, modification of habitat, or predation.*

#An area of 'important habitat' for a migratory species is:

- *habitat utilised by a migratory species occasionally or periodically within a region that supports an ecologically significant proportion of the population of the species; and/or*
- *habitat that is of critical importance to the species at particular life-cycle stages; and/or*
- *habitat utilised by a migratory species which is at the limit of the species range; and/or*
- *habitat within an area where the species is declining.*

##Listed migratory species cover a broad range of species with different life cycles and population sizes. Therefore what is an 'ecologically significant proportion' of the population varies with the species (each circumstance will need to be evaluated). Some factors that should be considered include the species' population status, genetic distinctiveness and species specific behavioural patterns (for example, site fidelity and dispersal rates).

'Population', in relation to migratory species, means the entire population or any geographically separate part of the population of any species or lower taxon of wild animals, a significant proportion of whose members cyclically and predictably cross one or more national jurisdictional boundaries including Australia.

Summary of the findings of the EPBC Act Assessment

Threatened Flora

There is a small potential for *Eucalyptus glaucina* to occur in the proposed inundation area and it could therefore be subject to possible impact. However, given the presence of numerous records of the species in the study locality and beyond, any local impacts on the species would be very restricted and unlikely to occur to the extent that an important population as defined in the assessment criteria would be placed at risk of extinction. Although unlikely to occur, *Marsdenia longiloba* would be restricted to the areas of rainforest or moist gully forest that would be practically unaffected by the proposal. No significant impact is therefore expected on threatened flora species listed under the Act.

Threatened Fauna

Listed endangered species with some potential to occur are the regent honeyeater, spotted-tailed quoll and swift parrot however records exist within the locality for only the spotted-tailed quoll.

Of the listed vulnerable threatened fauna only the grey-headed flying-fox was recorded. This species is unlikely to be significantly impacted by the proposal as although foraging habitat would be lost this would be compensated for by the proposed revegetation of land above the high water level. In addition, the species forages over a large area and vast tracts of forested land occur to the north and east of the study area. Additional vulnerable species with limited potential to occur are the large-eared pied bat, long-nosed potoroo and stuttering frog.

Most impact is likely to occur on the sedentary species, in this case the stuttering frog. Whether the stuttering frog occurs in the study area is currently unknown however based on the disturbed nature of the available habitat and lack of records it is considered that the chance of occurrence is low. As the likelihood of this frog species occurring is limited, if a population did exist, the proposal would not have a significant impact on that population based on the EPBC Act criteria. One of the reasons for this conclusion is that the small, isolated remnants of suitable habitat do not represent important habitat as described in the criteria. In addition, the long term survival of the species within the remnant habitats cannot be guaranteed therefore the population is unlikely to be classed as important as defined in the criteria.

With regards to the remaining threatened species it is considered unlikely that a significant impact would occur on any local population, should one occur within the study area. The reasons for this assumption relate to the large home range exhibited by most of the species and the general disturbance and modification to the existing vegetation within the inundation area.

Migratory Species

Five migratory species listed on the Commonwealth EPBC Act were recorded within the study area during the field surveys, the black-faced monarch (Site 9), rainbow bee-eater (Site 5), rufous fantail (Sites 12 and 14), white-bellied sea-eagle (Site 4) and white-throated needletail (Sites 14 and 15). Habitat for an additional eight species, the cattle egret, great egret, painted snipe, Latham's snipe, regent honeyeater, satin flycatcher and spectacled monarch, are predicted to occur within the study locality based on EPBC habitat modelling. The regent honeyeater has already been discussed above as it is also listed as endangered.

As no important habitat for migratory species was identified and an ecologically significant proportion of the population of a recorded migratory species was not observed, the proposal is considered unlikely to have a significant impact on migratory species according to the EPBC Act criteria.

Ramsar Sites

Hunter Estuary Wetlands occur directly downstream from the subject site (see **Table 5**). The Ramsar site could therefore potentially be affected by runoff from the proposal, but given the long intervening distance there is a considerable buffer between the subject site and the wetland and consequently any impacts are unlikely.

The Myall Lakes Ramsar site is not downstream from the subject site and would not be affected.

Key Threatening Processes

Seventeen key threatening processes have been finally determined under the EPBC Act. Eight of these could be potentially relevant to the proposal and are discussed below:

1) Competition and land degradation by feral Rabbits

The proposal is unlikely to increase the incidence of this key threatening process within the study locality.

2) Dieback caused by the root-rot fungus (*Phytophthora cinnamomi*); and
3) Infection of amphibians with chytrid fungus resulting in chytridiomycosis

The proposal could potentially result in *Phytophthora cinnamomi* or chytrid fungus being transported into or out of the study area on boots, machinery, tools and vehicles if appropriate controls were not adopted.

4) Land clearance

The proposal is expected to result in the clearing of 223 hectares of native vegetation and the loss of a large number of scattered paddock trees within the inundation area.

5) Loss of climatic habitat caused by anthropogenic emissions of greenhouse gases

The proposal is expected to result in the emission of greenhouse gases from rotting vegetation, the use of vehicles and other machinery and the loss of vegetation associated with the proposal. However the proposal also includes measures to off-set these emissions.

6) Predation by feral Cats; and
7) Predation by the European Red Fox (*Vulpes vulpes*)

The proposal is unlikely to increase the incidence of these key threatening processes within the study locality.

8) Predation, Habitat Degradation, Competition and Disease Transmission by Feral Pigs

The proposal is unlikely to increase the incidence of this key threatening process within the study locality.

Conclusions based on EPBC Act Assessment

This assessment indicates that the proposed action is unlikely to result in a significant impact on any matter of National Environmental Significance as described in the EPBC Act. During the preliminary assessment, the stuttering frog species was identified as a subject species of concern, however additional expert advice has determined that the available habitat within the project area for this species is limited and any impacts would not be significant based on EPBC assessment criteria.

Consequently, it is considered that the proposal would not constitute a 'controlled action' on terrestrial flora and fauna issues under the EPBC Act. However given the size of the project and the extent of both terrestrial and aquatic habitat likely to be affected, it is suggested that the Hunter Water Corporation refer the proposal to the Department of the Environment, Water, Heritage and the Arts (DEWHA). Ultimately it is the Federal Minister of the Environment, Water, Heritage and the Arts who decides whether a proposal represents a 'controlled action'.

4.6 State Environmental Planning Policies (SEPPs)

4.6.1 SEPP 44 – Koala Habitat Protection

SEPP 44 was implemented on the 13th of February, 1995, with the reasoning that the current known distribution of the koala in NSW is fragmented, with most colonies appearing to be small and isolated. Many of these populations are in locations that are under increased pressure from habitat loss or modification, predation and exposure to drought, disease and bushfire. These facts are the reason for the koala being listed as 'Vulnerable' in Schedule 2 of the Threatened Species Conservation Act, 1995.

In order to determine the importance of the available habitats to the koala the following considerations need to be assessed:

a) identification of "potential koala habitats" within the proposed development area; if the total tree cover contains 15% or more of the koala food tree species listed in Schedule 2 of SEPP 44 then it is deemed to be "potential" koala habitat;
b) identification of "core koala habitat" within the development area. "Core koala habitat" is defined as an area of land with a resident population of koalas, evidenced by attributes such as breeding females (females with young), recent sightings and historical records of a koala population;
c) identification of "core koala habitat" would require that a plan of management must accompany the DA application;
d) if the rezoning of lands, other than to environmental protection, involves potential or core koala habitat then the Director of Planning may require a local environmental study be carried out.

In order to decide whether habitat within the subject site represents "potential" or "core" Koala habitat as defined under SEPP44, a combination of targeted surveys and visual assessment of the percentage of Koala food tree species present on the subject land was carried out. Koala food tree species were identified as those listed in Schedule 2 of SEPP 44.

Schedule 2 Feed Tree Species (SEPP 44):

Scientific Name	Common Name
Eucalyptus tereticornis	Forest red gum
Eucalyptus microcorys	Tallowwood
Eucalyptus punctata	Grey gum
Eucalyptus viminalis	Ribbon or manna gum
Eucalyptus camaldulensis	River red gum
Eucalyptus haemastoma	Broad-leaved scribbly gum
Eucalyptus signata	Scribbly gum
Eucalyptus albens	White box
Eucalyptus populnea	Bimble box/poplar box
Eucalyptus robusta	Swamp mahogany

The koala was recorded at Sites 3, 4, 12 and 14 during the field surveys. One preferred food species, *Eucalyptus tereticornis* (forest red gum), was recorded during the field surveys. The forest red gum was recorded in moister vegetation within the subject site (including gullies, lower slopes and riparian zones) and constitutes greater than 15 percent of the total tree cover in many of these areas.

One tree species known to be a secondary koala food tree species, *Eucalyptus moluccana* (grey box), was also recorded during the field surveys and koalas are likely to be utilising other tree species within the study area.

Given the results of the field surveys, most vegetation within the subject site represents either core or potential koala habitat according to the SEPP 44 definitions. This includes larger patches of remnant vegetation (e.g. Tillegra TSR) as well as predominantly cleared areas containing scattered trees. In order to meet the requirements of SEPP 44 under Part 4 of the EP&A Act a koala plan of management is usually needed to be prepared. However, although SEPP 44 is not relevant in the case of this Part 3A proposal, it is recommended that the koala be taken into account with regards to habitat regeneration programs (plant or encourage the growth of known food trees in the proposed wildlife corridors) and traffic management at any identified crossing places on the new road alignment.

4.7 Locally Significant Fauna Species

Given the level of vegetation clearing for agriculture within the study area it could be argued that much of the existing native fauna, particularly mammals and reptiles, are locally significant, as they would primarily exist in the remaining remnants of natural or modified habitat. However, some of the remnants that occur above the high water level of the proposed dam would still be capable of supporting most of the species encountered during the field surveys. In addition, large tracts of natural habitats, albeit modified to varying degrees by forestry, occur within State Forests and National Parks to the north and east of the study area.

Within the study area, the species at most risk are the aquatic mammals, the platypus (*Ornithorhynchus anatinus*) and water rat (*Hydromys chrysogaster*) as they are dependant on the permanent flowing water in the Williams River. Although this report deals with terrestrial fauna, these species are included here as they either occupy burrows and/or forage (water rat) in the riparian zones of streams. These species are the only mammals which utilise aquatic and the adjacent riparian habitats in Australia. The water rat is also found in New Guinea but the platypus is unique to Australia, is an icon species and is of world-wide scientific importance as being one of the few surviving species of a previously more diverse egg-laying group of mammals (the Monotremes).

Neither species is listed as being threatened within the Schedules of the NSW TSC Act or Commonwealth EPBC Act. Based on the currently used International Union for the Conservation of Nature (IUCN) criteria both the platypus and water rat are currently classified as a species "of least concern". Despite the fact that the platypus is quite common in lots of places where it does occur, the Australian Platypus Conservancy is uneasy about the general idea that the species is a common one and therefore not of concern. The status of the water rat is poorly known as it is difficult to observe and little research on wild populations has been carried out.

Platypus (*Ornithorhynchus anatinus*)

During the field surveys, two platypuses were observed foraging in pools of the Williams River in the vicinity of the Tillegra road bridge. Residents along the river also report observing platypuses and it is expected that individuals forage along the whole length of the study area and beyond.

The exact size of the platypus population within the inundation area is currently unknown. Studies on other rivers have shown that on average, 1-2 platypuses per kilometre of river length is normal (The Australian Platypus Conservancy, 2008). On this basis, it is estimated that the proposal will directly affect about 40 platypuses in total.

Ecology

The platypus is a small-medium sized egg-laying mammal with males averaging 1700 g in weight and 50 cm in length and females 900 g in weight and 43 cm in length (Grant, 2007). It is adapted for aquatic life by possessing webbed feet, excellent fur insulation and a specialist sensitive bill by which it detects and catches prey from the beds of a variety of water bodies in which it is found. Platypuses feed on benthic macroinvertebrates, particularly insect larvae, freshwater shrimps and crayfish. The composition and percentage of food items changes with the season (Grant, 2007). Several studies have indicated that pools greater than one metre and no more than five metres in depth are preferred by platypuses (Bethge *et al.* 2003; Grant 2004; Rohweder, 1992; Bryant, 1993; and McLeod, 1993) but adjoining shallower riffle areas appear to also be important feeding areas (Grant, 2007). A varied substrate of gravel, pebbles, cobbles, rocks, submerged logs and overhanging streamside vegetation are important for the supply of sufficient food items however areas of fine gravel, silt and mud appear to be less commonly utilised for foraging (Grant 2004, Rohweder, 1992 and Serena *et al.*, 2001).

Platypuses can be active at any time of the day, particularly during winter, however, most activity occurs at night. When not active the platypus shelters in a burrow situated in the river bank. The entrance is usually situated above the water level where the earth banks are consolidated by tree roots. Breeding burrows are usually more elaborate with more than one entrance and side arms to the tunnel which can be up to 30 metres long, although the average is 3-8 metres. Shorter simple nesting burrows may also be used (Grant, 2007).

Mating takes place in August – September and 1-3 eggs are thought to be laid onto the females belly within the breeding nest chamber. The gestation period between mating and egg laying is about 21 days. The female platypus incubates the eggs by curling its body around them for a period thought to be around 10 days. Following hatching the young are fed on milk secreted onto the skin of the abdomen. The young stay in the nest for 3-4 months and the female is thought to seal up the tunnel with soil when entering and exiting to feed. In NSW young emerge from the burrow in late January – March and are approximately two thirds the weight of adult animals. The breeding events vary within populations and dependent young may be found in burrows between mid-September and mid-March in NSW (Grant, 2007).

Potential Impacts on the Platypus Resulting from the Proposal

Significant impacts on platypus have been identified to occur upstream and downstream of the proposed dam wall and these are listed and discussed.

Upstream Inundation Area

Platypuses are seldom found in the deep waters of impoundments and are normally restricted to their headwaters (Grant 1991). As a result, the proposed impoundment would make approximately 19.2 kilometres of the Williams River and parts of its larger tributaries largely unsuitable for occupation by platypuses and the impoundment and dam may represent a barrier to normal breeding and foraging movements by adults and to the dispersal of juveniles. Little is known of these aspects of the species' breeding biology.

The inundated section of the river would become unsuitable for occupation by platypuses as a result of the following:

- Loss of burrows

The existing burrows along the Williams River would be lost as the water rises. This is likely to result in the loss of young in the burrow if these are inundated during the season in which dependent young are being fed by lactating females (3-4 months during the period of mid-September to mid March in New South Wales) and the possible displacement of adults over a long period of time. It is expected that the full water level would not be reached for many years and therefore a series of new burrows would need to be constructed over time as the water level rises. Large jumps in water levels are expected to occur after major rainfall events which could be at any time of the year. Given the cleared nature of much of the ground cover and the gentle slope, suitable sites for the construction of burrows are expected to be very limited. Therefore the recruitment of young platypuses over the inundation period may not occur although there may be some dispersal into the dam from upstream of the inundation area. Recruitment to the impoundment from downstream is unlikely due to the dam wall acting as a barrier. Platypuses would move overland around obstacles but are quite prone to predation, particularly by foxes, while moving on land.

When the dam reaches full capacity it is expected that platypuses could forage along the edges of the impoundment, particularly in the side arms of entering creeks such as Quart Pot Creek, Native Dog Creek, Black Camp Creek, Sheep Station Creek and Taylor's Creek. However, the ability to construct stable, permanent burrows would still depend on the presence of riparian vegetation and a suitable substrate, which is limited by shallow soils over a rocky substrate and the gently-sloping nature of much of the fringe of the inundation area. It has been estimated that the shoreline at full supply level would be approximately 125 km long.

- Alteration of foraging areas

The Williams River currently provides ideal foraging areas for the platypus as the river bed generally consists of gravels, pebbles, cobbles and larger rocks and there is a combination of deep pools and shallower riffle areas. Based on the aquatic survey results (The Ecology Lab 2008) the diversity and abundance of available platypus food items (larvae of caddisflies, dragonflies, mayflies, and some crustaceans, e.g. freshwater shrimps) appears to suggest that foraging habitat is currently good. As the water depth increases beyond five metres the impoundment would become increasingly unfavourable as platypus foraging habitat for the following reasons:

- The aerobic capacity of the platypus is less than 1 minute and maximum foraging dive just over 2 minutes. As a result, diving to depths of greater than 5 metres to utilise very small macroinvertebrate food items is energetically extremely demanding for the platypus.

- The low temperature of the deep water increases the metabolic demand of the platypus to regulate its body temperature.

- Lower benthic productivity of cold water with low oxygen saturation at the bottom of the impoundment.

- Over time, the inflow of sediments to the impoundment may further reduce foraging by platypuses, which favour coarser substrates. However sediment levels are predicted to be low.

- Wave action due to wind often produces severe erosion of foreshores in impoundments, especially in those where water levels fluctuate as the storage is drawn down during demand and refilled by rain events.

- Such erosion can have an adverse affect on the productivity of macroinvertebrate food species along the lake margins. Outside of drought conditions, it is intended to keep the water level between 90% and the full supply level. This would result in a difference in water levels of approximately 1.8 metres.

- Potential increase in predation

The entrances to burrows are usually situated just above the normal water level. The full water level in the dam is expected to fluctuate depending on the demand for water. Therefore some burrows may end up some distance from the waters edge, increasing potential predation by the European red fox (*Vulpes vulpes*) and feral and domestic dogs. Larger birds of prey such as the wedge-tailed eagle (*Aquila audax*) and possibly the white-bellied sea-eagle (*Haliaeetus leucogastor*) could also prey on platypuses if they leave their burrows before dark and are required to travel over land.

Downstream of the Dam Wall

The reduction in downstream flows along the Williams River has the potential to have multiple effects on the current platypus habitat. The following impacts were identified for previous dam projects (Tallowa Dam, LesryK Environmental Consultants, 2006).

- Siltation of the river bed if there are insufficient flows to periodically flush out the river bed would decrease foraging areas and reduce the water depth.

- The loss of refuge pools if water levels become too low, particularly during drought.

- Changes to food availability through the loss of riffle areas and if the temperature of water released from the dam is too low. Platypuses foraging in cold water would require an increased food intake.

- Potential increase in predation could occur if a platypus is required to travel over land from their burrow to reach suitable foraging pools.

Mitigation Measures

Upstream Inundation Area

As can be deduced from the likely impacts discussed above, mitigation measures upstream of the dam are extremely limited.

- Habitat restoration along the high water level of the dam is recommended. The placement of semi submerged logs and planting riparian vegetation along sections of the lake bank could assist in bank stabilisation and allow burrow construction in the future. The side arms of the creeks entering the dam where steep earth banks occur would be the best place to target any such habitat restoration for the platypus. The creation of cobbled rocky areas where natural stream flows enter the storage may also be beneficial, however in still water areas such structures are more likely to become covered in silt.

Downstream of the Dam

- A release strategy for environmental flows and bulk water transfers is being prepared. This strategy should take into account the maintenance of a series of pools and riffles downstream of the dam, thus preserving connectivity between pools for movement and foraging by platypuses.

It has been predicted that scouring of the river bed would occur, particularly in the section below the dam wall if large flows are released from the dam. This has the potential to remove the gravel and cobbles leaving only the larger boulders which could change the composition or reduce the macro invertebrate food availability for the platypus. Such flows could also cause erosion of the river banks, flooding of burrows (especially in the breeding season) and increase metabolic demands on platypuses swimming against high water flows. It is proposed to release up to 1500 ML/day for drought period transfers to Seaham Weir. This is considered to be a low flow rate for the size of the river and is considered unlikely to cause bank erosion. It is also predicted that these flows will result in increased riparian and in–stream vegetation which would improve habitat for aquatic fauna (Gippel and Anderson 2008). Larger flow have been identified as important for cleaning fine sediments and heavy biofilms of gravel surfaces and these would inundate riffles and gravel bars (Gippel and Anderson 2008). As larger flows may flood platypus burrows it is suggested that they only be made if they mimic natural flow durations for which, the platypus should already be capable of tolerating. If non natural flows with a significant rise of overall water levels are released, particularly if these are of extended duration, these releases should be timed outside of the breeding season which occurs during the period of September – March.

- Include facilities in the dam to permit control of the temperature, oxygen saturation and chemical quality of the water released from the dam. It is proposed that the water offtake tower would be designed to allow water to be drawn off at a range of levels in order to best suit the downstream water quality and avoid the identified impacts.

- Rehabilitate any riparian vegetation damaged during construction work.

- Maintain and enhance the riparian vegetation further down stream, particularly in the vicinity of permanent pools and riffle areas.

Australian water rat (*Hydromys chrysogaster*)

Although the water rat was not recorded during field surveys, it is expected to occur in the larger pools of the Williams River and in the larger farm dams.

The water rat is a large native rodent weighing up to over 1000 grams (average 700 grams). It is a carnivorous species mainly feeding on aquatic items such as large insects, fish, crustaceans and shellfish, although birds' eggs, waterbirds, frogs, lizards and small mammals are sometimes taken, particularly in winter when less time is spent in the water (Olsen, 1995). In inhabits both freshwater and marine habitats and nests in burrows or hollow logs, with burrows running parallel to the river bank. Regular tracks are used along the river bank and middens of prey remains are often deposited on flat rocks near the waters edge (Watts and Aslin, 1981). The water rat tends to be more terrestrial than the platypus and studies have shown that it is a poorer thermoregulator in water (Fanning and Dawson, 1980) and therefore tends to carry out short foraging trips and the resulting catch is consumed on land.

Females start to breed when about eight months old and after a gestation of about 34 days three to four young are born. The young are weaned after four weeks however the fur does not become waterproof until they are two to three months old. The main breeding season is between spring and late summer and up to five litters can be born each year, although one or two litters tends to be more normal (Olsen, 1995).

With regards to the proposed Tillegra Dam, the impacts on the water rat are unlikely to be as great as those identified for the platypus. The reasons for this assumption are that the water rat is more terrestrial than the platypus, has a higher birth rate and it forages on a wider range of prey species, including terrestrial vertebrate species. The local population would still suffer a loss of shelter burrows, which could affect breeding success and a reduction in aquatic prey once the dam reaches a depth greater than ten metres. A lack of cover on the edge of dam during and after inundation may lead to increased predation from birds of prey, foxes and cats.

The same ameliorative measures suggested for the platypus would also apply to the water rat.

4.8 Riparian Vegetation Assessment downstream of the Tillegra Dam wall to Seaham Weir

In order to identify any impacts on riparian habitats as a result of the predicted changes to existing flow regimes downstream of the proposed Tillegra Dam wall an assessment of the existing vegetation and any likely impacts on these habitats has been carried out.

The riparian vegetation along the Williams River has been identified as comprising two Endangered Ecological Communities (EEC). The following communities have been identified within the study area:

- River-Flat Eucalypt Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions.
- Subtropical Coastal Floodplain Forest of the New South Wales North Coast Bioregion.

The subtropical coastal floodplain forest only occurs as small linear remnants at two isolated locations within the inundation area where it intergrades with the river-flat eucalypt forest. However similar habitat occur on the northern extremities of the inundation area along Moolee Creek and similar habitats are expected to occur downstream of the dam wall.

Habitat Assessment

An assessment of the habitat type and general condition of the vegetation has been carried out at selected locations along the Williams River between Tillegra Bridge and the Seaham Weir. Note that not all of the river could be assessed as a result of limited access. For convenience the study area has been divided into the following sections. A broad description of the habitat in each section is given.

1) Tillegra Bridge to the Chichester River Junction

This section is dominated by the *Casuarina cunninghamiana* (river oak) and occasional *Backhousia myrtifolia* (grey myrtle) within the river channel and banks with scattered eucalypts, mainly *Eucalyptus tereticornis* (forest red gum), occurring on top of the river banks in predominantly cleared pasture. The vegetation for the first 2 km downstream from Tillegra Bridge is generally sparse and in poor condition however the quality improves as it progresses to the Chichester River junction where old growth river oaks occur. The riparian strip is generally narrow and bordered by cleared grazing land for the length of the section.

Riparian habitat downstream from Tillegra Bridge

Example of sparse riparian habitat near the proposed Salisbury Road deviation

2) Chichester River to the Fosterton Road Bridge

Tall river oaks dominate the vegetation at George Dowling Bridge at Bandon Grove. The river oaks appear to dominate until about 500 m from the Fosterton low level bridge where the vegetation changes to moist rainforest habitat dominated by *Waterhousea floribunda* (weeping myrtle). Again the riparian strip is generally narrow and bordered by cleared grazing land for much of the length of the section, although there is some connectivity with forest remnants between Fosterton Hill and the low level bridge. When the vegetation changes from being dominated by river oaks to more rainforest elements, the EEC would be Subtropical Coastal Floodplain Forest rather than River-flat Eucalypt Forest on Coastal Floodplains. All natural riparian vegetation downstream from the proposed dam wall would be an EEC.

Looking down Chichester River to the Williams River junction

3) Fosterton Bridge to Dungog Bridge

Waterhousea floribunda (weeping myrtle) continues to dominate on the western bank of the river, downstream of the bridge for about 200 m where the vegetation changes back to river oak dominance. The vegetation alternates between the two communities until the moist forest becomes more dominant closer to Dungog. The riparian strip is generally narrow and bordered by cleared grazing land for much of the length of the section. In-stream vegetation consisting of river oak, *Callistemon* sp. (bottlebrush) and *Lomandra longifolia* (spiny mat rush) occurs on gravel bars downstream of the bridge (see photograph below)

In-stream vegetation at Fosterton Bridge showing rainforest habitat on the western bank

4) Dungog to Clarence Town

Waterhousea floribunda (weeping myrtle), *Tristaniopsis laurina* (water gum) and associated moist eucalypt forest appears to be dominant as a low forest strip over much of this section of the river. Again the riparian strip is generally narrow and bordered by cleared grazing land for much of the length of the section except for connectivity to bushland for approximately a 1 km stretch north of Glen William.

Moist riparian habitat at Thalaba Bridge, Waimarama

Large pools and a well established riparian strip are a feature at Glen William Bridge

5) Clarence Town to Seaham Weir

Moist riparian eucalypt forest with rainforest elements is dominant at Clarence Town with the riparian strip much reduced as it passes through agricultural land. The river oak is replaced by *Casuarina glauca* (swamp oak) and *Allocasuaria torulosa* (forest oak) around Clarence Town. The cross over point was not determined but is expected to occur at the former tidal limit at Mill Dam Falls north of Clarence Town prior to the construction of Seaham Weir in 1968 and sealing in 1978 which changed the weir pool from brackish to freshwater. The swamp oak becomes more dominant as the river approaches Seaham Weir, below which is the current limit of salt water.

Seaham Weir

Predicted Impacts

Most impact to the river channel has been predicted to occur between the dam wall and at least the junction with the Chichester River, 5 km downstream from the dam wall, although over time impacts may occur as far as Glen Martin. Impacts on the river channel downstream from the proposed dam wall that were identified in the fluvial geomorphology report (Gippel and Anderson 2008) are:

- Altered frequency, duration and timing of flows capable of maintaining an open channel resulting in stable substrate with a denser in-stream vegetation cover.
- Reduced sediment transport along the river as it would be trapped by the dam wall. This would result in the scouring of the river bed as new material would not be available as a replacement. This could result in only coarse river bed material and a deepening of the channel.
- Increased water clarity and lower nutrient concentration, particularly during minor to moderate flood events.
- Altered hydrology with features such as bars, benches, floodplains and wetlands being less frequently inundated. The vegetation on these features may become more terrestrial and the opportunity to flush carbon and propagules into the river would be reduced.
- All these issues need to be taken into account for the filling phase, normal operation and drought operation as the outflow requirements would be different for each event.

Discussion

Based on this assessment and a cursory inspection of the habitats below Chichester Dam, it would appear that there would be little impact on the existing riparian vegetation below the proposed Tillegra Dam wall. The riparian vegetation along the Chichester River was noted to be intact between the road bridge at Dusodie, 4 km downstream from the dam wall, and the junction with the Williams River. The river passes through forested land between the dam wall and Dusodie bridge

however the condition of the vegetation was not viewed as the access road was closed for road repairs. Large pools and riffle areas, ideal habitat for the platypus, were also noted to occur at Dusodie and Bandon Grove.

It has been predicted that there would be an increase in riparian vegetation within the river channel as a result of the likely reduction of the high level flows that currently clean out the channel. Gippel and Anderson (2008) have suggested that in-stream vegetation be left in place as it provides stability to the stream bed and may reduce the level of scouring in these areas. Partially submerged vegetation would also provide shelter and foraging sites for aquatic fauna.

Sections of the riparian habitat immediately below the proposed dam wall are currently sparse and degraded for at least 2 km however there is the potential for the regeneration of riparian vegetation in the area between the dam wall, spillway, dam access road and Salisbury Road deviation as part of the proposed fauna habitat corridor.

All the riparian vegetation below the proposed dam wall consists of an endangered ecological community. The same two communities that were identified in the study area above the dam wall occur however there are some changes to the species composition and frequency of each community.

The *River-Flat Eucalypt Forest on Coastal Floodplains* is dominated by the river oak plus some forest red gums further up the bank in limited areas and makes up most of the riparian habitat within the inundation area. It extends from below the proposed dam wall to near the Fosterton Bridge where it is partially replaced by *Subtropical Coastal Floodplain Forest* and occurs as sporadic sections to just north of Clarence Town. At this point the river oak is replaced by the swamp oak and to a lesser extent the forest oak due to the past saline influences above Seaham Weir. Eucalypts are also more common within the riparian habitats of this EEC.

The *Subtropical Coastal Floodplain Forest* is uncommon within the inundation area, with the largest section being approximately 1.5 km long at 'Underbank'. However below the dam wall it is the dominant vegetation type between Fosterton and Clarence Town with *Waterhousea floribunda* (weeping myrtle) and *Tristaniopsis laurina* (water gum) being dominant. Above the proposed dam wall the dominant species were identified as *Backhousia myrtifolia* (grey myrtle) and *Acmena smithii* (Lillypilly) and eucalypts however these species also occur below the proposed dam wall in both EECs.

5.0 CONCLUSION

This flora and fauna assessment for the proposed dam at Tillegra has been prepared based on a combination of literature review and field surveys within the study area. The assessment process has taken into account the Director General's requirements and the Guidelines for Threatened Species Assessment for Part 3A of the *Environmental Planning and Assessment Act 1979*.

The subject site provides known habitat for a number of threatened species and endangered ecological communities and potential impacts on these species and communities have been assessed under the relevant legislation.

Field surveys resulted in a total of 315 flora species from 100 families have been identified. This total includes 21 ferns, 220 dicotyledons and 73 monocotyledons. Of the total species recorded, 78 species of exotic flora were identified, representing approximately 25% of the total species. With regards to fauna, a total of 157 fauna species were positively identified during the field surveys (comprising 95 bird, 32 mammal, 16 frog and 14 reptile species). A further five species of insectivorous bat were given a probable identification and two species given a tentative (possible) identification based on ultrasonic call analysis. Six of the species recorded, the black rat, brown hare, common myna, dog, house mouse and rabbit, are introduced species.

Considering the agricultural land use of the study area the terrestrial biodiversity is regarded as being high and probably reflects the large size of the study area, the diversity of habitats within naturally vegetated remnants as well as the cleared paddocks, particularly where scattered habitat trees occur.

With regards to the Director General's requirements for this proposal the following items are relevant to the terrestrial biodiversity.

1. **Impacts on any critical habitats, threatened species, populations or ecological communities listed in State or Commonwealth legislation and recorded within and around the project area.**

In terms of flora, no threatened species or endangered populations have been recorded during field surveys. However a low potential for threatened species or an endangered population to occur in small or very limited areas not surveyed still remains. If present, no significant impact is expected on any of these species or populations due to the proposal as known populations occur outside of the study area.

The study area has been found to contain two endangered ecological communities (EECs) plus small areas of one intergrade EEC that are listed by the NSW TSC Act. Most of the riparian vegetation along the river appears to be the EEC *River-flat Eucalypt Forest on Coastal Floodplains* with small elements of embedded *Subtropical Coastal Floodplain Forest*. Most of these EECs in the study area would be inundated by the proposal (estimated 145 ha), and therefore the local impacts would be substantial (estimated 22.5% loss) but at the regional level the proportion of the EEC affected would be minor (estimated 0.7% loss). Additionally, a greater abundance of the EEC probably occurs locally than estimated by the regional mapping (NPWS 1999). As this EEC is unlikely to regenerate above the high water level of the proposed dam (a drier open forest is most likely to occur) any offsets would need to be carried out by the restoration of riparian habitat upstream and downstream of the inundation area. This would be required in order to fulfill the like-for-like or better conservation outcome expected for the creation of offsets (DECC 2007b).

The adoption of this strategy could mean that less funding would be available for the creation of the proposed fauna corridors above the expected high water level thus resulting in a reliance on the occurrence of natural revegetation. As this land would not be owned by the Hunter Water Corporation any revegetation proposal would need to be carried out with the permission of land owners in these areas.

It is considered unlikely that the existing riparian habitat downstream of the proposed dam wall will be impacted upon by the proposal. It is possible that there will be an increase in riparian vegetation, particularly within the river channel, as a result of changes to flow regimes.

Small patches of subtropical rainforest that qualify as the EEC *Lowland Rainforest* occur in moist, sheltered gullies in parts of the study area. A small area (approximately 0.2ha) of this EEC may be affected by construction of the proposed Salisbury Road deviation both at the local and regional levels.

The potential presence of the EECs *Lower Hunter Spotted Gum – Ironbark Forest* and *Hunter Lowland Redgum Forest* has been ruled out by the underlying geology (being Carboniferous rather than of Permian origin), although the species composition of two communities in the study area bears a superficial resemblance to these EECs.

With regards to threatened fauna, eight species, the speckled warbler, eastern bent-wing bat, east-coast freetail-bat, southern myotis, squirrel glider, brush-tailed phascogale, koala and grey-headed flying-fox, were positively identified within the study area during the survey period. Two additional species, the eastern false pipistrelle and greater broad-nosed bat, were given a probable identification based on ultrasonic call analysis and one species, the golden-tipped bat, was tentatively identified from a poor, short ultrasonic call. A number of other threatened fauna species have potential to occur within the study area as suitable habitat occurs. All of the above species are listed as vulnerable in Schedule 2 of the NSW TSC Act. With regards to the Commonwealth EPBC Act, only the grey-headed flying-fox is listed as vulnerable within the Act.

No listed critical habitats or endangered populations of fauna were recorded or are expected to occur within the study area.

The main potential impacts associated with the proposal are the loss of habitat and potential movement corridors (particularly along the Williams River). Areas of important fauna habitat features, including winter-flowering tree species, riparian habitat and hollow-bearing trees will be reduced in the local region. The proposed natural regeneration of habitat and tree planting would help to alleviate some of these losses in the longer term however it would take 100+ years for replacement tree hollows to form. Over time the proposed revegetation works around the perimeter of the dam would substantially increase the area of available fauna habitat when this is compared to the existing habitat.

Threatened fauna species most likely to be impacted by the proposal are those known or likely to breed within the study area. Such species include the brush-tailed phascogale, east-coast freetail-bat, koala, southern myotis, speckled warbler and squirrel glider. Additional species have some potential to forage and possibly breed within the study area, including the glossy black-cockatoo, golden-tipped bat, hollow-roosting bats, spotted-tailed quoll, stuttering frog, threatened forest owls and threatened woodland birds. For those species that do occur and breed within the study area, the loss of habitat is likely to result in a corresponding decline in population numbers. Ameliorative measures such as replanting and rehabilitation of cleared land would assist in mitigating impacts for some of these species, particularly if corridor links are formed.

With regard to the stuttering frog, the small areas of potential habitat are already isolated by long stretches of unfavourable riparian habitat. The probability of the species occuring is also considered to be low given the isolation of the habitat remnant, the clearing of much of the vegetation for agriculture and past riverbank and snag removal works (Biosphere 2008 in **Appendix 8**). On a pre-cautionary basis it is assumed that individuals actually occur within the inundation area, however overall, due to the limited habitat area, impacts cannot be considered as significant for the species.0

A number of threatened fauna species are reliant upon hollow-bearing trees for roosting and breeding purposes. Given the large land area likely to be flooded or cleared as a result of the proposal, it is expected that a large number of hollow-bearing trees would be lost, thus removing potential roosting and breeding hollows for threatened fauna.

The southern myotis is likely to roost under bridges and culverts within the study area and there is potential for a breeding colony to occur (particularly under the Tillegra Bridge). The eastern and little bent-wing bats could also potentially roost in these areas, although no breeding habitat for these species occurs within the study area. The installation of artificial roosts under new and unaffected bridges further downstream would assist in ameliorating the impacts on microbat species. Individuals could potentially be killed if a bridge or culvert containing roosting bats is destroyed or removed. If a breeding colony of the southern myotis does occur under Tillegra Bridge the proposal would result in the loss of that colony. The bat management plan provided in **Appendix 7** of this report aims to address and ameliorate against these potential impacts.

No known camp sites for the grey-headed flying-fox are likely to be affected as a result of the proposal, though this species could form temporary seasonal camps in rainforest pockets or riparian vegetation within the study area. Some foraging habitat for the grey-headed flying-fox is likely to be lost as a result of the proposal, including important winter-flowering trees. The loss of winter-flowering trees may also affect other species, such as the swift parrot and regent honeyeater. The loss of this foraging habitat is unlikely to have a significant impact on the local population of any of these species however it would reduce the availability of foraging habitat within the study locality. However, over time, the proposed natural regeneration of habitat and tree planting above the full supply level would more than compensate for any loss of foraging habitat.

2. Impacts on Water Dependent Fauna

Although not part of the terrestrial assessment process, aquatic mammals have been addressed in this report. Although not listed as threatened species, aquatic mammals, the platypus and perhaps, to a lesser extent, the Australian water rat, are likely to suffer most impact as a result of proposal (see **Section 4.6** for detail).

The platypus will be unlikely to survive in the water deeper than 5m and the filling of the dam would result in burrows being progressively flooded. This is predicted to result in no breeding taking place within the inundation area (a 19.2 km stretch of the Williams River) over at least the period of time required for the dam to reach full capacity. Whether populations of platypus will establish along the edge of the resulting dam and within creek side arms is currently unclear as this will depend on the frequency of the fluctuation of the water level due to required water use.

Water flows released downstream of the dam also have the potential to flood burrows and change the food diversity and availability for the platypus, particularly if cold water is released. A release strategy for environmental flows and bulk water transfers is being prepared and is to take into account the needs of the platypus.

3. Impacts on Terrestrial Ecology including details on location, composition, quality and quantity of habitat proposed to be affected

The proposed dam at Tillegra would result in the inundation of 2100 hectares of predominantly cleared land and the clearing of additional areas at the proposed dam wall site and along road routes. The proposal is expected to result in the loss of 223 hectares of native vegetation, mainly consisting of riparian vegetation along a 19.2 kilometre stretch Williams River and various other small creeks and tributaries (see **Table 14** for details). Outside of the larger patches of vegetation, a large number of hollow-bearing trees that occur as scattered trees within otherwise cleared pasture are expected to be lost. Farm dams identified as providing frog habitat will also be flooded.

Vegetation communities are mapped in **Figure 3** and the details of the composition and quality of each vegetation community is shown in **Table 9.**

4. Presentation of framework monitoring programs, management and rehabilitation plans and comprehensive compensatory habitat/biodiversity offset packages to address the impacts on terrestrial ecology associated with the project and taking into consideration the amount and type of habitat that will be lost.

Most of these requirements will be dealt with in the EIA report being prepared by Connell Wagner. Terrestrial ecology and habitat will partly be managed by an Integrated Land Use Plan being prepared by Connell Wagner. An environmental flow strategy is also being prepared by Connell Wagner.

Proposed mitigation measures and suggested recommendations are discussed in **Sections 6 and 7**).

6.0 MITIGATION MEASURES TO BE ADOPTED FOR THE PROPOSAL

The following mitigation measures have been accepted or are proposed as part of the proposal by the Hunter Water Corporation.

1) Given the large area of native vegetation to be cleared or inundated, appropriate offset areas for fauna habitat are to be secured. This is to be achieved by rehabilitating or revegetating currently cleared or degraded Hunter Water Corporation owned land above the full supply level of the proposed dam. It is intended to create a north-south vegetated corridor along the eastern side of the dam and a south-west link from the proposed dam wall to Mount Butterwicki. It is intended to allow natural regeneration of vegetation to take place in designated habitat corridors (see **Figure 6**). Where regeneration is found to be poor revegetation is proposed. It is suggested that priority be given to restoring habitat for threatened species and endangered ecological communities, including the restoration and enhancement of corridor links. The loss of *Lowland Rainforest* (0.2 ha) can be easily offset by allowing regeneration around the edges of existing pockets of the EEC. Offsets for the riparian vegetation are more problematic in that regeneration of this EEC is unlikely around the edge of the proposed dam. Therefore any regeneration/revegetation of riparian habitat upstream or downstream of the dam is likely to be mainly outside Hunter Water Corporation land and any works would be out of their control. The proposed regeneration/revegetation would also be used to offset greenhouse emissions resulting from the proposed dam.

   Regeneration/planting in areas identified as corridor links outside the inundation area, particularly the link between Tillegra Reserve and Mount Butterwicki, should commence as soon as possible. This should include the removal of stock and allow time for trees and shrubs to reach a suitable size to be utilised by species such as the koala, squirrel glider, speckled warbler and brush-tailed phascogale as a corridor link for displaced fauna to safely access similar habitat during clearing activities for the dam wall and associated facilities.

   Flora species recommended for planting in offset and corridor areas are indicated in **Appendix 2**. It is important to include a large proportion of those plant species that provide important food and shelter habitat for threatened fauna species likely to be displaced as a result of the proposal (including koala food trees and winter-flowering trees). These are also indicated in **Appendix 2**.

2) Prior to any clearing in the Tillegra Travelling Stock Reserve, surveys of all hollow-bearing trees should be undertaken. Removal of these trees should be timed to avoid the peak bird and bat breeding season (September – January inclusive). This timing would also cover the period that young brush tailed phascogales would be left in the nest however the squirrel glider can breed over an extended period therefore the complete avoidance of young in a nest would be difficult to achieve.

3) Prior to vegetation clearing nest boxes suitable for known hollow dependant threatened species (brush-tailed phascogale, squirrel glider and insectivorous bats) are to be erected in retained remnants above the high water level, particularly in areas where hollow bearing trees are absent or scarce. This will provide short term shelter (+10 years) for displaced threatened species and allow new territories to be established.

4) During tree removal and vegetation clearing in the Tillegra Travelling Stock Route an experienced and fully equipped wildlife handler is to be present to manage any displaced wildlife. As it is likely that bats will be encountered, handlers must be vaccinated against the bat Lyssavirus as a precaution.

5) In order to avoid the accidental deaths of bats that may be roosting in bridges and culverts (particularly Tillegra Bridge), it is proposed to inspect these structures for roosting bats immediately prior to demolition works. Surveys should also be conducted during the southern myotis breeding season (October to March) although the height of Tillegra Bridge from the river bed makes close inspections impossible without the use of climbing equipment. A bat management plan has been prepared (**Appendix 7**) and will be implemented prior to the exclusion of the bats from the roost. As part of the management plan, it is recommended that artificial roosts suitable for the southern myotis be installed under replacement bridges downstream and upstream of the proposed dam. Monitoring of the outcome of any relocation/exclusion works will also be a part of the bat management plan.

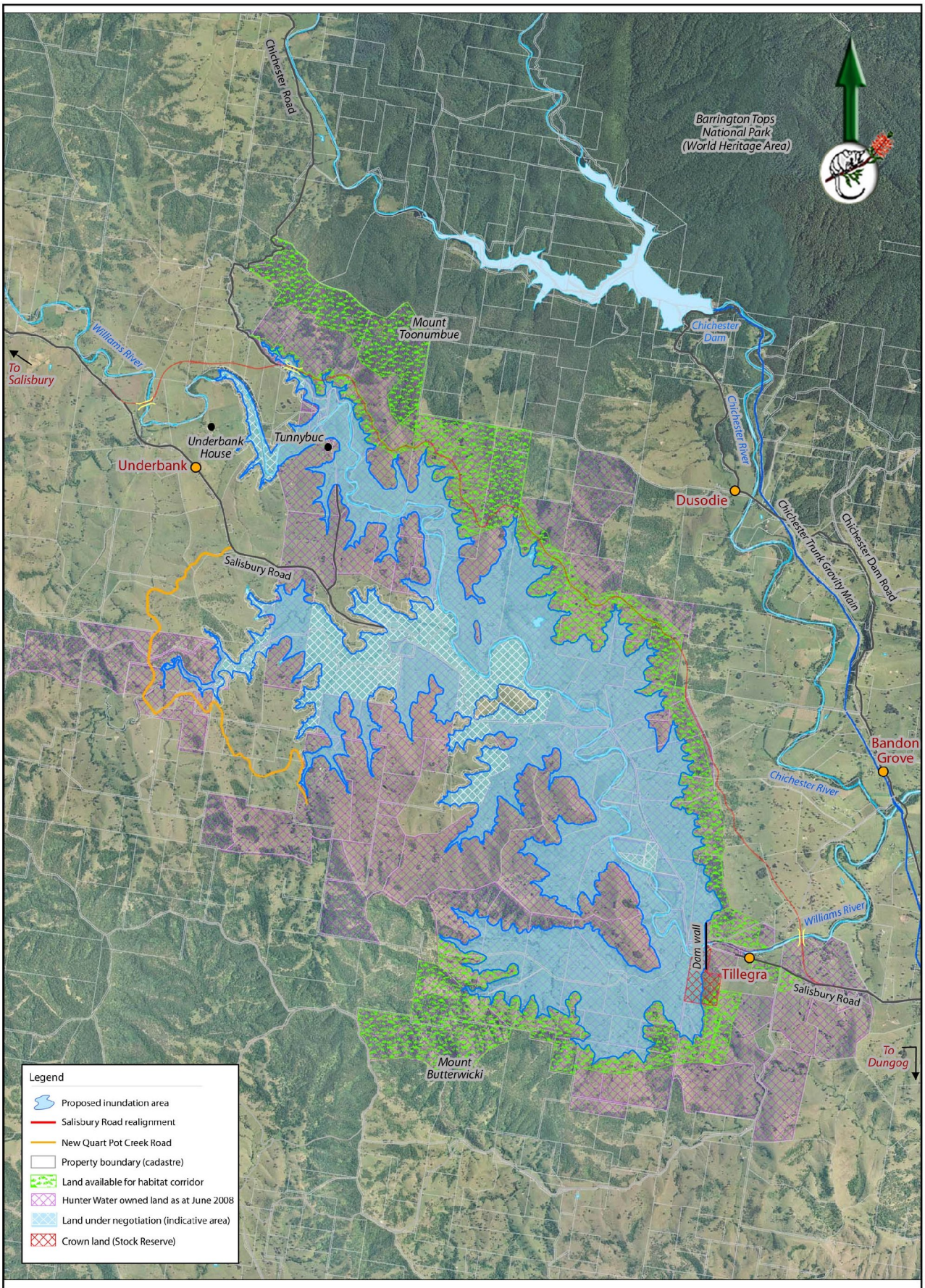
6) Mitigative measures to assist in reducing impacts on the platypus and water rat are to be undertaken as part of the habitat restoration works above the high water level. Recommended measures are discussed in **Section 4.6** and those involving downstream impacts are to be taken into account in a release strategy for environmental flows and bulk water transfers being prepared for the proposal.

7) Current best practice measures are to be incorporated into the dam wall, road and infrastructure designs in order to adequately manage pollution and sediment runoff, including during construction.

8) A weed and feral pest management strategy is to be included in the Integrated Land Use Plan being currently prepared. This is to address the likely impacts associated with invasions of noxious and environmental weeds into disturbed areas not subject to inundation (for example the road deviation and dam wall/spillway areas), or in areas from which cattle grazing is excluded.

9) Protocols to prevent the introduction or spread of *Phytophthora cinnamomi* are to be implemented following DECC guidelines.

10) Protocols to prevent the introduction or spread of chytrid fungus are to be implemented following DECC guidelines.


Chichester Road
Barrington Tops National Park (World Heritage Area)
Mount Toonumbue
Chichester Dam
Williams River
To Salisbury
Underbank House
Tunnybuc
Underbank
Chichester River
Dusodie
Chichester Trunk Gravity Main
Chichester Dam Road
Salisbury Road
Bandon Grove
Chichester River
Williams River
Dam wall
Tillegra
Salisbury Road
To Dungog
Mount Butterwicki
Legend
Proposed inundation area
Salisbury Road realignment
New Quart Pot Creek Road
Property boundary (cadastre)
Land available for habitat corridor
Hunter Water owned land as at June 2008
Land under negotiation (indicative area)
Crown land (Stock Reserve)
0 0.5 1 2 Km
Source: Connell Wagner (2008)
Ecotone Ecological Consultants Pty Ltd
Figure 6. Land Available for Habitat Corridor
Flora and Fauna Impact Assessment: Proposed Construction & Operation of the Tillegra Dam west of Dungog NSW
September 2008

7.0 FURTHER RECOMMENDATIONS

In order to ameliorate impacts of the proposal on the local natural environment, including habitat for threatened species and endangered ecological communities, in addition to the proposed mitigation measures, it is recommended that:

1) Relocate hollow-bearing trees and large fallen timber (particularly logs with hollows) from the inundation area and from dam wall construction site to the planned revegetation areas. While the trees would be on the ground, the hollows they contain may provide valuable habitat for displaced hollow-reliant fauna, including the threatened brush-tailed phascogale. Hollow bearing trees within shallow water on the edge of the dam could be retained for their habitat value. Although these trees will eventually die, tree hollows will be available for many years and these trees would pose little hazard to boating traffic. The trunks would also provide shelter and foraging areas for aquatic fauna, including the platypus.

2) Where ever possible offsets should be implemented "like for like" however it would not be possible to fully offset the loss of the river flat eucalypt EEC habitat within Hunter Water Corporation land as the environment around the full supply level of the dam would be unsuitable. An alternative to the habitat corridor is for HWC to sponsor revegetation works on privately owned river banks, flats and floodplain upstream and downstream of the proposed dam. Should this avenue be followed however, it would take funding away from the proposed north-south and east-west corridors around the dam, which is likely to be of great importance for the retention of the known terrestrial fauna species.

3) A combination of culverts and fauna fencing at any identified potential black spots would assist in minimising the risk of road death for fauna along the proposed Salisbury Road realignment. Wildlife crossing road signs and speed limits could also be used.

4) Because of the known risk to fauna (particularly gliders and flying-foxes) of becoming entangled, barbed wire should not be used in any fencing erected as part of the project.

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9.0 APPENDICES

Appendix 1. EPBC Act Protected Matters Database Report

Australian Government
Department of the Environment, Water, Heritage and the Arts

[ ]

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Environmental Reporting Tool

You are here: Environment Home > ERIN > ERT

30 April 2008 08:40

Database Report

This report includes places of national environmental significance that are registered in the Department of the Environment and Water Resources' databases, for the selected area. The information presented here has been provided by a range of groups across Australia, and the accuracy and resolution varies.

Search Type:	**Point**
Buffer:	**20 km**
Coordinates:	**-32.29440,151.64310**

Report Contents: Summary >> Details >> Caveat >> Acknowledgment

This map may contain data which are
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Biodiversity

Threatened Species:	**20**
Migratory Species:	**15**
Listed Marine Species:	**13**
Invasive Species:	**17**
Whales and Other Cetaceans:	**None**
Threatened Ecological Communities:	**1**
Heritage	
World Heritage Properties:	**1**
Australian Heritage Sites:	**5**
Wetlands	
Ramsar sites: (Internationally important)	**2**
Nationally Important Wetlands:	**None**
National Pollutant Inventory	
Reporting Facilities:	**3**
Airsheds:	**None**
Catchments:	**1**
Protected Areas	
Reserves and Conservation Areas:	**3**
Regional Forest Agreements:	**1**

Biodiversity

Threatened Species [Dataset Information]	**Status**	**Comments**
Birds		
Lathamus discolor **Swift Parrot**	**Endangered**	**Species or species habitat may occur within area**
Rostratula australis **Australian Painted Snipe**	**Vulnerable**	**Species or species habitat may occur within area**
Xanthomyza phrygia **Regent Honeyeater**	**Endangered**	**Species or species habitat may occur within area**
Frogs		
Litoria aurea **Green and Golden Bell Frog**	**Vulnerable**	**Species or species habitat may occur within area**
Litoria booroolongensis **Booroolong Frog**	**Endangered**	**Species or species habitat may occur within area**

Mixophyes balbus **Stuttering Frog, Southern Barred Frog (in Victoria)**	**Vulnerable**	**Species or species habitat likely to occur within area**
Mixophyes iteratus **Southern Barred Frog, Giant Barred Frog**	**Endangered**	**Species or species habitat likely to occur within area**
Mammals		
Chalinolobus dwyeri **Large-eared Pied Bat, Large Pied Bat**	**Vulnerable**	**Species or species habitat may occur within area**
Dasyurus maculatus maculatus (SE mainland population) **Spot-tailed Quoll, Spotted-tail Quoll, Tiger Quoll (south-eastern mainland population)**	**Endangered**	**Species or species habitat may occur within area**
Petrogale penicillata **Brush-tailed Rock-wallaby**	**Vulnerable**	**Species or species habitat may occur within area**
Potorous tridactylus tridactylus **Long-nosed Potoroo (SE mainland)**	**Vulnerable**	**Species or species habitat may occur within area**
Pseudomys oralis **Hastings River Mouse**	**Endangered**	**Species or species habitat likely to occur within area**
Pteropus poliocephalus **Grey-headed Flying-fox**	**Vulnerable**	**Roosting known to occur within area**
Plants		
Cryptostylis hunteriana **Leafless Tongue-orchid**	**Vulnerable**	**Species or species habitat may occur within area**
Cynanchum elegans **White-flowered Wax Plant**	**Endangered**	**Species or species habitat likely to occur within area**
Eucalyptus glaucina **Slaty Red Gum**	**Vulnerable**	**Species or species habitat likely to occur within area**
Pultenaea campbellii **New England Bush-pea**	**Vulnerable**	**Species or species habitat likely to occur within area**
Syzygium paniculatum **Magenta Lilly Pilly, Magenta Cherry, Pocket-less Brush Cherry, Scrub Cherry, Creek Lilly Pilly, Brush Cherry**	**Vulnerable**	**Species or species habitat likely to occur within area**
Thesium australe **Austral Toadflax, Toadflax**	**Vulnerable**	**Species or species habitat likely to occur within area**
Tylophora woollsii	**Endangered**	**Species or species habitat likely to occur within area**

Migratory Species [Dataset Information]	Status	Comments
Migratory Terrestrial Species		
Birds		
Haliaeetus leucogaster **White-bellied Sea-Eagle**	**Migratory**	**Species or species habitat likely to occur within area**
Hirundapus caudacutus **White-throated Needletail**	**Migratory**	**Species or species habitat may occur within area**
Merops ornatus **Rainbow Bee-eater**	**Migratory**	**Species or species habitat may occur within area**
Monarcha melanopsis **Black-faced Monarch**	**Migratory**	**Breeding may occur within area**
Monarcha trivirgatus **Spectacled Monarch**	**Migratory**	**Breeding likely to occur within area**
Myiagra cyanoleuca **Satin Flycatcher**	**Migratory**	**Breeding likely to occur within area**
Rhipidura rufifrons **Rufous Fantail**	**Migratory**	**Breeding may occur within area**
Xanthomyza phrygia **Regent Honeyeater**	**Migratory**	**Species or species habitat may occur within area**
Migratory Wetland Species		
Birds		
Ardea alba **Great Egret, White Egret**	**Migratory**	**Species or species habitat may occur within area**
Ardea ibis **Cattle Egret**	**Migratory**	**Species or species habitat may occur within area**
Gallinago hardwickii **Latham's Snipe, Japanese Snipe**	**Migratory**	**Species or species habitat may occur within area**
Rostratula benghalensis s. lat. **Painted Snipe**	**Migratory**	**Species or species habitat may occur within area**
Migratory Marine Birds		
Apus pacificus **Fork-tailed Swift**	**Migratory**	**Species or species habitat may occur within area**
Ardea alba **Great Egret, White Egret**	**Migratory**	**Species or species habitat may occur within area**
Ardea ibis **Cattle Egret**	**Migratory**	**Species or species habitat may occur within area**

Listed Marine Species [Dataset Information]	Status	Comments
Birds		
Apus pacificus Fork-tailed Swift	Listed - overfly marine area	Species or species habitat may occur within area
Ardea alba Great Egret, White Egret	Listed - overfly marine area	Species or species habitat may occur within area
Ardea ibis Cattle Egret	Listed - overfly marine area	Species or species habitat may occur within area
Gallinago hardwickii Latham's Snipe, Japanese Snipe	Listed - overfly marine area	Species or species habitat may occur within area
Haliaeetus leucogaster White-bellied Sea-Eagle	Listed	Species or species habitat likely to occur within area
Hirundapus caudacutus White-throated Needletail	Listed - overfly marine area	Species or species habitat may occur within area
Lathamus discolor Swift Parrot	Listed - overfly marine area	Species or species habitat may occur within area
Merops ornatus Rainbow Bee-eater	Listed - overfly marine area	Species or species habitat may occur within area
Monarcha melanopsis Black-faced Monarch	Listed - overfly marine area	Breeding may occur within area
Monarcha trivirgatus Spectacled Monarch	Listed - overfly marine area	Breeding likely to occur within area
Myiagra cyanoleuca Satin Flycatcher	Listed - overfly marine area	Breeding likely to occur within area
Rhipidura rufifrons Rufous Fantail	Listed - overfly marine area	Breeding may occur within area
Rostratula benghalensis s. lat. Painted Snipe	Listed - overfly marine area	Species or species habitat may occur within area
Invasive Species [Dataset Information]	**Status**	**Comments**
Selected Invasive Species: Weeds reported here are the 20 species of national significance (WoNS), along with other introduced plants that are considered by the States and Territories to pose a particularly significant threat to biodiversity. The following feral animals are reported: Goat, Red Fox, Cat, Rabbit, Pig, Water Buffalo and Cane Toad. Maps from Landscape Health Project, National Land and Water Resources Audit, 2001.		
Frogs		
Bufo marinus Cane Toad	Feral	Species or species habitat likely to occur within area
Mammals		

Bubalus bubalis **Water Buffalo, Swamp Buffalo**	**Feral**	**Species or species habitat may occur within area**
Capra hircus **Goat**	**Feral**	**Species or species habitat may occur within area**
Felis catus **Cat, House Cat, Domestic Cat**	**Feral**	**Species or species habitat likely to occur within area**
Oryctolagus cuniculus **Rabbit, European Rabbit**	**Feral**	**Species or species habitat may occur within area**
Sus scrofa **Pig**	**Feral**	**Species or species habitat may occur within area**
Vulpes vulpes **Red Fox, Fox**	**Feral**	**Species or species habitat likely to occur within area**
Plants		
Cabomba caroliniana **Cabomba**	**WoNS**	**Species or species habitat may occur within area**
Chrysanthemoides monilifera **Bitou Bush, Boneseed**	**WoNS**	**Species or species habitat likely to occur within area**
Genista sp. X Genista monspessulana **Broom**	**Invasive**	**Species or species habitat may occur within area**
Lantana camara **Lantana**	**WoNS**	**Species or species habitat likely to occur within area**
Lycium ferocissimum **African Boxthorn, Boxthorn**	**Invasive**	**Species or species habitat may occur within area**
Nassella trichotoma **Serrated Tussock**	**WoNS**	**Species or species habitat may occur within area**
Pinus radiata **Monterey Pine, Radiata Pine**	**Invasive**	**Species or species habitat may occur within area**
Rubus fruticosus agg. **Blackberry**	**WoNS**	**Species or species habitat likely to occur within area**
Salvinia molesta **Salvinia**	**WoNS**	**Species or species habitat likely to occur within area**
Ulex europaeus **Gorse**	**WoNS**	**Species or species habitat may occur within area**
Threatened Ecological Communities [Dataset Information]	**Status**	**Comments**
White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland	**Critically Endangered**	**Community may occur within area**

Heritage		
World Heritage Properties [Dataset Information]		
Gondwana Rainforests of Australia NSW		
Australian Heritage Sites [Dataset Information] **Note that not all Indigenous sites may be listed.**		
Historic		
Cawarra Estate Group NSW		
Dungog Courthouse NSW		
Dungog Information and Neighbourhood Centre NSW		
School of Arts Museum NSW		
Natural		
Barrington Tops National Park (1978 boundary) NSW		
Wetlands		
Wetlands of International Importance (Ramsar sites) [Dataset Information]		
HUNTER ESTUARY WETLANDS		**Within same catchment as Ramsar site**
MYALL LAKES		**Within same catchment as Ramsar site**
National Pollutant Inventory		
Reporting Facility [Dataset Information]	**Top Substance**	**Source**
Substance emissions are ranked on a scale of 1-100: 1=lowest; 100=highest. Rankings are shown as: =0-25; =26-50; =51-75; =76-100.		
Allen Taylor and Company Limited (Boral Timber Maxwells Creek Board Plant, Maxwells Creek via Dungog NSW)	**Polychlorinated dioxins and furans [Low]**	**Hardwood board processing plant.**
Hunter Water Corporation (Chichester Dam Chlorinator, Chichester NSW)	**Chlorine [Low]**	**Disinfection of drinking water.**
Hunter Water Corporation (Dungog Water Treatment Plant, Dungog NSW)	**Chlorine [Low]**	**Treatment of water for potable use**
Catchment [Dataset Information]	**Substances**	**Sources**
Hunter River, NSW	**2**	**32**
Other		
Reserves and Conservation Areas [Dataset Information]		
Barrington Tops National Park, NSW		
Killarney Nature Reserve, NSW		
Monkerai Nature Reserve, NSW		

Regional Forest Agreements [Dataset Information]
Note that all RFA areas including those still under consideration have been included.

Lower North East NSW RFA, New South Wales

Caveat

The information presented here has been drawn from a range of sources, compiled for a variety of purposes. Details of the coverage of each dataset are included in the metadata [Dataset Information] links above.

Acknowledgment

This database has been compiled from a range of data sources. The Department acknowledges the following custodians who have contributed valuable data and advice:

- **New South Wales National Parks and Wildlife Service**
- **Department of Sustainability and Environment, Victoria**
- **Department of Primary Industries, Water and Environment, Tasmania**
- **Department of Environment and Heritage, South Australia Planning SA**
- **Parks and Wildlife Commission of the Northern Territory**
- **Environmental Protection Agency, Queensland**
- **Birds Australia**
- **Australian Bird and Bat Banding Scheme**
- **Australian National Wildlife Collection**
- **Natural history museums of Australia**
- **Queensland Herbarium**
- **National Herbarium of NSW**
- **Royal Botanic Gardens and National Herbarium of Victoria**
- **Tasmanian Herbarium**
- **State Herbarium of South Australia**
- **Northern Territory Herbarium**
- **Western Australian Herbarium**
- **Australian National Herbarium, Atherton and Canberra**
- **University of New England**
- **Other groups and individuals**

ANUCliM Version 1.8, Centre for Resource and Environmental Studies, Australian National University was used extensively for the production of draft maps of species distribution. The

Department is extremely grateful to the many organisations and individuals who provided expert advice and information on numerous draft distributions.

Appendix 2. Flora Species Recorded in the Study Area

The following is a list of all flora species recorded within the study area. Please note that this list may be not fully comprehensive, and should be regarded as an indication of the flora present. A period of some years is often needed to identify all species present in an area, particularly for cryptic or seasonally detectable species (such as orchids and small grass-like herbs).

Notes:

* indicates an exotic or introduced native species
R indicates locally indigenous species that are potentially suitable for revegetation or replanting works
? indicates identification uncertain

Nomenclature follows Harden (1990, 1992, 1993, 2002), Harden & Murray (2000) and subsequent recent revisions.

Location

p – cleared pasture / roadside areas
w – dam wall / spillway area
r – riparian (riverside/creekside) area
n – new Salisbury Road deviation area

CLASS FILICOPSIDA (Ferns)

ADIANTACEAE						
Adiantum aethiopicum	R	Common maidenhair fern			r	n
Adiantum formosum	R	Giant maidenhair fern / black stem				n
Adiantum hispidulum	R	Rough maidenhair fern			r	n
Cheilanthes distans	R	Bristly cloak fern		w		
Cheilanthes sieberi subsp. *sieberi*	R	Mulga fern	p	w		n
Pellaea falcata	R	Sickle fern				n
Pellaea nana	R	Dwarf sickle fern				n
Pellaea paradoxa	R	Heart fern				n
ASPLENIACEAE						
Asplenium australasicum	R	Bird's nest fern				n
AZOLLACEAE						
Azolla pinnata	R	Ferny azolla	p	w		n
BLECHNACEAE						
Blechnum cartilageneum	R	Gristle fern				n
Doodia aspera	R	Prickly rasp fern			r	n
DAVALLIACEAE						
Arthropteris tenella	R	-				n
Rumohra adiantiformis	R	-				n
DENNSTAEDTIACEAE						
Pteridium esculentum		Bracken	p		r	n
DICKSONIACEAE						
Calochlaena dubia	R	False bracken fern				n
DRYOPTERIDACEAE						
Lastreopsis decomposita	R	Trim shield fern				n
POLYPODIACEAE						
Platycerium bifurcatum	R	Elkhorn				n
Pyrrosia rupestris	R	Rock felt-fern				n
PTERIDACEAE						

Pteris umbrosa	R	Jungle brake				n
THELYPTERIDACEAE						
Christella dentata	R	Binung			r	n
CLASS MAGNOLIOPSIDA (Flowering Plants)						
Subclass Magnoliidae (Dicotyledons)						
ACANTHACEAE						
Brunoniella australis	R	Blue trumpet/native yam				n
Pseuderanthemum variabile	R	Pastel flower				n
ADOXACEAE						
Sambucus australasica	R	Native elderberry / yellow elderberry				n
AMARANTHACEAE						
*Alternanthera pungens**		Khaki weed	p			
Deeringia amaranthoides	R	Shrubby Deeringia				n
Nyssanthes erecta		-	p			
AMYGDALACEAE						
*Prunus persica**		Peach				
ANACARDIACEAE						
*Schinus terebinthifolius**?		Brazilian pepper tree				
APIACEAE						
Centella asiatica	R	Swamp pennywort				n
*Cyclospermum leptophyllum**		Slender celery	p			n
Daucus glochidiatus		Native carrot	p			n
Hydrocotyle tripartita	R	A pennywort			r	n
APOCYNACEAE						
Parsonsia straminea		Common silkpod / monkey rope				n
Parsonsia velutina		-				n
Tylophora barbata	R	Bearded tylophora				n
ARALIACEAE						
Polyscias murrayi	R	Pencil cedar				
Polyscias sambucifolia	R	Elderberry panax				
ASCLEPIADACEAE						
*Araujia sericifera**		Moth plant			r	
*Gomphocarpus fruticosus**		Narrow leaf cotton bush	p			n
ASTERACEAE						
*Ageratina adenophora**		Crofton weed	p			n
*Ageratina riparia**		Creeping crofton weed			r	n
*Bidens pilosa**		Cobblers pegs	p	w	r	n
Brachyscome microcarpa	R	-		w		n
Cassinia aculeata	R	Dogwood / dolly bush		w		n
Chrysocephalum apiculatum	R	Yellow buttons		w		n
*Cirsium vulgare**		Spear thistle / black thistle	p			n
Conyza sp.*		Fleabane	p	w		n
Cymbonotus lawsonianus		Austral bear's ear				n
*Delairea odorata**		Cape ivy				
Euchiton sphaericus		Star cudweed		w		n
*Gamochaeta spicata**		Cudweed	p	w		n
*Hypochaeris radicata**		Flatweed/catsear	p			n
Ozothamnus diosmifolius	R	Ball everlasting/pill flower/ rice flower		w		n
*Senecio madagascariensis**		Fire weed		w		n

Sigesbeckia orientalis subsp. *orientalis*		Indian weed		w		n
*Sonchus oleraceus**		Common sowthistle			r	n
*Tagetes minuta**		Stinking roger				n
Vernonia cinerea	R	-				n
*Xanthium occidentale**		Noogoora burr			r	n
Xerochrysum bracteatum	R	Golden everlasting	p			
BIGNONIACEAE						
*Macfadyena unguis-cati**		Cat's claw creeper			r	
Pandorea pandorana	R	Wonga wonga vine			r	n
BRASSICACEAE						
*Lepidium africanum**		Common peppercress	p			
*Sisymbrium officinale**		Hedge mustard				
CAMPANULACEAE						
Wahlenbergia communis	R	Tufted bluebell	p	w		n
Wahlenbergia gracilis	R	Sprawling/Australian bluebell				n
Wahlenbergia stricta subsp. *stricta*	R	-		w		
CAPPARACEAE						
Capparis arborea	R	Brush copper berry / wild lime / noble caper				n
CARYOPHYLLACEAE						
*Stellaria media**		Common chickweed	p			n
CASUARINACEAE						
Allocasuarina littoralis	R	Black she-oak	p			
Allocasuarina torulosa	R	Forest oak				n
Casuarina cunninghamiana subsp. *cunninghamiana*	R	River oak			r	
CELASTRACEAE						
Maytenus silvestris	R	Narrow-leaved orange bark		w		n
CHENOPODIACEAE						
Einadia hastata		Saloop		w		n
CLUSIACEAE						
Hypericum gramineum		Small St. John's wort	p			n
CONVOLVULACEAE						
Dichondra repens	R	Kidney weed		w		n
Polymeria calycina	R	Swamp bindweed				n
CUCURBITACEAE						
Zehneria cunningamii	R	Slender cucumber				n
DILLENIACEAE						
Hibbertia diffusa	R	Guinea flower		w		n
Hibbertia scandens	R	Golden guinea flower				n
EBENACEAE						
Diospyros australis	R	Black/grey plum / yellow persimmon				n
ELAEOCARPACEAE						
Elaeocarpus reticulatus		Blueberry ash				n
ERICACEAE - Subfamily Styphelioideae						
Leucopogon juniperinus	R	Prickly beard heath		w		
EUPHORBIACEAE						
Breynia oblongifolia	R	Coffee bush		w		n
*Chamaesyce drummondii**		Caustic weed	p		r	

Croton verauxii	R	Green or native cascarilla				n
*Euphorbia peplus**		Petty spurge			r	
Glochidion ferdinandi var. *ferdinandi*		Cheese tree				n
Omalanthus populifolius		Bleeding heart				n
Phyllanthus gunnii		Scrubby spurge			r	n
Poranthera microphylla		Small poranthera				n
Sloanea australis	R	Maiden's blush / blush alder				n
FABACEAE - Subfamily Caesalpinoideae						
*Gleditsia triacanthos**		Honey locust			r	
FABACEAE - Subfamily Faboideae						
Austrosteenisia blackii var. *blackii*	R	Blood vine			r	
Daviesia genistifolia	R	Broom bitter pea		w		
Desmodium brachypodum		Large Tick-trefoil	p			n
Desmodium rhytidophyllum		-		w		n
Desmodium varians	R	Slender Tick-trefoil		w		n
Glycine microphylla	R	Small-leaf glycine				n
Glycine tabacina sens. lat.	R	A love creeper		w		n
Hardenbergia violacea	R	False sarsaparilla		w		n
Indigofera australis	R	Native indigo				n
Jacksonia scoparia		Dogwood		w		n
Kennedia rubicunda	R	Dusky coral pea		w		
*Medicago polymorpha**		Burr medic				n
*Medicago sativa**		Lucerne				
*Trifolium repens**		White clover	p			n
Zornia dictyocarpa var. *dictyocarpa*		Zornia				n
FABACEAE - Subfamily Mimosoideae						
Acacia falcata	R	Falcate wattle		w		
Acacia floribunda	R	White sallow wattle/sally				n
Acacia implexa		Hickory/lightwood		w		
Acacia irrorata subsp. *irrorata*	R	Green wattle		w		n
Acacia maidenii		Hickory / Maidens wattle			r	n
Acacia melanoxylon		Blackwood			r	n
Acacia ulicifolia	R	Prickly Moses		w		n
FLACOURTIACEAE						
Scolopia braunii		Flintwood/brown birch				n
GENTIANACEAE						
*Centaurium erythraea**		Common centaury	p	w		n
GERANIACEAE						
Geranium homeanum		Northern cranesbill			r	
Geranium solanderi var. *solanderi*		Cutleaf cranesbill	p	w		n
GOODENIACEAE						
Scaevola albida var. *albida*	R	Pale fan-flower	p	w		n
LAMIACEAE						
Ajuga australis	R	Austral bugle				n
Mentha sp.*		Mint				
Plectranthus parviflorus		Cockspur flower		w		n
*Salvia coccinea**		Texas sage / red salvia		w		
Scutellaria mollis		Soft skullcap				n
LAURACEAE						
Neolitsea dealbata	R	White/hairy-leaved bolly gum				n
Neolitsea australiensis	R	Green bolly gum				n
LOBELIACEAE						
Pratia purpurascens	R	White root				n

LORANTHACEAE						
Amyema pendulum subsp. *pendulum*		A mistletoe			r	n
LYTHRACEAE						
*Lagerstroemia indica**		Crepe myrtle	p			
Lythrum hyssopifolia		Hessop loosestrife		w		
MALACEAE						
*Malus X domestica**		Apple	p			
MALVACEAE						
Hibiscus heterophyllus subsp. *heterophyllus*		Native hibiscus / rosella				n
*Modiola caroliniana**		Redflower mallow	p		r	
*Sida rhombifolia**		Paddy's lucerne	p	w	r	n
MELIACEAE						
Dysoxylum fraserianum		Rosewood / rose mahogany				n
Melia azedarach		White cedar				n
Synoum glandulosum subsp. *glandulosum*		Scentless rosewood				n
MENISPERMACEAE						
Sarcopetalum harveyanum	R	Pearl vine				n
Stephania japonica	R	Snake vine				n
MONIMIACEAE *s. lat.*						
Doryphora sassafras	R	Sassafras				n
Wilkiea huegeliana	R	Veiny wilkiea				n
MORACEAE						
Ficus coronata	R	Creek sandpaper fig			r	n
Ficus rubiginosa	R	Port Jackson fig				n
Streblus brunonianus	R	Whalebone tree				
MYOPORACEAE						
Eremophila debilis	R	Amulla / winter apple		w		
MYRSINACEAE						
Myrsine variabilis	R	Muttonwood			r	n
MYRTACEAE						
Acmena smithii	R	Lilly-pilly				
Angophora floribunda	R	Rough-barked apple	p		r	n
Backhousia myrtifolia	R	Grey myrtle/lancewood			r	n
Callistemon salignus	R	Willow bottlebrush			r	n
Corymbia maculata	R	Spotted gum	p	w		n
Eucalyptus acmenoides	R	White mahogany				n
Eucalyptus canaliculata	R	Large-fruited grey gum				n
Eucalyptus globoidea	R	White stringybark		w		
Eucalyptus microcorys	R	Tallowwood				n
Eucalyptus moluccana	R	Grey box	p	w		n
Eucalyptus saligna	R	Sydney blue gum			r	n
Eucalyptus siderophloia	R	Northern grey ironbark	p	w		n
Eucalyptus tereticornis	R	Forest red gum	p	w	r	n
Eucalyptus umbra	R	Broadleaf white mahogany				n
Melaleuca styphelioides	R	Prickly-leaved paperbark			r	n
Rhodamnia rubescens	R	Scrub turpentine				n
Syncarpia glomulifera	R	Turpentine				n
Tristaniopsis laurina	R	Water gum / kanuka			r	
OLEACEAE						
Jasminum volubile		Stiff jasmine		w		
*Ligustrum sinense**		Small-leaved privet	p	w		n
Notelaea longifolia forma *longifolia*	R	Mock olive		w		

Notelaea ovata	R	A native olive		w		n
ONAGRACEAE						
Ludwigia peploides subsp. *montevidensis**		Water primrose	p	w		n
OXALIDACEAE						
*Oxalis articulata**		Shamrock oxalis				
Oxalis exilis		A wood sorrell	p			n
Oxalis perennans		A wood sorrell				n
PAPAVERACEAE						
Argemone ochroleuca subsp. *ochroleuca**		Mexican poppy				
PASSIFLORACEAE						
Passiflora herbertiana	R	Native passionfruit		w		n
PITTOSPORACEAE						
Billardiera scandens var. *scandens*	R	Apple dumplings		w		
Hymenosporum flavum		Native frangipani				n
Pittosporum revolutum	R	Rough-fruit pittosporum		w		n
Pittosporum multiflorum	R	Orange thorn				n
Pittosporum undulatum		Sweet pittosporum		w		n
PLANTAGINACEAE						
*Plantago lanceolata**		Common plantain		w		n
POLYGONACEAE						
*Acetosa sagittata**		Turkey rhubarb / rambling dock	p		r	
Persicaria decipiens	R	Slender knotweed	p			
Persicaria hydropiper	R	Knotweed			r	n
Rumex brownii		Swamp dock	p			n
*Rumex crispus**		Curly dock				
PORTULACACEAE						
Portulaca oleracea		Pigweed / purslane	p			
PRIMULACEAE						
*Anagallis arvensis**		Pimpernel	p		r	n
PROTEACEAE						
Grevillea robusta	R	Silky oak				
Helicia glabriflora	R	Smooth helicia				n
Persoonia linearis	R	Narrow-leaved geebung		w		
RANUNCULACEAE						
Clematis aristata	R	Old man's beard / traveller's joy			r	n
Ranunculus plebeius	R	Hairy buttercup				n
*Ranunculus sceleratus**		Celery buttercup				n
RHAMNACEAE						
Alphitonia excelsa		Red ash				n
Pomaderris ferruginea	R	Rusty pomaderris				n
ROSACEAE						
*Rosa rubiginosa**		Sweet briar				
Rubus fruticosus species aggregate*		Blackberry	p			n
Rubus parvifolius		Native raspberry			r	n
Rubus rosifolius		Rose-leaf bramble				n
RUBIACEAE						
Galium binifolium		A bedstraw	p			n
Pomax umbellata	R	Pomax		w		
*Richardia brasiliensis**		Mexican clover	p			n

*Sherardia arvensis**		Field Madder			r	n
RUTACEAE						
Acronychia oblongifolia	R	White aspen / yellow wood				n
*Citrus limonia**		Lemon tree	p			n
*Citrus x taitensis**		Bush lemon / rough lemon	p			
Melicope micrococca		Hairy-leaved doughwood				n
Sarcomelicope simplicifolia subsp. *simplicifolia*		Yellow aspen / big yellow wood				n
Zieria smithii		Sandfly zieria			r	
SALICACEAE						
*Populus alba**		White poplar			r	
*Salix babylonica**		Weeping willow			r	
*Salix nigra**?		Black willow			r	
SANTALACEAE						
Exocarpus cupressiformis	R	Cherry ballart		w		
SAPINDACEAE						
Alectryon subcinereus		Native quince / wild quince				n
Dodonaea viscosa subsp *angustifolia*	R	Sticky hop bush		w		
SCROPHULARIACEAE						
*Verbascum virgatum**		Twiggy mullein	p		r	
Veronica plebeia	R	Trailing speedwell				n
SOLANACEAE						
*Solanum mauritianum**		Wild tobacco tree	p		r	n
*Solanum nigrum**		Blackberry nightshade				n
Solanum prinophyllum		Southern forest nightshade				n
*Solanum pseudocapsicum**		Madeira winter cherry		x		
Solanum stelligerum		Devil's needles				n
STERCULIACEAE						
Brachychiton populneus subsp. *populneus*		Kurrajong		w	r	n
Commersonia fraseri		Brush kurrajong				n
ULMACEAE						
Trema tomentosa		Native peach			r	n
URTICACEAE						
Dendorcnide excelsa		Giant stinging tree				n
Urtica incisa		Stinging nettle	p		r	n
VERBENACEAE						
Clerodendrum tomentosum	R	Hairy clerodendrum			r	n
*Lantana camara**		Lantana		w	r	n
*Verbena bonariensis**		Purpletop	p		r	n
Verbena rigida var. *rigida**		Veined verbena	p	w		n
VIOLACEAE						
Hybanthus stellarioides		A spade flower				n
Viola betonicifolia		Purple violet				n
Viola hederacea	R	Native violet			r	n
*Viola odorata**		-				
VISCACEAE						
Notothixos subaureus		Golden mistletoe	p			
VITACEAE						
Cayratia clematidea		Slender grape	p		r	n
Cissus antarctica		Kangaroo grape				n
Cissus hypoglauca		Five-leaf water vine			r	n

Cissus opaca		Small-leaved water vine / pepper vine				n
Subclass Liliidae (Monocotyledons)						
ANTHERICACEAE						
Arthropodium milleflorum		Vanilla lily			r	n
Tricoryne elatior	R	Yellow rush-lily		w		n
ARACEAE						
Alocasia brisbanensis		Cunjevoi / spoon lily				n
COMMELINACEAE						
Aneilema acuminatum	R	Pointed Aneilema				n
Commelina cyanea		Scurvy weed	p	w		n
Murdannia graminea		Blue murdannia	p		r	
Pollia crispata		Pollia				n
*Tradescantia fluminensis**		Trad/wandering jew			r	
CYPERACEAE						
Carex appressa	R	Tall sedge			r	n
Carex longebrachiata	R	Drooping sedge				n
*Cyperus brevifolius**		Mullumbimby couch	p			
*Cyperus eragrostis**		Umbrella sedge		w		
Cyperus gracilis	R	-				n
Cyperus polystachyos		-	p			
*Cyperus sesquiflorus**		-				n
Cyperus tetraphyllus		-				n
Eleocharis sphacelata	R	Tall spike-rush	p			n
Fimbristylis dichotoma	R	-		w		n
Lepidosperma laterale	R	Flat sword-sedge		w		
Schoenoplectus mucronatus	R	A club-rush	p			
DIOSCOREACEAE						
Dioscorea transversa		Native yam				n
HYDROCHARITACEAE						
Ottelia ovalifolia		Swamp lily	p	w		n
IRIDACEAE						
*Sisyrinchium iridifolium**		Blue pigroot	p	w		
JUNCACEAE						
Juncus prismatocarpus	R	Branching rush	p			
Juncus usitatus	R	Common rush	p	w		n
LOMANDRACEAE						
Lomandra filiformis subsp. *filiformis*	R	Iron grass		w		
Lomandra longifolia	R	Spiny-headed mat-rush				n
Lomandra multiflora subsp. *multiflora*	R	Many-flowered mat-rush				n
LUZURIAGACEAE						
Eustrephus latifolius	R	Wombat berry		w		n
Geitonoplesium cymosum	R	Scrambling lily			r	n
ORCHIDACEAE						
Dipodium punctatum		Hyacinth orchid			r	n
PHORMIACEAE						
Dianella caerulea var. *cinarescens*	R	Blue flax lily		w		
Dianella caerulea var. *producta*	R	Blue flax lily			r	n
POACEAE						
Aristida ramosa	R	Purple wiregrass		w		

Aristida vagans	R	A three-awn speargrass		w		n
*Arundo donax**		Giant reed				
Austrodanthonia sp.	R	Wallaby grass	p	w		n
Austrostipa scabra subsp. *scabra*		A speargrass				n
*Axonopus fissifolius**		Narrow-leaved carpet grass	p	w		n
*Briza minor**		Shivery grass				
*Bromus cartharticus**		Prairie grass	p			n
*Chloris gayana**		Rhodes grass	p			
Cymbopogon refractus		Barbed-wire grass		w		n
Cynodon dactylon		Couch	p			n
Dichelachne micrantha	R	Shorthair plumegrass		w		n
Digitaria parviflora	R	A fingergrass				n
Echinopogon caespitosus var. *caespitosus*	R	Bushy hedgehog grass	p	w		n
Echinopogon ovatus	R	Forest hedgehog grass			r	n
*Ehrharta erecta**		Panic veldtgrass			r	n
*Eleusine indica**		Crowsfoot grass	p			
Entolasia marginata	R	Bordered panic				n
Eragrostis brownii	R	Brown's love grass		w		n
*Eragrostis cilianensis**		Stinkgrass	p	w		n
Eragrostis leptostachya		Paddock love grass				n
Eragrostis sp.		A love grass				n
Imperata cylindrica var. *major*		Blady grass	p	w		n
*Lolium perenne**		Perennial rye grass	p			
*Melinis repens**		Red natal grass		w		
Microlaena stipoides var. *stipoides*	R	Weeping grass				n
Oplismenus aemulus	R	Basket grass			r	n
Panicum maximum var. *maximum**		Guinea grass				n
Panicum simile		Two colour panic	p			n
Panicum sp. A?		A panic				n
Paspalidium distans	R	-	p			n
*Paspalum dilatatum**		Paspalum	p	w	r	n
Paspalum distichum		Water couch	p			n
*Pennisetum clandestinum**		Kikuyu	p	w	r	n
Poa labillardierei var. *labillardierei*		Tussock grass	p	w		n
*Sporobolus africanus**		Parramatta grass	p	w		n
Sporobolus elongatus		Slender rat's tail grass				n
Themeda australis	R	Kangaroo grass	p	w		n
SMILACACEAE						
Smilax australis	R	Austral sarsaparilla				n
TYPHACEAE						
Typha orientalis	R	Bullrush/cumbungi	p	w		
ZINGIBERACEAE						
Alpinia caerulea	R	Native ginger				n

Appendix 3. Actions required in relation to Notifiable Weeds pursuant to the Noxious Weeds Act 2003

Section 8 of the amended Noxious Weeds Act 1993 classifies noxious weeds into 5 weed control classes as follows:

(a) Class 1 - State Prohibited Weeds,
(b) Class 2 - Regionally Prohibited Weeds,
(c) Class 3 - Regionally Controlled Weeds,
(d) Class 4 - Locally Controlled Weeds,
(e) Class 5 - Restricted Plants.

The characteristics of each class are as follows:

(a) Class 1 noxious weeds are plants that pose a potentially serious threat to primary production or the environment and are not present in the State or are present only to a limited extent.
(b) Class 2 noxious weeds are plants that pose a potentially serious threat to primary production or the environment of a region to which the order applies and are not present in the region or are present only to a limited extent.
(c) Class 3 noxious weeds are plants that pose a serious threat to primary production or the environment of an area to which the order applies, are not widely distributed in the area and are likely to spread in the area or to another area.
(d) Class 4 noxious weeds are plants that pose a threat to primary production, the environment or human health, are widely distributed in an area to which the order applies and are likely to spread in the area or to another area.
(e) Class 5 noxious weeds are plants that are likely, by their sale or the sale of their seeds or movement within the State or an area of the State, to spread in the State or outside the State.

A noxious weed that is classified as a Class 1, 2 or 5 noxious weed is referred to in the Act as a "**notifiable weed**".

The relevant sections of the Act that define the actions required in relation to **notifiable weeds** are reproduced below:

Section 15: An occupier of land (other than a local control authority) on which there is a **notifiable weed** must notify the local control authority for the land of that fact within 3 days after becoming aware that the **notifiable weed** is on the land. ***Maximum penalty (for an occupier other than a public authority): 20 penalty units***

Section 16: For the purpose of proving in any prosecution under section 15 (1) that an occupier of land was aware that a **notifiable weed** was located on the land, if it is proved that the occupier or an employee of the occupier or other person using the land ought reasonably to have known that a **notifiable weed** was located on the land, that is evidence that the occupier was aware that it was on the land.

Section 28:
(1) A person (including a public authority) must not sell or purchase:
(a) any **notifiable weed** material or other noxious weed material prescribed by the regulations, or
(b) any animal or thing which has on it, or contains, **notifiable weed** material or other noxious weed material prescribed by the regulations, knowing it to be, or to have on it or to contain, any such weed material.
(2) An occupier of land (including a public authority) must not knowingly remove or cause to be removed from the land any animal or thing which has on it, or contains, **notifiable weed material** or other noxious weed material prescribed by the regulations. ***Maximum penalty: 50 penalty units.***
(3) Notifiable weed material:
(a) in subsection (1) extends to the weed material of a weed that is a **notifiable weed** in any part of the State, and
(b) in subsection (2) is limited to the weed material of a weed that is a **notifiable weed** in that part of the State that includes the land that is relevant for the purposes of that subsection.

Section 29: An occupier of land (including a public authority) must not use or permit the land to be used for the purpose of disposing of, transporting or selling soil, turf or fodder, if the occupier knows, or ought reasonably to know, that there is a weed on the land that is a **notifiable weed** in any part of the State. ***Maximum penalty: 50 penalty units.***

Section 40: An inspector who has reasonable cause to suspect that **notifiable weed** material of a weed that is a notifiable weed in any part of the State is or may be present in an agricultural machine may require the person apparently in charge of the machine to treat the machine immediately, in the manner specified by the inspector, to remove any such weed material.

For further information about notifiable noxious weeds, contact: Weeds Hotline 1800 680 244 or email: weeds@dpi.nsw.gov.au (NSW Department of Primary Industries).

Appendix 4. Fauna recorded within the Study Area

* indicates introduced species (not native to the area)
Bold indicates a threatened species
V – Vulnerable, E – Endangered, M – Migratory

Sites:
1 – Chichester Road South – along Chichester Road north of Salisbury Road and south of the Williams River (371228E 6429730N Acc 1.5km)
2 – Heatherbrae Road – along Heatherbrae Road from Tillegra Bridge (375141E 6426533N Acc 150m)
3 – Line A – remnant vegetation north of Tillegra Bridge (376690E 6424172N Acc 350m)
4 – Lines B, C & D – remnant vegetation south of Tillegra Bridge (Tillegra TSR) (376553E 6422978N Acc 350m)
5 – Munni House (374593E 6426528N Acc 150m)
6 – Quartpot Road – along Quartpot Road from Salisbury Road (370727E 6427841N Acc 1.5km)
7 – Salisbury Road – along Salisbury Road either side of Bullee Coggee Creek crossing (368412E 6430638N Acc 1.5km)
8 – Williams River at Tillegra Bridge (376490E 6423431N Acc 100m)
9 – Tillegra TSR Road – along Tillegra TSR Road west of Salisbury Road and Tillegra TSR (374829E 6422721N Acc 1.5km)
10 – Williams River – riparian strip along the Williams River on Moore's property – north of the junction with Quartpot Creek (372899E 6428059N Acc 1km)
11 – Chichester Road North – along Chichester Road north of the Williams River (370434E 6431677N Acc 1.5km)
12 – Property 272 (Lot 7 DP 5937) north-east of the Williams River and Chichester Road (371970E 6431453N Acc 250m)
13 – Dam north of Heatherbrae Road (Lot 1 DP 829408) (374051E 6427932N Acc 250m)
14 – Property 114 (Lot 50 DP 753201) north of Heatherbrae Road (373854E 6429724N Acc 1km)
15 – Along ridge north of Line A (Lot 142 DP 617159 & Lot 12 DP 825979) (376661E 6425352N Acc 500m)

Observation types:

O	observed	W	Heard	H	Hair, feathers or skin
F	tracks/scratchings	P	scat	E	Nest/roost
T	Trapped or netted	Y	Bone or teeth	Z	In raptor/owl pellet
K	Dead	X	In scat	R	Road kill
M	Miscellaneous	U	Ultrasonic call	d	Definite identification
p	Probable identification				

Scientific name	Common name	Status (TSC)	No.	Obs. type	Site No.	Notes
FROGS						
Adelotus brevis	Tusked frog		3	W	2, 7, 10, 14	
Crinia signifera	Common eastern froglet		5+	W	12, 14	
Limnodynastes peronii	Brown-striped frog		2	W	4	
Limnodynastes tasmaniensis	Spotted grass frog		2	O/W	2, 3, 14, 15	
Litoria caerulea	Green tree frog		1	W	5, 14	
Litoria chloris	Red-eyed tree frog		1	W	14	
Litoria fallax	Eastern dwarf tree frog		10+	W	2, 3, 4, 6	
Litoria latopalmata	Broad-palmed frog		15+	O/W	1, 2, 12, 14	
Litoria lesueuri	Lesueur's frog		2	O/W	1, 4, 8, 12, 14	
Litoria peronii	Peron's tree frog		5+	W	2, 3, 4, 5, 9, 12, 14	
Litoria phyllochroa	Leaf-green tree frog		5+	W	1, 2	
Litoria tyleri	Tyler's tree frog		1	W	4, 14	
Litoria wilcoxii			5	O	4, 14	

Scientific name	Common name	Status (TSC)	No.	Obs. type	Site No.	Notes
Mixophyes fasciolatus	Great barred frog		3	O/W	14	
Uperoleia fusca	Dusky toadlet		20+	O/W	3, 4	
Uperoleia laevigata	Smooth toadlet		1	O	4	
BIRDS						
Acanthiza chrysorrhoa	Yellow-rumped thornbill		3	O/W	3, 4, 9, 15	
Acanthiza lineata	Striated thornbill		8+	O/W	3, 4, 12, 14	
Acanthiza nana	Yellow thornbill		4+	O/W	4, 10, 14	
Acanthiza pusilla	Brown thornbill		6	O/W	3, 4, 7, 10, 12, 14	
Acanthiza reguloides	Buff-rumped thornbill		2	O/W	3, 4	
Acanthorhynchus tenuirostris	Eastern spinebill		1	O/W	14	
Accipiter cirrhocaphalus	Collared sparrowhawk		1	O	6, 15	
Accipiter fasciatus	Brown goshawk		2	O	3, 9	
*Acridotheres tristis**	Common myna		2	O	1, 4	
Aegotheles cristatus	Australian owlet-nightjar		2	W	4, 12, 14	
Alisterus scapularis	Australian king-parrot		2	O/W	4, 12	
Anas superciliosa	Pacific black duck		1	O	15	
Anthochaera carunculata	Red wattlebird		2	O/W	3, 4	
Anthus novaeseelandiae	Richard's pipit		4	O	9, 12	
Aquila audax	Wedge-tailed eagle		2	O	4, 6, 7, 15	
Ardea pacifica	Pacific heron		1	O	5	
Cacatua galerita	Sulphur-crested cockatoo		10+	O/W	1, 3, 4, 7, 10, 15	
Cacomantis flabelliformis	Fan-tailed cuckoo		1	W	4	
Centropus phasianinus	Pheasant coucal		2	W	3, 4, 7	
Chalcites lucidus	Shining bronze-cuckoo		1	W	4	
Chenonetta jubata	Australian wood duck		1	O	8, 11, 15	
Colluricincla harmonica	Grey shrike-thrush		2	O/W	1, 3, 4, 15	
Columba leucomela	White-headed pigeon		1	O	7	
Coracina novaehollandiae	Black-faced cuckoo-shrike		4	O	1, 3, 4, 9, 12, 15	
Coracina tenuirostris	Cicadabird		1	O/W	12, 14	
Corcorax melanorhamphos	White-winged chough		3	O	10, 14	27/11/2007 - Nest at 369785E 6432451
Cormobates leucophaeus	White-throated treecreeper		5	W	3, 4, 10, 12	
Corturnix pectoralis	Stubble quail		1	O	14	

Scientific name	Common name	Status (TSC)	No.	Obs. type	Site No.	Notes
Corvus coronoides	Australian raven		6	O/W	3, 4, 6, 10, 14, 15	
Cracticus nigrogularis	Pied butcherbird		3	W	3, 4, 6, 14, 15	
Cracticus torquatus	Grey butcherbird		2	W	3, 4, 15	
Dacelo novaeguineae	Laughing kookaburra		4	O/W	3, 4, 6, 9, 14	
Daphoenositta chrysoptera	Varied sittella		4	O/W	4, 11	
Egretta novaehollandiae	White-faced heron		2	O	6, 11	
Elanus axillaris	Black-shouldered kite		2	O	6, 10	
Eolophus roseicapillus	Galah		6	O	1, 3, 4, 6, 10	
Eopsaltria australis	Eastern yellow robin		2	O/W	4, 12, 14	
Eudynamys orientalis	Common koel		3	W	3, 4	
Eurystomus orientalis	Dollarbird		4	O/W	3, 4, 10, 14	
Falco berigora	Brown falcon		1	O	2, 3, 15	
Falco cenchroides	Nankeen kestrel		2	O	1, 4	possible nest site in large hollow in cabbage gum near Salisbury Rd at approx 373046E 6427168N
Falco peregrinus	Peregrine falcon		1	O	15	
Gallinula tenebrosa	Dusky moorhen		1	O	13	
Geopelia humeralis	Bar-shouldered dove		2	O/W	2, 4, 10	
Gerygone mouki	Brown gerygone		1	E	12, 14	
Gerygone olivacea	White-throated gerygone		3	W	4, 9, 10	
Glossopsitta concinna	Musk lorikeet		2	O/W	4	
Grallina cyanoleuca	Australian magpie-lark		5	O/W/ E	3, 4, 11	nest at 369785E 6432451N
Gymnorhina tibicen	Australian magpie		10+	O/W	1, 3, 4, 6, 10, 15	
Haliaeetus leucogaster	White-bellied sea-eagle		1	O	4	376292E 6423459N - possible nest nearby to east
Hirundapus caudacutus	White-throated needletail		1+	O	14, 15	
Hirundo ariel	Fairy martin		10+	O	1	
Hirundo neoxena	Welcome swallow		10+	O	1, 7	
Leucosarcia melanoleuca	Wonga pigeon		1	W	14	
Lichenostomus chrysops	Yellow-faced honeyeater		6	O/W/ E	3, 4, 10, 11, 12, 14, 15	Line A - nest with 3 eggs near tree trap 3
Macrophygia amboinensis	Brown cuckoo-dove		1	W	4, 14	
Malurus cyaneus	Superb fairy-wren		1	O/W	3,4, 6, 9, 10, 11, 14	
Malurus lamberti	Variegated fairy-wren		1+	O/W	12	

Scientific name	Common name	Status (TSC)	No.	Obs. type	Site No.	Notes
Manorina melanocephala	Noisy miner		1	O/W	4, 6, 11	
Manorina melanophrys	Bell miner		5+	W	14, 15	
Meliphaga lewinii	Lewin's honeyeater		1	O	3, 4, 12, 14	
Melithreptus brevirostris	Brown-headed honeyeater		5+	O/W	4	
Melithreptus lunatus	White-naped honeyeater		1+	W	12	
Merops ornatus	Rainbow bee-eater		1	W	5	
Microeca fascinans	Jacky winter		1	W	4	
Monarcha melanopsis	Black-faced monarch		1	O/W	9, 14	
Myiagra inquieta	Restless flycatcher		1	O/W	11	
Myiagra rubecula	Leaden flycatcher		2	W	3, 4, 10, 12, 15	
Myzomela sanguinolenta	Scarlet honeyeater		2	W	3, 4, 14	
Neochmia temporalis	Red-browed finch		2	O/W	4, 14	
Ninox boobook	Southern boobook		2	O/W	3, 4, 5, 12	
Ocyphaps lophotes	Crested pigeon		1	O	7	
Oriolus sagittatus	Olive-backed oriole		1	W	4	
Pachycephala pectoralis	Golden whistler		2	W	1, 4, 14	
Pachycephala rufiventris	Rufous whistler		5	W	4, 9, 11	
Pardalotus punctatus	Spotted pardalote		6	W	3, 4, 6, 11, 12	
Pardalotus striatus	Striated pardalote		1	W	4	
Philemon corniculatus	Noisy friarbird		1+	W	12, 15	
Platycercus elegans	Crimson rosella		5+	O	1, 3, 4, 6, 10, 12, 14	
Platycercus eximius	Eastern rosella		10+	O	1, 3, 7, 10, 14	
Podargus strigoides	Tawny frogmouth		1	W	3	
Psophodes olivaceus	Eastern whipbird		4	W	3, 4, 9, 12, 14	
Ptilonorhynchus violaceus	Satin bowerbird		3	W	3, 4, 12, 14, 15	
Pyrrholaemus sagittatus	**Speckled warbler**	**V**	**3+**	**O/W**	**3, 4**	**26/11/2007 Line B near dam/pond (376550E 6422816N); 29/11/2007 Line B (376585E 6422809N) & Line D; 07/12/2007 Line A near tree trap 10 (376567E 6424333N)**
Rhipidura fuliginosa	Grey fantail		5	O/W	3, 4, 14, 15	
Rhipidura leucophrys	Willie wagtail		5	O/W	3, 5, 9, 11	
Rhipidura rufifrons	Rufous fantail		1	O/W	12, 14	
Scythrops novaehollandiae	Channel-billed cuckoo		3	W	3, 4, 14	

Scientific name	Common name	Status (TSC)	No.	Obs. type	Site No.	Notes
Sericornis frontalis	White-browed scrubwren		3	O/W	4, 10, 12	
Stipiturus malachurus	Southern emu-wren		1	O	14	
Strepera graculina	Pied currawong		1	O	14	
Threskiornis spinicollis	Straw-necked ibis		5+	O	7	
Todiramphus sanctus	Sacred kingfisher		5	O/W	1, 3, 4, 6, 9	
Vanellus miles	Masked lapwing		3	W	4, 6, 14	
Zosterops lateralis	Silvereye		3	W	4, 12, 14	
MAMMALS						
Antechinus stuartii	Brown antechinus		21	T	3, 4	
*Canis familiaris**	Dog		1	F	12	
Chalinolobus gouldii	Gould's wattled bat		1+	T/Ud	1, 2, 3, 4, 5, 8, 12, 14	
Chalinolobus morio	Chocolate wattled bat		1+	Ud	1, 2, 3, 4, 5, 8, 10, 12, 14	
Falsistrellus tasmaniensis	**Eastern false pipistrelle**	**V**	**1+**	**Up**	**1**	**09/01/2008 Site 1 anabat unit 1 (371347E 6430171N)**
Kerivoula papuensis	**Golden-tipped bat**	**V**	**1+**	**Upo**	**4**	**Site 4 28/11/2007 - Ultrasonic detection (376515E 6422915N)**
*Lepus capensis**	Brown hare		2	O	4, 12	
Macropus rufogriseus	Red-necked wallaby		3	O	4	
*Mus musculus**	House mouse		1+	H	3, 4	
Miniopterus schreibersii oceanensis	**Eastern bentwing-bat**	**V**	**1+**	**Ud**	**1, 2, 3, 4**	**26/11/2007 Line A anabat unit 1 (376721E 6423964N); 27/11/2007 Heatherbrae Rd (near Munni Bridge) anabat unit 3 (375142E 6426533N); 28/11/2007 Line D anabat unit 3 (376253E 6423192N); 09/01/2008 Site 1 anabat unit 1 (371347E 6430171N)**
Mormopterus norfolkensis	**East-coast freetail-bat**	**V**	**1+**	**Ud**	**1, 2, 3, 4, 8**	**26/11/2007 Line A anabat unit 1 (376721E 6423964N) & Munni House anabat unit 3 (374593E 6426528N); 27/11/2007 Heatherbrae Rd (near Munni Bridge) anabat unit 3 (375142E 6426533N); 28/11/2007 Tillegra Bridge anabat unit 1 (376492E 6423418N) & Line D anabat unit 3 (376253E 6423192N); 09/01/2008 Site 1 anabat unit 1 (371347E 6430171N)**
Mormopterus sp. 2 (Adams *et al* 1988)	A freetail bat		1+	Ud	2, 3, 5, 8, 14	
Mormopterus sp. 4 (Adams *et al* 1988)	Southern freetail-bat		1+	Up	5	

Scientific name	Common name	Status (TSC)	No.	Obs. type	Site No.	Notes
Myotis macropus	**Southern myotis**	**V**	**5**	**O/T/ Ud**	**1, 2, 3, 4, 5, 8, 10, 14**	**26/11/2007 Line A anabat unit 1 (376721E 6423964N) & Munni House anabat unit 3 (374593E 6426528N); 27/11/2007 spotlight at Heatherbrae Rd (observed flying low over water) & anabat unit 3 (375142E 6426533N); 28/11/2007 Munni House harp trap A (adult female), Line B anabat unit 1 (376515E 6422915N), Tillegra Bridge anabat unit 1 (376492E 6423418N) & Line D anabat unit 3 (376253E 6423192N); 29/11/2007 near Tillegra Bridge (observed flying low over water); 09/01/2008 Site 1 anabat unit 1 (371347E 6430171N); 10/01/2008 Site 10 anabat unit 1 (372301E 6427820N); 10/01/2008 Site 14 anabat unit 3 (373854E 6429724N)**
Nyctophilus geoffroyi	Lesser long-eared bat		27	T	5	
Nyctophilus gouldi	Gould's long-eared bat		1	T	5	
Nyctophilus sp.	-		1+	Ud	3	
Ornithorhynchus anatinus	Platypus		1	O	8	26/11/2007 in Williams River near Tillegra Bridge - observed at 20:00
*Oryctolagus cuniculus**	Rabbit		1	O/P	3, 14	
Perameles nasuta	Long-nosed bandicoot		2	O/W	14	
Petaurus norfolcensis	**Squirrel glider**	**V**	**4**	**O/T/ W**	**3, 4**	**28/11/2007 Line B call playback (heard 4 calls; seen on tree trunk) & Line D (near tree trap 1); 29/11/2007 in ironbark near Tillegra Bridge & Line A spotlight in ironbark (376662E 6424110N); 30/11/2007 Line A tree trap 7 (adult post-lactating female)**
Phascogale tapoatafa	**Brush-tailed phascogale**	**V**	**1**	**T/O**	**4**	**28/11/2007 Line D tree trap 1 (lactating female) & during spotlight**
Phascolarctos cinereus	**Koala**	**V**	**1**	**O/W**	**3, 4, 12, 14**	**28/11/2007 LineD (heard calling); 29/11/2007 - spotlight (heard calling from near river/Line D to south-west); 09/01/2008 Site 12 - call playback (heard calling upslope near ridge to NE); 10/01/2008 Site 14 - call playback (observed in melaleuca)**

Scientific name	Common name	Status (TSC)	No.	Obs. type	Site No.	Notes
Pseudocheirus peregrinus	Common ringtail possum		4	O/P	2, 3, 4	
Pteropus poliocephalus	**Grey-headed flying fox**	**V**	**2**	**O**	**3, 8**	**29/11/2007 Line A call playback (observed flying overhead ridgeline); 10/01/2008 Site 8 - dusk bridge watch (observed flying over Tillegra Bridge)**
Rattus fuscipes	Bush rat		9	T/O	3, 4	
Rattus lutreolus	Swamp rat		1+	H	3, 4	
*Rattus rattus**	Black rat		1	T	3	
Rhinolophus megaphyllus	Eastern horseshoe bat		1+	Ud	2, 3, 8, 10	
Scoteanax rueppellii	**Greater broad-nosed bat**	**V**	**1+**	**Up**	**5, 8, 14**	**26/11/2007 Munni House anabat unit 3 (374593E 6426528N); 28/11/2007 Site 8 - Tillegra Bridge anabat unit 1 (376492E 6423418N); 10/01/2008 Site 14 anabat unit 3 (373854E 6429724N)**
Scotorepens balstoni	Inland broad-nosed bat		1+	Upo	4	
Scotorepens orion	Eastern broad-nosed bat		1+	Up	3, 14	
Tachyglossus aculeatus	Short-beaked echidna		1	F	4	
Tadarida australis	White-striped freetail bat		8	W,Ud	2, 3, 4, 5, 8, 12, 14	
Trichosurus caninus	Short-eared possum		1	O/W	14	
Trichosurus vulpecula	Common brushtail possum		10	O/P	2, 3, 4, 5	
Vespadelus darlingtoni	Large forest bat		1+	Ud	2	
Vespadelus pumilis	Eastern forest bat		1+	Ud	2, 3, 4, 10, 12, 14	
Vespadelus regulus	Southern forest bat		1+	Up	2	
Vespadelus sp.	-		1+	Upo	3, 8	
Vespadelus vulturnus	Little forest bat		3	T/Ud	2, 4, 5, 8, 10, 14	
REPTILES						
Amphibolurus muricatus	Jacky lizard		1	O	4, 14	
Carlia (Lysasaurus) folorium			1	O	4	
Carlia tetradactyla	Southern rainbow skink		1	O	4	
Chelodina longicollis	Eastern long-necked tortoise		2	O	9, 10, 15	
Cryptophis nigrescens	Eastern small-eyed snake		1	O	2	
Ctenotus robustus	Striped skink		4	O	3, 4	
Egernia major	Land mullet		2	O	14	
Eulamprus quoyii	Eastern water skink		1	O	9	
Lampropholis delicata	Grass skink		2	O	5, 6, 12	
Physignathus lesueurii	Eastern water dragon		5	O	2, 4, 9, 10, 14	

Scientific name	Common name	Status (TSC)	No.	Obs. type	Site No.	Notes
Pogona barbata	Bearded dragon		2	R	1, 5	
Saiphos equalis	Three-toed skink		1	O	10	
Tiliqua scincoides	Eastern blue-tongued lizard		1	O	10	
Varanus varius	Lace monitor		1	O	14	

Scientific name	Common name	Status (TSC)	No.	Obs. type	Site No.	Notes
FROGS						
Adelotus brevis	Tusked frog			W		
Crinia signifera	Common eastern froglet			W	13,	
Litoria caerulea	Green tree frog			W	5	
Litoria chloris	Red-eyed tree frog			W	13,	
Litoria fallax	Eastern dwarf tree frog			W		
Litoria latopalmata	Broad-palmed frog			W		
Litoria peronii	Peron's tree frog			W	13,	
Litoria phyllochroa	Leaf-green tree frog			W		
Litoria tyleri	Tyler's tree frog		1	W	4, 14	
Litoria wilcoxii	-		5	O	4, 14	
Limnodynastes peronii	Brown-striped frog			W		
Limnodynastes tasmaniensis	Spotted grass frog			W		
Mixophyes fasciolatus	Great barred frog		3	O/W	14	
Uperoleia fusca	Dusky toadlet		20+	O/W	3, 4	
Uperoleia laevigata	Smooth toadlet		1	O	4	
BIRDS						
Acanthiza chrysorrhoa	Yellow-rumped thornbill		3	O/W	3, 4, 9, 15	
Acanthiza lineata	Striated thornbill		8+	O/W	3, 4, 12, 14	
Acanthiza nana	Yellow thornbill		4+	O/W	4, 10, 14	
Acanthiza pusilla	Brown thornbill		6	O/W	3, 4, 7, 10, 12, 14	
Acanthiza reguloides	Buff-rumped thornbill		2	O/W	3, 4	
Acanthorhynchus tenuirostris	Eastern spinebill		1	O/W	14	
Accipiter cirrhocaphalus	Collared sparrowhawk		1	O	6, 15	
Accipiter fasciatus	Brown goshawk		2	O	3, 9	
*Acridotheres tristis**	Common myna		2	O	1, 4	
Aegotheles cristatus	Australian owlet-nightjar		2	W	4, 12, 14	
Alisterus scapularis	Australian king-parrot		2	O/W	4, 12	
Anas superciliosa	Pacific black duck		1	O	15	
Anthochaera carunculata	Red wattlebird		2	O/W	3, 4	

Scientific name	Common name	Status (TSC)	No.	Obs. type	Site No.	Notes
Anthus novaeseelandiae	Richard's pipit		4	O	9, 12	
Aquila audax	Wedge-tailed eagle		2	O	4, 6, 7, 15	
Ardea pacifica	Pacific heron		1	O	5	
Cacatua galerita	Sulphur-crested cockatoo		10+	O/W	1, 3, 4, 7, 10, 15	
Cacomantis flabelliformis	Fan-tailed cuckoo		1	W	4	
Centropus phasianinus	Pheasant coucal		2	W	3, 4, 7	
Chalcites lucidus	Shining bronze-cuckoo		1	W	4	
Chenonetta jubata	Australian wood duck		1	O	8, 11, 15	
Colluricincla harmonica	Grey shrike-thrush		2	O/W	1, 3, 4, 15	
Columba leucomela	White-headed pigeon		1	O	7	
Coracina novaehollandiae	Black-faced cuckoo-shrike		4	O	1, 3, 4, 9, 12, 15	
Coracina tenuirostris	Cicadabird		1	O/W	12, 14	
Corcorax melanorhamphos	White-winged chough		3	O	10, 14	27/11/2007 - Nest at 369785E 6432451
Cormobates leucophaeus	White-throated treecreeper		5	W	3, 4, 10, 12	
Corturnix pectoralis	Stubble quail		1	O	14	
Corvus coronoides	Australian raven		6	O/W	3, 4, 6, 10, 14, 15	
Cracticus nigrogularis	Pied butcherbird		3	W	3, 4, 6, 14, 15	
Cracticus torquatus	Grey butcherbird		2	W	3, 4, 15	
Dacelo novaeguineae	Laughing kookaburra		4	O/W	3, 4, 6, 9, 14	
Daphoenositta chrysoptera	Varied sittella		4	O/W	4, 11	
Egretta novaehollandiae	White-faced heron		2	O	6, 11	
Elanus axillaris	Black-shouldered kite		2	O	6, 10	
Eolophus roseicapillus	Galah		6	O	1, 3, 4, 6, 10	
Eopsaltria australis	Eastern yellow robin		2	O/W	4, 12, 14	
Eudynamys orientalis	Common koel		3	W	3, 4	
Eurystomus orientalis	Dollarbird		4	O/W	3, 4, 10, 14	
Falco berigora	Brown falcon		1	O	2, 3, 15	
Falco cenchroides	Nankeen kestrel		2	O	1, 4	possible nest site in large hollow in cabbage gum near Salisbury Rd at approx 373046E 6427168N
Falco peregrinus	Peregrine falcon		1	O	15	
Gallinula tenebrosa	Dusky moorhen		1	O	13	
Geopelia humeralis	Bar-shouldered dove		2	O/W	2, 4, 10	

Scientific name	Common name	Status (TSC)	No.	Obs. type	Site No.	Notes
Gerygone mouki	Brown gerygone		1	E	12, 14	
Gerygone olivacea	White-throated gerygone		3	W	4, 9, 10	
Glossopsitta concinna	Musk lorikeet		2	O/W	4	
Grallina cyanoleuca	Australian magpie-lark		5	O/W/ E	3, 4, 11	nest at 369785E 6432451N
Gymnorhina tibicen	Australian magpie		10+	O/W	1, 3, 4, 6, 10, 15	
Haliaeetus leucogaster	White-bellied sea-eagle		1	O	4	376292E 6423459N - possible nest nearby to east
Hirundapus caudacutus	White-throated needletail		1+	O	14, 15	
Hirundo ariel	Fairy martin		10+	O	1	
Hirundo neoxena	Welcome swallow		10+	O	1, 7	
Leucosarcia melanoleuca	Wonga pigeon		1	W	14	
Lichenostomus chrysops	Yellow-faced honeyeater		6	O/W/ E	3, 4, 10, 11, 12, 14, 15	Line A - nest with 3 eggs near tree trap 3
Macrophygia amboinensis	Brown cuckoo-dove		1	W	4, 14	
Malurus cyaneus	Superb fairy-wren		1	O/W	3,4, 6, 9, 10, 11, 14	
Malurus lamberti	Variegated fairy-wren		1+	O/W	12	
Manorina melanocephala	Noisy miner		1	O/W	4, 6, 11	
Manorina melanophrys	Bell miner		5+	W	14, 15	
Meliphaga lewinii	Lewin's honeyeater		1	O	3, 4, 12, 14	
Melithreptus brevirostris	Brown-headed honeyeater		5+	O/W	4	
Melithreptus lunatus	White-naped honeyeater		1+	W	12	
Merops ornatus	Rainbow bee-eater		1	W	5	
Microeca fascinans	Jacky winter		1	W	4	
Monarcha melanopsis	Black-faced monarch		1	O/W	9, 14	
Myiagra inquieta	Restless flycatcher		1	O/W	11	
Myiagra rubecula	Leaden flycatcher		2	W	3, 4, 10, 12, 15	
Myzomela sanguinolenta	Scarlet honeyeater		2	W	3, 4, 14	
Neochmia temporalis	Red-browed finch		2	O/W	4, 14	
Ninox boobook	Southern boobook		2	O/W	3, 4, 5, 12	
Ocyphaps lophotes	Crested pigeon		1	O	7	
Oriolus sagittatus	Olive-backed oriole		1	W	4	
Pachycephala pectoralis	Golden whistler		2	W	1, 4, 14	
Pachycephala rufiventris	Rufous whistler		5	W	4, 9, 11	
Pardalotus punctatus	Spotted pardalote		6	W	3, 4, 6, 11, 12	
Pardalotus striatus	Striated pardalote		1	W	4	

Scientific name	Common name	Status (TSC)	No.	Obs. type	Site No.	Notes
Philemon corniculatus	Noisy friarbird		1+	W	12, 15	
Platycercus elegans	Crimson rosella		5+	O	1, 3, 4, 6, 10, 12, 14	
Platycercus eximius	Eastern rosella		10+	O	1, 3, 7, 10, 14	
Podargus strigoides	Tawny frogmouth		1	W	3	
Psophodes olivaceus	Eastern whipbird		4	W	3, 4, 9, 12, 14	
Ptilonorhynchus violaceus	Satin bowerbird		3	W	3, 4, 12, 14, 15	
Pyrrholaemus sagittatus	**Speckled warbler**	**V**	**3+**	**O/W**	**3, 4**	26/11/2007 Line B near dam/pond (376550E 6422816N); 29/11/2007 Line B (376585E 6422809N) & Line D; 07/12/2007 Line A near tree trap 10 (376567E 6424333N)
Rhipidura fuliginosa	Grey fantail		5	O/W	3, 4, 14, 15	
Rhipidura leucophrys	Willie wagtail		5	O/W	3, 5, 9, 11	
Rhipidura rufifrons	Rufous fantail		1	O/W	12, 14	
Scythrops novaehollandiae	Channel-billed cuckoo		3	W	3, 4, 14	
Sericornis frontalis	White-browed scrubwren		3	O/W	4, 10, 12	
Stipiturus malachurus	Southern emu-wren		1	O	14	
Strepera graculina	Pied currawong		1	O	14	
Threskiornis spinicollis	Straw-necked ibis		5+	O	7	
Todiramphus sanctus	Sacred kingfisher		5	O/W	1, 3, 4, 6, 9	
Vanellus miles	Masked lapwing		3	W	4, 6, 14	
Zosterops lateralis	Silvereye		3	W	4, 12, 14	
MAMMALS						
Antechinus stuartii	Brown antechinus		21	T	3, 4	
*Canis familiaris**	Dog		1	F	12	
Chalinolobus gouldii	Gould's wattled bat		1+	T/Ud	1, 2, 3, 4, 5, 8, 12, 14	
Chalinolobus morio	Chocolate wattled bat		1+	Ud	1, 2, 3, 4, 5, 8, 10, 12, 14	
Falsistrellus tasmaniensis	**Eastern false pipistrelle**	**V**	**1+**	**Up**	**1**	09/01/2008 Site 1 anabat unit 1 (371347E 6430171N)
Kerivoula papuensis	**Golden-tipped bat**	**V**	**1+**	**Upo**	**4**	Site 4 28/11/2007 - Ultrasonic detection (376515E 6422915N)
*Lepus capensis**	Brown hare		2	O	4, 12	
Macropus rufogriseus	Red-necked wallaby		3	O	4	
*Mus musculus**	House mouse		1+	H	3, 4	

Scientific name	Common name	Status (TSC)	No.	Obs. type	Site No.	Notes
Miniopterus schreibersii oceanensis	**Eastern bentwing-bat**	**V**	**1+**	**Ud**	**1, 2, 3, 4**	26/11/2007 Line A anabat unit 1 (376721E 6423964N); 27/11/2007 Heatherbrae Rd (near Munni Bridge) anabat unit 3 (375142E 6426533N); 28/11/2007 Line D anabat unit 3 (376253E 6423192N); 09/01/2008 Site 1 anabat unit 1 (371347E 6430171N)
Mormopterus norfolkensis	**East-coast freetail-bat**	**V**	**1+**	**Ud**	**1, 2, 3, 4, 8**	26/11/2007 Line A anabat unit 1 (376721E 6423964N) & Munni House anabat unit 3 (374593E 6426528N); 27/11/2007 Heatherbrae Rd (near Munni Bridge) anabat unit 3 (375142E 6426533N); 28/11/2007 Tillegra Bridge anabat unit 1 (376492E 6423418N) & Line D anabat unit 3 (376253E 6423192N); 09/01/2008 Site 1 anabat unit 1 (371347E 6430171N)
Mormopterus sp. 2 (Adams *et al* 1988)	A freetail bat		1+	Ud	2, 3, 5, 8, 14	
Mormopterus sp. 4 (Adams *et al* 1988)	Southern freetail-bat		1+	Up	5	
Myotis macropus	**Southern myotis**	**V**	**5**	**O/T/ Ud**	**1, 2, 3, 4, 5, 8, 10, 14**	26/11/2007 Line A anabat unit 1 (376721E 6423964N) & Munni House anabat unit 3 (374593E 6426528N); 27/11/2007 spotlight at Heatherbrae Rd (observed flying low over water) & anabat unit 3 (375142E 6426533N); 28/11/2007 Munni House harp trap A (adult female), Line B anabat unit 1 (376515E 6422915N), Tillegra Bridge anabat unit 1 (376492E 6423418N) & Line D anabat unit 3 (376253E 6423192N); 29/11/2007 near Tillegra Bridge (observed flying low over water); 09/01/2008 Site 1 anabat unit 1 (371347E 6430171N); 10/01/2008 Site 10 anabat unit 1 (372301E 6427820N); 10/01/2008 Site 14 anabat unit 3 (373854E 6429724N**)**
Nyctophilus geoffroyi	Lesser long-eared bat		27	T	5	
Nyctophilus gouldi	Gould's long-eared bat		1	T	5	
Nyctophilus sp.	-		1+	Ud	3	
Ornithorhynchus anatinus	Platypus		1	O	8	26/11/2007 in Williams River near Tillegra Bridge - observed at 20:00

Scientific name	Common name	Status (TSC)	No.	Obs. type	Site No.	Notes
*Oryctolagus cuniculus**	Rabbit		1	O/P	3, 14	
Perameles nasuta	Long-nosed bandicoot		2	O/W	14	
Petaurus norfolcensis	**Squirrel glider**	**V**	**4**	**O/T/ W**	**3, 4**	28/11/2007 Line B call playback (heard 4 calls; seen on tree trunk) & Line D (near tree trap 1); 29/11/2007 in ironbark near Tillegra Bridge & Line A spotlight in ironbark (376662E 6424110N); 30/11/2007 Line A tree trap 7 (adult post-lactating female)
Phascogale tapoatafa	**Brush-tailed phascogale**	**V**	**1**	**T/O**	**4**	28/11/2007 Line D tree trap 1 (lactating female) & during spotlight
Phascolarctos cinereus	**Koala**	**V**	**1**	**O/W**	**3, 4, 12, 14**	28/11/2007 Line D (heard calling); 29/11/2007 - spotlight (heard calling from near river/Line D to south-west); 09/01/2008 Site 12 - call playback (heard calling upslope near ridge to NE); 10/01/2008 Site 14 - call playback (observed in *Melaleuca***)**
Pseudocheirus peregrinus	Common ringtail possum		4	O/P	2, 3, 4	
Pteropus poliocephalus	**Grey-headed flying fox**	**V**	**2**	**O**	**3, 8**	29/11/2007 Line A call playback (observed flying overhead ridgeline); 10/01/2008 Site 8 - dusk bridge watch (observed flying over Tillegra Bridge)
Rattus fuscipes	Bush rat		9	T/O	3, 4	
Rattus lutreolus	Swamp rat		1+	H	3, 4	
*Rattus rattus**	Black rat		1	T	3	
Rhinolophus megaphyllus	Eastern horseshoe bat		1+	Ud	2, 3, 8, 10	
Scoteanax rueppellii	**Greater broad-nosed bat**	**V**	**1+**	**Up**	**5, 8, 14**	26/11/2007 Munni House anabat unit 3 (374593E 6426528N); 28/11/2007 Site 8 - Tillegra Bridge anabat unit 1 (376492E 6423418N); 10/01/2008 Site 14 anabat unit 3 (373854E 6429724N)
Scotorepens balstoni	Inland broad-nosed bat		1+	Upo	4	
Scotorepens orion	Eastern broad-nosed bat		1+	Up	3, 14	
Tachyglossus aculeatus	Short-beaked echidna		1	F	4	
Tadarida australis	White-striped freetail bat		8	W,Ud	2, 3, 4, 5, 8, 12, 14	
Trichosurus caninus	Short-eared possum		1	O/W	14	
Trichosurus vulpecula	Common brushtail possum		10	O/P	2, 3, 4, 5	
Vespadelus darlingtoni	Large forest bat		1+	Ud	2	

Scientific name	Common name	Status (TSC)	No.	Obs. type	Site No.	Notes
Vespadelus pumilis	Eastern forest bat		1+	Ud	2, 3, 4, 10, 12, 14	
Vespadelus regulus	Southern forest bat		1+	Up	2	
Vespadelus sp.	-		1+	Upo	3, 8	
Vespadelus vulturnus	Little forest bat		3	T/Ud	2, 4, 5, 8, 10, 14	
REPTILES						
Amphibolurus muricatus	Jacky lizard		2	O	4, 14	
Carlia (Lysasaurus) folorium			1	O	4	
Carlia tetradactyla	Southern rainbow skink		1	O	4	
Chelodina longicollis	Eastern long-necked tortoise		3	O	9, 10, 15	
Cryptophis nigrescens	Eastern small-eyed snake		1	O	2	
Ctenotus robustus	Striped skink		4	O	3, 4	
Egernia major	Land mullet		2	O	14	
Eulamprus quoyii	Eastern water skink		1	O	9	
Lampropholis delicata	Grass skink		3	O	5, 6, 12	
Physignathus lesueurii	Eastern water dragon		5	O	2, 4, 9, 10, 14	
Pogona barbata	Bearded dragon		2	R	1, 5	
Saiphos equalis	Three-toed skink		1	O	10	
Tiliqua scincoides	Eastern blue-tongued lizard		1	O	10	
Varanus varius	Lace monitor		1	O	14	

Appendix 5. Summary of Survey Effort

Method	Line A (Site 3)	Line B (Site 4)	Line C (Site 4)	Line D (Site 4)	Additional Sites
Bird Survey	29/11/2007 1 person (20min)	29/11/2007 1 person (20min)	29/11/2007 1 person (20min)	29/11/2007 1 person (20min)	
Bridge Watch					10/01/2008 – Site 8 2 persons (40min)
Frog Search		28/11/2007 2 persons (45min)			29/11/2007 – Site 8 2 persons (45min)
Ground and Tree Trapping	26-30/11/2007 3 cage traps 25 "A" Elliotts (ground) 10 "B" Elliotts (tree) - plus 2 cage traps south of Line A	26-30/11/2007 3 cage traps 25 "A" Elliotts (ground) 10 "B" Elliotts (tree) - plus 2 cage traps near Line B	26-30/11/2007 2 cage traps 13 "A" Elliotts (ground) 5 "B" Elliotts (tree)	27-30/11/2007 1 cage traps 12 "A" Elliotts (ground) 5 "B" Elliotts (tree)	27-30/11/2007 Site 8 2 cage traps
Hairtubes	26-30/11/2007 3 large (ground) 10 med (ground) 10 small (tree) 10 small (ground)	26-30/11/2007 3 large (ground) 10 med (ground) 10 small (tree) 10 small (ground)	26-30/11/2007 1 large (ground) 5 med (ground) 5 small (tree) 5 small (ground)	27-30/11/2007 2 large (ground) 5 med (ground) 5 small (tree) 5 small (ground)	
Harp Trapping		26 & 28/11/2007 1 harp trap			28-29/11/2007 Site 5 2 harp traps
Koala Scat Search	29/11/2007 1 person (2 quadrats x 20 trees)				
Nocturnal Call Playback	29/11/2007 2 persons (1.25hrs)	28/11/2007 2 persons (1.25hrs)			09/01/2008 – Site 12 2 persons (1.25hrs) 10/01/2008 – Site 14 2 persons (1.5hrs)
Reptile Survey	29/11/2007 1 person (1.25hrs)			29/11/2007 1 person (1hr)	
Spotlight	29/11/2007 2 persons (1.25hrs)	28/11/2007 1 person (30min)	28/11/2007 1 person (30min)	28/11/2007 1 person (1hr)	27/11/2007 – Site 2 2 persons (1.25hrs) 09/01/2008 – Site 12 2 persons (1.75hrs) 10/01/2008 – Site 14 2 persons (1.5hrs)
Stag Watch		28/11/2007 1 person (30min)		28/11/2007 1 person (30min)	
Ultrasonic Detection	26/11/2007 Unit 1 overnight 27/11/2007 Unit 1 overnight 29/11/2007 Unit 3 (3hrs)	26/11/2007 Unit 4 overnight 28/11/2007 Unit 1 (1.5hrs)	27/11/2007 Unit 4 overnight	28/11/2007 Unit 3 overnight	26/11/2007 – Site 5 Unit 3 overnight 27/11/2007 – Site 2 Unit 3 overnight 28/11/2007 – Site 8 Unit 1 overnight 28/11/2007 – Site 10 Unit 4 overnight 09/01/2008 – Site 1 Unit 1 overnight 09/01/2008 – Site 12 Unit 3 (3.5hrs) 09/01/2008 – Site 12 Unit 2 (3.5hrs) 10/01/2008 – Site 8 Unit 3 (0.5hrs) 10/01/2008 – Site 10 Unit 1 overnight 10/01/2008 – Site 14 Unit 3 (4hrs) 10/01/2008 – Site 14 Unit 2 overnight

Appendix 6. Fauna Survey Results Tables

A6.1 Survey Weather Conditions

Date	Temperature (^{o}C)		Cloud Cover (eights of sky)	Moon (quarters)	Wind	Rain
	Min	Max				
26/11/2007	15.0	27.7	1	4 (not visible early in night)	1	0
27/11/2007	13.7	25.2	0-8 (2 at 22:00)	4 (not visible early in night)	0-1	0
28/11/2007	14.3	27.2	0-4 (day) 4-8 (night)	3 (not visible early in night)	0-1	0
29/11/2007	16.6	27.6	6-8	3 (not visible early in night)	0-1	afternoon storm (heavy rain)
30/11/2007	16.6	23.8	8	-	0-1	light rain in morning
09/01/2008	18.4	27.2	8	0	0-1	light rain in morning
10/01/2008	18.5	28	2	0	0-1	0
11/01/2008	15.6	29.5	1	1	0-1	0

A6.2 Bat Call Analysis Results

Detector number/type of recording *	Date	Location	Species	Number of passes (D/Pr/Po) **
1 / S 20:00-06:00	26/11/07	Site 3 (376721E 6423964N)	White-striped freetail-bat (*Tadarida australis*)	(3/0/0)
			Gould's wattled bat (*Chalinolobus gouldii*)	(2/4/0)
			Eastern horseshoe bat (*Rhinolophus megapyhllus*)	(2/0/0)
			A freetail bat (*Mormopterus* sp. 2 [Adams *et al.* 1988])	(1/4/0)
			Nyctophilus sp.	(1/0/0)
			Chocolate wattled bat (*Chalinolobus morio*)	(0/2/1)
			Eastern broad-nosed bat (*Scotorepens orion*)	(0/2/0)
			Eastern bentwing-bat (*Miniopterus schreibersii oceanensis*)	(0/1/0)
			Eastern forest bat (*Vespadelus pumilis*)	(0/1/0)
			East-coast freetail-bat (*Mormopterus norfolkensis*)	(0/0/1)
			Southern myotis (*Myotis macropus*)	(0/0/1)
			East-coast freetail-bat (*Mormopterus norfolkensis*) <u>or</u> a freetail-bat (*Mormopterus* sp. 2)	(0/0/2)
3 / S 21:00-06:00	26/11/07	Site 5 (374593E 6426528N)	**Southern myotis (*Myotis macropus*)**	(37/27/0)
			Gould's wattled bat (*Chalinolobus gouldii*)	(2/1/2)
			White-striped freetail-bat (*Tadarida australis*)	(1/0/0)
			Little forest bat (*Vespadelus vulturnus*)	(1/0/0)
			East-coast freetail-bat (*Mormopterus norfolkensis*)	(0/2/0)
			Chocolate wattled bat (*Chalinolobus morio*)	(0/1/0)

Detector number/type of recording *	Date	Location	Species	Number of passes (D/Pr/Po) **
			A freetail-bat (*Mormopterus* sp. 2)	(0/1/0)
			Southern freetail-bat (*Mormopterus sp. 4* [Adams *et al.* 1988])	(0/1/0)
			Greater broad-nosed bat (*Scoteanax rueppellii*)	(0/1/0)
			Eastern bentwing-bat (*Miniopterus schreibersii oceanensis*) or large forest bat (*Vespadelus darlingtoni*)	(0/0/3)
			East-coast freetail-bat (*Mormopterus norfolkensis*) or a freetail-bat (*Mormopterus* sp. 2)	(0/0/3)
			Gould's wattled bat (*Chalinolobus gouldii*) **or** *Mormopterus sp.*	(0/0/1)
			Chocolate wattled bat (*Chalinolobus morio*) **or** *Vespadelus sp.*	(0/0/1)
			Chocolate wattled bat (*Chalinolobus morio*) **or** eastern forest bat (*Vespadelus pumilis*)	(0/0/1)
			a freetail-bat (*Mormopterus* sp. 2) **or** southern freetail-bat (*Mormopterus sp. 4*)	(0/0/1)
			Southern myotis (*Myotis macropus*) or *Nyctophilus sp.*	(0/0/1)
			Eastern false pipistrelle (*Falsistrellus tasmaniensis*) or eastern broad-nosed bat (*Scotorepens orion*)	(0/0/1)
4 / S 20:00-06:00	26/11/07	Site 4 (376552E 6422810N)	No calls (equipment malfunction)	
1 / S 20:00-06:00	27/11/07	Site 3 (376546E 6424632N)	*Nyctophilus sp.*	(0/9/5)
			Gould's wattled bat (*Chalinolobus gouldii*)	(0/0/1)
			Chocolate wattled bat (*Chalinolobus morio*)	(0/0/1)
			Vespadelus sp.	(0/0/1)
			Southern myotis (*Myotis macropus*) or *Nyctophilus sp.*	(0/0/3)
			Little forest bat (*Vespadelus vulturnus*) **or** eastern forest bat (*Vespadelus pumilis*)	(0/0/1)
3 / HH & S 21:00-06:00	27/11/07	Site 2 (375142E 6426533N)	**East-coast freetail-bat (*Mormopterus norfolkensis*)**	(311/0/1)
			Large forest bat (*Vespadelus darlingtoni*)	(17/22/0)
			Eastern horseshoe bat (*Rhinolophus megapyhllus*)	(10/0/0)
			Gould's wattled bat (*Chalinolobus gouldii*)	(4/0/0)
			Southern myotis (*Myotis macropus*)	(4/25/0)
			Little forest bat (*Vespadelus vulturnus*)	(4/1/0)
			Chocolate wattled bat (*Chalinolobus morio*)	(0/7/5)
			Eastern bentwing-bat (*Miniopterus schreibersii oceanensis*)	(0/3/0)
			A freetail-bat (*Mormopterus* sp. 2)	(0/3/0)
			Eastern forest bat (*Vespadelus pumilis*)	(0/3/0)
			Southern forest bat (*Vespadelus regulus*)	(0/1/0)
			Chocolate wattled bat (*Chalinolobus morio*) **or** eastern forest bat (*Vespadelus pumilis*)	(0/0/6)
			Chocolate wattled bat (*Chalinolobus morio*) **or** *Vespadelus sp.*	(0/0/8)
			Eastern false pipistrelle (*Falsistrellus tasmaniensis*) or east-coast freetail-bat (*Mormopterus norfolkensis*)	(0/0/1)
			Eastern false pipistrelle (*Falsistrellus tasmaniensis*) or eastern broad-nosed bat (*Scotorepens orion*)	(0/0/1)
			Eastern bentwing-bat (*Miniopterus schreibersii oceanensis*) or large forest bat (*Vespadelus darlingtoni*)	(0/0/22)
			A freetail-bat (*Mormopterus* sp. 2) **or** southern freetail-bat (*Mormopterus sp. 4*)	(0/0/2)
			Southern myotis (*Myotis macropus*) or *Nyctophilus sp.*	(0/0/1)
			Large forest bat (*Vespadelus darlingtoni*) **or** southern forest bat (*Vespadelus regulus*)	(0/0/7)

Detector number/type of recording *	Date	Location	Species	Number of passes (D/Pr/Po) **
			Little forest bat (*Vespadelus vulturnus*) **or** eastern forest bat (*Vespadelus pumilis*)	(0/0/6)
4 / S 20:00-06:00	27/11/07	Site 4 (376499E 6423229N)	No calls (equipment malfunction)	
1 / S 20:00-21:25	28/11/07	Site 4 (376515E 6422915N)	**Southern myotis (*Myotis macropus*)**	(0/1/0)
			Little forest bat (*Vespadelus vulturnus*)	(0/1/0)
			Golden-tipped bat (*Kerivoula papuensis*)	(0/0/1)
			Inland broad-nosed bat (*Scotorepens balstoni*)	(0/0/1)
			Eastern forest bat (*Vespadelus pumilis*)	(0/0/1)
			Southern myotis (*Myotis macropus*) or *Nyctophilus sp.*	(0/0/1)
1 / S 2120-06:00	28/11/07	Site 8 (376492E 6423418N)	**East-coast freetail-bat (*Mormopterus norfolkensis*)**	(404/6/0)
			White-striped freetail-bat (*Tadarida australis*)	(29/0/0)
			Eastern horseshoe bat (*Rhinolophus megapyhllus*)	(5/0/0)
			Gould's wattled bat (*Chalinolobus gouldii*)	(1/0/0)
			Southern myotis (*Myotis macropus*)	(1/0/0)
			Greater broad-nosed bat (*Scoteanax rueppellii*)	(0/6/0)
			Chocolate wattled bat (*Chalinolobus morio*)	(0/1/0)
			Little forest bat (*Vespadelus vulturnus*)	(0/1/0)
			Vespadelus sp.	(0/0/1)
			Little forest bat (*Vespadelus vulturnus*) **or** eastern forest bat (*Vespadelus pumilis*)	(0/0/4)
3 / S 20:00-06:00	28/11/07	Site 4 (376253E 6423192N)	**Southern myotis (*Myotis macropus*)**	(5/1/0)
			Little forest bat (*Vespadelus vulturnus*)	(5/0/0)
			Gould's wattled bat (*Chalinolobus gouldii*)	(4/2/0)
			East-coast freetail-bat (*Mormopterus norfolkensis*)	(1/0/0)
			Chocolate wattled bat (*Chalinolobus morio*)	(0/5/0)
			Eastern bentwing-bat (*Miniopterus schreibersii oceanensis*)	(0/2/0)
			Southern myotis (*Myotis macropus*) or *Nyctophilus sp.*	(0/0/6)
			Chocolate wattled bat (*Chalinolobus morio*) **or** *Vespadelus sp.*	(0/0/4)
			A freetail-bat (*Mormopterus* sp. 2) **or** southern freetail-bat (*Mormopterus sp. 4*)	(0/0/3)
			Gould's wattled bat (*Chalinolobus gouldii*) **or** southern freetail-bat (*Mormopterus sp. 4*)	(0/0/3)
			Gould's wattled bat (*Chalinolobus gouldii*) **or greater broad-nosed bat (*Scoteanax rueppellii*)**	(0/0/1)
			Greater broad-nosed bat (*Scoteanax rueppellii*) or eastern broad-nosed bat (*Scotorepens orion*)	(0/0/1)
4 / S 20:00-06:00	28/11/07	Site 10 (372296E 6427819N)	No calls (equipment malfunction)	
3 / S 20:00-23:00	29/11/07	Site 3 (376765E 6424110N)	No calls	
1 / S 21:00-06:00	09/01/08	Site 1 (371347E 6430171N)	**East-coast freetail-bat (*Mormopterus norfolkensis*)**	(10/0/0)
			Gould's wattled bat (*Chalinolobus gouldii*)	(7/0/0)
			Eastern bentwing-bat (*Miniopterus schreibersii oceanensis*)	(5/1/0)
			Chocolate wattled bat (*Chalinolobus morio*)	(1/0/1)
			Southern myotis (*Myotis macropus*)	(1/0/0)
			Eastern false pipistrelle (*Falsistrellus tasmaniensis*)	(0/1/0)
			Nyctophilus sp. **or southern myotis (*Myotis macropus*)**	(0/0/1)
			Eastern forest bat (*Vespadelus pumilis*) **or** chocolate wattled bat (*Chalinolobus morio*)	(0/0/2)

Detector number/type of recording *	Date	Location	Species	Number of passes (D/Pr/Po) **
2 / S 21:30-01:00	09/01/08	Site 12 (371981E 6431497N)	Gould's wattled bat (*Chalinolobus gouldii*)	(18/0/0)
			Chocolate wattled bat (*Chalinolobus morio*)	(2/0/0)
			Eastern forest bat (*Vespadelus pumilis*)	(1/2/0)
			Eastern bentwing-bat (*Miniopterus schreibersii oceanensis*)	(0/0/1)
			A freetail-bat (*Mormopterus* sp. 2) **or** Gould's wattled bat (*Chalinolobus gouldii*)	(0/0/1)
3 / S 21:00-00:30	09/01/08	Site 12 (371970E 6431453N)	Gould's wattled bat (*Chalinolobus gouldii*)	(1/1/0)
			Greater broad-nosed bat (*Scoteanax rueppellii*) or eastern false pipistrelle (*Falsistrellus tasmaniensis*) or eastern broad-nosed bat (*Scotorepens orion*)	(0/0/3)
1 / S 20:30-06:00	10/01/08	Site 10 (372301E 6427820N)	Chocolate wattled bat (*Chalinolobus morio*)	(41/4/1)
			Southern myotis (*Myotis macropus*)	(39/0/0)
			Eastern forest bat (*Vespadelus pumilis*)	(33/3/0)
			Eastern horseshoe bat (*Rhinolophus megapyhllus*)	(2/0/0)
			Little forest bat (*Vespadelus vulturnus*)	(0/3/0)
			Chocolate wattled bat (*Chalinolobus morio*) **or** eastern forest bat (*Vespadelus pumilis*)	(0/0/2)
			Little forest bat (*Vespadelus vulturnus*) **or** chocolate wattled bat (*Chalinolobus morio*)	(0/0/2)
			Mormopterus sp.	(0/0/1)
2 / S 20:00-06:00	10/01/08	Site 14 (373665E 6429813N)	Gould's wattled bat (*Chalinolobus gouldii*)	(52/1/0)
			White-striped freetail-bat (*Tadarida australis*)	(2/0/0)
			Eastern broad-nosed bat (*Scotorepens orion*)	(0/1/0)
			Little forest bat (*Vespadelus vulturnus*)	(0/1/0)
			Chocolate wattled bat (*Chalinolobus morio*)	(0/3/2)
			A freetail-bat (*Mormopterus* sp. 2)	(0/0/8)
			Eastern forest bat (*Vespadelus pumilis*)	(0/0/3)
			Southern freetail-bat (*Mormopterus sp. 4*)	(0/0/2)
			Greater broad-nosed bat (*Scoteanax rueppellii*)	(0/0/2)
			Greater broad-nosed bat (*Scoteanax rueppellii*) or eastern broad-nosed bat (*Scotorepens orion*) **or eastern false pipistrelle (*Falsistrellus tasmaniensis*)**	(0/0/3)
			Little forest bat (*Vespadelus vulturnus*) **or** eastern forest bat (*Vespadelus pumilis*)	(0/0/2)
			Southern myotis (*Myotis macropus*) or *Nyctophilus sp.*	(0/0/1)
			Eastern forest bat (*Vespadelus pumilis*) **or** chocolate wattled bat (*Chalinolobus morio*)	(0/0/2)
3 / S 20:30-21:00	10/01/08	Site 8 (376490E 6423431N)	Gould's wattled bat (*Chalinolobus gouldii*)	(30/0/0)
			Southern myotis (*Myotis macropus*)	(2/0/0)
			Little forest bat (*Vespadelus vulturnus*)	(0/3/0)
			A freetail-bat (*Mormopterus* sp. 2)	(0/1/2)
3 / HH & S 21:00-01:00	10/01/08	Site 14 (373854E 6429724N)	Gould's wattled bat (*Chalinolobus gouldii*)	(23/0/0)
			Southern myotis (*Myotis macropus*)	(7/0/0)
			Little forest bat (*Vespadelus vulturnus*)	(3/0/0)
			White-striped freetail-bat (*Tadarida australis*)	(2/0/0)
			Eastern forest bat (*Vespadelus pumilis*)	(1/1/0)
			A freetail-bat (*Mormopterus* sp. 2)	(1/0/1)
			Greater broad-nosed bat (*Scoteanax rueppellii*)	(0/3/1)
			Eastern broad-nosed bat (*Scotorepens orion*)	(0/2/1)
			Chocolate wattled bat (*Chalinolobus morio*)	(0/2/0)
			Chocolate wattled bat (*Chalinolobus morio*) **or** little forest bat (*Vespadelus vulturnus*)	(0/0/4)
			Eastern forest bat (*Vespadelus pumilis*) **or** little forest bat (*Vespadelus vulturnus*)	(0/0/3)

Detector number/type of recording *	Date	Location	Species	Number of passes (D/Pr/Po) **
			Eastern broad-nosed bat (*Scotorepens orion*) **or greater broad-nosed bat (*Scoteanax rueppellii*)**	(0/0/1)
			Eastern broad-nosed bat (*Scotorepens orion*) **or greater broad-nosed bat (*Scoteanax rueppellii*) or eastern false pipistrelle (*Falsistrellus tasmaniensis*)**	(0/0/1)

* type of recording S = stationary; HH = hand-held
** reliability of call D = definite; Pr = probable; Po = possible

A6.3 Trapping Results

Trap Line	Date	Trap No.	Trap size	Position	Species Captured	Age/ Sex	Notes
A	27/11/2007	18	A	Ground	Bush rat (*Rattus fuscipes*)	Ad/M	
	28/11/2007	23	A	Ground	Bush rat (*Rattus fuscipes*)	Ad/M	recapture
	28/11/2007	24	A	Ground	Black rat (*Rattus rattus*)*	Ad/F	
	29/11/2007	16	A	Ground	Brown antechinus (*Antechinus stuartii*)	Ad/F	lactating
	29/11/2007	25	A	Ground	Bush rat (*Rattus fuscipes*)	Ad/M	recapture
	30/11/2007	18	A	Ground	Bush rat (*Rattus fuscipes*)	Ad/M	
	30/11/2007	24	A	Ground	Bush rat (*Rattus fuscipes*)	Ad/M	
	30/11/2007	25	A	Ground	Bush rat (*Rattus fuscipes*)		
	30/11/2007	7	B	Tree	**Squirrel glider (*Petaurus norfolcensis*)**	Ad/F	post-lactating
B	27/11/2007	13	A	Ground	Brown antechinus (*Antechinus stuartii*)	Ad/F	lactating
	27/11/2007	18	A	Ground	Brown antechinus (*Antechinus stuartii*)	Ad/F	lactating
	27/11/2007	19	A	Ground	Brown antechinus (*Antechinus stuartii*)	Ad/F	lactating
	27/11/2007	22	A	Ground	Brown antechinus (*Antechinus stuartii*)	Ad/F	lactating
	27/11/2007	23	A	Ground	Brown antechinus (*Antechinus stuartii*)	Ad/F	lactating
	28/11/2007	19	A	Ground	Bush rat (*Rattus fuscipes*)	Ad/F	
	28/11/2007	16	A	Ground	Brown antechinus (*Antechinus stuartii*)	Ad/F	lactating
	28/11/2007	17	A	Ground	Brown antechinus (*Antechinus stuartii*)	Ad/F	lactating
	28/11/2007	20	A	Ground	Brown antechinus (*Antechinus stuartii*)	Ad/F	lactating
	28/11/2007	24	A	Ground	Brown antechinus (*Antechinus stuartii*)	Ad/F	lactating
C	27/11/2007	10	A	Ground	Brown antechinus (*Antechinus stuartii*)	Ad/F	lactating
	28/11/2007	10	A	Ground	Brown antechinus (*Antechinus stuartii*)	Ad/F	lactating
	30/11/2007	1	A	Ground	Brown antechinus (*Antechinus stuartii*)	Ad/F	lactating
	30/11/2007	11	A	Ground	Brown antechinus (*Antechinus stuartii*)	Ad/F	lactating
D	28/11/2007	1	B	Tree	**Brush-tailed phascogale (*Phascogale tapoatafa*)**	Ad/F	lactating
	29/11/2007	8	A	Ground	Bush rat (*Rattus fuscipes*)	Juv	
	29/11/2007	10	A	Ground	Bush rat (*Rattus fuscipes*)	Juv/F	
	30/11/2007	7	A	Ground	Bush rat (*Rattus fuscipes*)	Juv/F	
	30/11/2007	8	A	Ground	Brown antechinus (*Antechinus stuartii*)	Ad/F	lactating

Notes:
Ad = adult; Juv = juvenile; M = male; F = female

A6.4 Harp Trapping Results

Harp Trap No.	Location	Date	Species	Sex	Notes
1	Elliott Trap Line B 376550E 6422774N	27/11/2007	Little forest bat (*Vespadelus vulturnus*)	M	adult
A	Munni House 374593E 6426528N	28/11/2007	Lesser long-eared bat (*Nyctophilus geoffroyi*)	F	juv
			Lesser long-eared bat (*Nyctophilus geoffroyi*)	F	juv
			Lesser long-eared bat (*Nyctophilus geoffroyi*)	F	juv
			Lesser long-eared bat (*Nyctophilus geoffroyi*)	F	adult
			Southern myotis (*Myotis macropus*)	F	adult
			Lesser long-eared bat (*Nyctophilus geoffroyi*)	F	juv
			Lesser long-eared bat (*Nyctophilus geoffroyi*)	F	adult
			Lesser long-eared bat (*Nyctophilus geoffroyi*)	F	adult
			Little forest bat (*Vespadelus vulturnus*)	M	adult
			Lesser long-eared bat (*Nyctophilus geoffroyi*)	F	juv
			Lesser long-eared bat (*Nyctophilus geoffroyi*)	M	juv
			Lesser long-eared bat (*Nyctophilus geoffroyi*)	F	adult (post-lactating)
			Lesser long-eared bat (*Nyctophilus geoffroyi*)	M	juv
			Lesser long-eared bat (*Nyctophilus geoffroyi*)	M	juv
			Lesser long-eared bat (*Nyctophilus geoffroyi*)	M	juv
		30/11/2007	Lesser long-eared bat (*Nyctophilus geoffroyi*)	F	juv
			Lesser long-eared bat (*Nyctophilus geoffroyi*)	M	adult
			Gould's wattled bat (*Chalinolobus gouldii*)	M	adult
			Gould's long-eared bat (*Nyctophilus gouldi*)	M	adult
B	Munni House 374593E 6426528N	28/11/2007	Little forest bat (*Vespadelus vulturnus*)	F	adult
			Lesser long-eared bat (*Nyctophilus geoffroyi*)	F	juv
			Lesser long-eared bat (*Nyctophilus geoffroyi*)	F	juv
			Lesser long-eared bat (*Nyctophilus geoffroyi*)	F	juv
		29/11/2007	Lesser long-eared bat (*Nyctophilus geoffroyi*)	M	juv
			Lesser long-eared bat (*Nyctophilus geoffroyi*)	M	juv
			Lesser long-eared bat (*Nyctophilus geoffroyi*)	M	adult
			Lesser long-eared bat (*Nyctophilus geoffroyi*)	F	adult (lactating)
			Lesser long-eared bat (*Nyctophilus geoffroyi*)	F	adult (lactating)
			Lesser long-eared bat (*Nyctophilus geoffroyi*)	F	adult (lactating)
		30/11/2007	Lesser long-eared bat (*Nyctophilus geoffroyi*)	M	juv
			Lesser long-eared bat (*Nyctophilus geoffroyi*)	F	adult
			Lesser long-eared bat (*Nyctophilus geoffroyi*)	F	juv

Appendix 7. Bat Management Plan

BAT MANAGEMENT PLAN FOR THE PROPOSED TILLEGRA DAM

1.0 Introduction

Surveys conducted for the proposed Tillegra Dam positively identified thirteen species of microbat, including three threatened species, as inhabiting the study area. A further five species, two of which are threatened species, were probably recorded based on the analysis of ultrasonic calls. This is considered to be a high level of species diversity, particularly given the cleared nature of much of the study area for agriculture and the fragmentation of the remaining forest remnants. The presence of scattered hollow bearing trees, particularly within the road easement and as paddock trees provide a large number of potential roost sites for many of the bat species recorded. The Tillegra Bridge and other smaller bridges also provide roosting opportunities for a range of species, particularly those preferring cave like habitat. Recorded species most likely to roost under bridges are the southern myotis (*Myotis macropus*), eastern bent-wing bat (*Miniopterus schreibersii oceanensis*) and eastern horseshoe bat (*Rhinolophus megaphyllus*), although tree hollows and buildings may also be used.

Little can be done to ameliorate the loss of tree hollows within the inundation area other than by retaining some mature trees in the shallows near the full supply level and providing artificial roost boxes within fringing forest remnants. New bridges are to be constructed for the realignment of Salisbury Road and therefore there is some potential to provide roost sites under these bridges to replace those lost by the removal or flooding of the existing bridge structures.

This bat management plan will discuss the methods of providing alternative roosts and a plan of action for the required sequence of events.

2.0 Project Overview

2.1 Proposed Bridge Design

Three new bridges will need to be constructed for the realignment of Salisbury Road. The first bridge to be constructed is the Tillegra Bridge replacement across the Williams River at the southern end of the road realignment. Two bridges will be required at the northern end of the realignment, one where the road crosses the flooded Moolee Creek near the proposed junction with Chichester Road and the other at the far northern end of the realignment where it crosses the Williams River.

Two bridge designs are currently being considered for the Tillegra Bridge replacement.

Option 1 consists of a two lane concrete structure, 10 metres wide with a 35 metre single span using super ‘T’ girders. Each lane will be 3.5m wide, with 1.5m outer shoulders. A farm access/livestock passage is proposed at both ends of the bridge.

Option 2 consists of a two lane concrete structure, 9.8 metres wide with a 36 metre overall span using two spans of 18 metre long precast prestressed concrete planks and a central blade pier and headstock. Each lane will be 3.5m wide, with 1.4m outer shoulders. A farm access/livestock passage is also proposed at both ends of the bridge.

2.2 Staging

The construction of the replacement Tillegra Bridge and the southern part of the Salisbury Road realignment will need to be completed prior to the removal of the existing timber bridge and the start of the construction of the dam wall. The construction of the two northern bridges and the rest of the road alignment is likely to be completed during the dam wall construction period.

2.3 Demolition

The existing bridge will be demolished following the completion of the new bridge. Although not confirmed, it is possible that a breeding colony of the southern myotis occurs within the hollow corbels under the bridge. Therefore, demolition during the breeding period October - April inclusive will need to be avoided unless the bats are excluded prior to the commencement of the breeding season. Alternative roost sites under the new bridge would need to be in place prior to any exclusion work.

Demolition shall generally be carried out in a controlled and systematic manner and any hollow timbers identified for installation under the new bridges are to be removed with care and transported to the new location or stockpiled for future use.

3.0 Aims and Objectives

The aims of the Bat Management Plan are:

- To maintain the species diversity of microbats within the study area during construction and after the completion of the Tillegra Dam project.
- To retain the integrity of the southern myotis population known to occur in the study area and possibly roosting and breeding under the existing Tillegra Bridge.
- To identify the potential impacts on the overall bat population as a result of the bridge demolitions and hollow bearing tree removal within the inundation area.
- To implement the construction of alternate artificial roost sites, initially under the new Tillegra Bridge and at a later date, under other new bridges and within fringing vegetation above the proposed full supply level.
- Set up a monitoring program before and after the construction of the bridge. The successful end result will be the formation of colony of southern myotis within the roost sites provided under the new bridges. Any roost boxes set up in fringing forest remnant should also be monitored for use by microbats in general.

4.0 Identified threatened Bat Species

The targeted bat surveys conducted in the study area for this proposal identified that five threatened species probably occur (three definite species and two probable species based on ultrasonic call analysis). Two of these species are likely to roost under the existing bridges or buildings within the study area, whereas the other three species are more likely to roost in tree hollows. A further threatened species, the golden-tipped bat (*Kerivoula papuensis*), was possibly recorded and if present would roost in rainforest vegetation or the hanging nests of the yellow-throated scrub wren.

Recorded threatened species that roost in caves, tunnels, bridges, buildings and culverts

Southern or large-footed myotis (*Myotis macropus* [formerly *adversus*]) – definite record
Eastern bent-wing bat (*Miniopterus schreibersii oceanensis*) – definite record

Recorded threatened species that primarily roost in tree hollows and sometimes buildings

East-coast or eastern freetail bat (*Mormopterus norfolkensis*) – definite record
Greater broad-nosed bat (*Scoteanax rueppellii*) – probable record
Eastern false pipistrelle (*Falsistrellus tasmaniensis*) – probable record

5.0 Roost Description and Identification

No actual roost sites were identified during the field surveys however potential hollows for the southern myotis and to a lesser extent the eastern bent-wing bat were noted in the corbels of the Tillegra Bridge (see **Plates 1 & 2**). Both the southern myotis and eastern bent-wing bat were recorded flying in the vicinity of the bridge although they may have been foraging along the river and not actually roost in the bridge. The southern myotis was however recorded foraging nearby not long after dusk suggesting that at least individuals roost under the bridge.

Numerous hollow bearing trees such as the one depicted in **Plate 3** occur as scattered trees along the Williams River and are common within sections of the Salisbury Road reserve. Such trees also occur as scattered paddock trees throughout the study area.

Plate 1. Tillegra Bridge viewed from downstream

Plate 2. Potential bat roost sites under Tillegra Bridge

Plate 3. Mature trees with trunk hollows and branch spouts

6.0 Management Techniques

6.1 Relocation/Exclusion Options

The following options to relocate any bat colony found to be roosting under Tillegra Bridge could be considered:

- Block the known roost hollows after the colony has vacated for the night. This should only be attempted if an alternate roost is known to occur nearby (under the new bridge in this case) or the roost site is not in use. All potential roost sites within the bridge would need to be blocked off. The exclusion of the southern myotis must avoid the breeding season (October-March inclusive) as non-flying young may be present.

- Catch the colony and move them to a known roost in the region. This is not recommended as the bats are likely to return, or worse, they may become disoriented and be unable to find a permanent roost site, resulting in a break up of the colony and increased exposure to predation.

With regards to hollow bearing trees there are too many within the inundation area to contemplate the exclusion of fauna including bats prior to their removal. The only viable option is to rescue individuals found during tree removal. The method of tree removal should involve the sectioning of the tree so that hollow limbs can be gently brought to the ground. As this is a time consuming method, the use of machinery that is capable of slowly lowering the tree to the ground should be investigated.

6.2 Ameliorative Measures

6.2.1 Provision and Design of Nest Boxes and Hollows

The proposed replacement of Tilligra Bridge will result in the loss of several potential roost sites in hollow timber corbels and girders. In order to ameliorate against this loss it is suggested that alternate roost sites, including the relocation of selected corbels from the old bridge, be incorporated into the new bridge design. The southern myotis is known to use dark cavities and blind holes in concrete structures at other locations. In addition the construction of artificial roosts has been successfully trialed under a bridge at Pottsville in northern NSW by NPWS and Tweed Shire Council (Marshall and Macfarlane 2000) and by the RTA at Millfield Bridge in the Hunter Valley (Ecotone 2006). At Millfield Bridge four types of roost design were constructed, an open plank lattice, concrete shafts, concrete chambers and hollow logs (relocated corbels) were installed in January 2004. The old wooden bridge was demolished in August 2005 and the breeding colony reformed in October 2005 in the roost corbel that had been moved to a new location under the new bridge. Monitoring since 2004 has found that a population of up to 70 southern myotis are using the roosts, with the concrete shaft and corbel roosts most preferred. Individuals and small groups also regularly use the timber lattice roosts however the chamber design has only recently been used and the species present is unknown. Because of the difficulty of construction and poor visibility into the roost the chamber design is not recommended.

Open Plank Lattice

This design resembles roost sites that may occur underneath houses. It consists of a 25 mm thick marine plywood backing board and an array of vertical planks, 50mm x 250mm, placed in parallel patterns with a 25-30mm gap between each board so as to provide dark cavities (**Fig 1 and Plate 4**). These can be bolted to the underside of the bridge at various locations.

Concrete Shafts

At Millfield these roosts consisted of a series of holes 75-100mm in diameter are sunk into concrete blocks 1 - 1.5 m long x 200mm wide x 300mm deep (**Fig 2 and Plates 4 and 5**). Some holes are joined at the top to provide a darker cavity and sloping holes have also been observed to be used in tunnel situations (Ray Williams pers. obs.). The concrete blocks can be bolted to the sides of the headstocks and to the underside of the deck between the girders in the darker parts of the bridge. These roosts proved to be difficult to manufacture as the lightweight concrete blocks were prone to breakage. As an alternative, concrete drain pipes with a blocked end would be easier to construct and attach to the headstocks of the bridge.

Hollow Logs

It is suggested that corbels with cracks and hollows be sourced from the demolition of the existing Tillegra Bridge, particularly those that are found to be used by the southern myotis. These could be suspended under the new bridge if the super "T' girders are used (**Plates 6 and 7**).

Suggested Roost Availability

The suggested number of each roost design to be placed under the new bridge if Super 'T' girders are used are as follows; one open plank lattice and one hollow corbel (sourced from the old Tillegra Bridge) placed between the girders and four concrete shafts (single concrete pipe design) located at either end of the bridge on the headstocks. If the concrete plank girders are used then only the concrete shafts can be used and it is recommended that six to eight concrete shafts be used with ideally four located on the central blade pier headstock and two each on the headstocks at each end of the bridge.

Relocation of Timbers

The transfer of a known roost logs (if one is identified) from the existing bridge to the underside of the new bridge should be given utmost importance as this action is considered to have the most potential to succeed. It is thought that the smell of regularly used roosts assists the bats in locating their roost on return and therefore, they are more likely to rapidly find and use such sites. The success of such a procedure has been demonstrated at Millfield Bridge and also at a bridge near Morisset, NSW, where a large colony of Southern Myotis was found to be roosting under a bridge due for replacement. The old timbers were secured to the piers of the new bridge and following the completion of the bridge construction, the bats rapidly returned from an alternate roost known to occur nearby (Fly by Night Bat Surveys, 1996 & 1998). It should be noted that in the case of Millfield Bridge, the new and old bridge were positioned side by side therefore it was easier for the bats to relocate their old roost.

The removal of the hollow corbels will need to be carried out during the demolition of the old bridge and timed to avoid the breeding season of the southern myotis (October-March), if the roosts are still in use. Alternatively bats could be excluded prior to the breeding season if the timing to avoid the breeding season cannot be avoided. A method of attaching the corbels to the underside of the new bridge will need to be considered at the planning stage. The corbels can be attached to the underside of the bridge between the girders if Super 'T' girders are used. The use of galvanised chains and eye bolts to support the corbels was found to be successful at Millfield Bridge (Plates 6 and 7).

Figure 1. Open Plank Lattice Roost Design

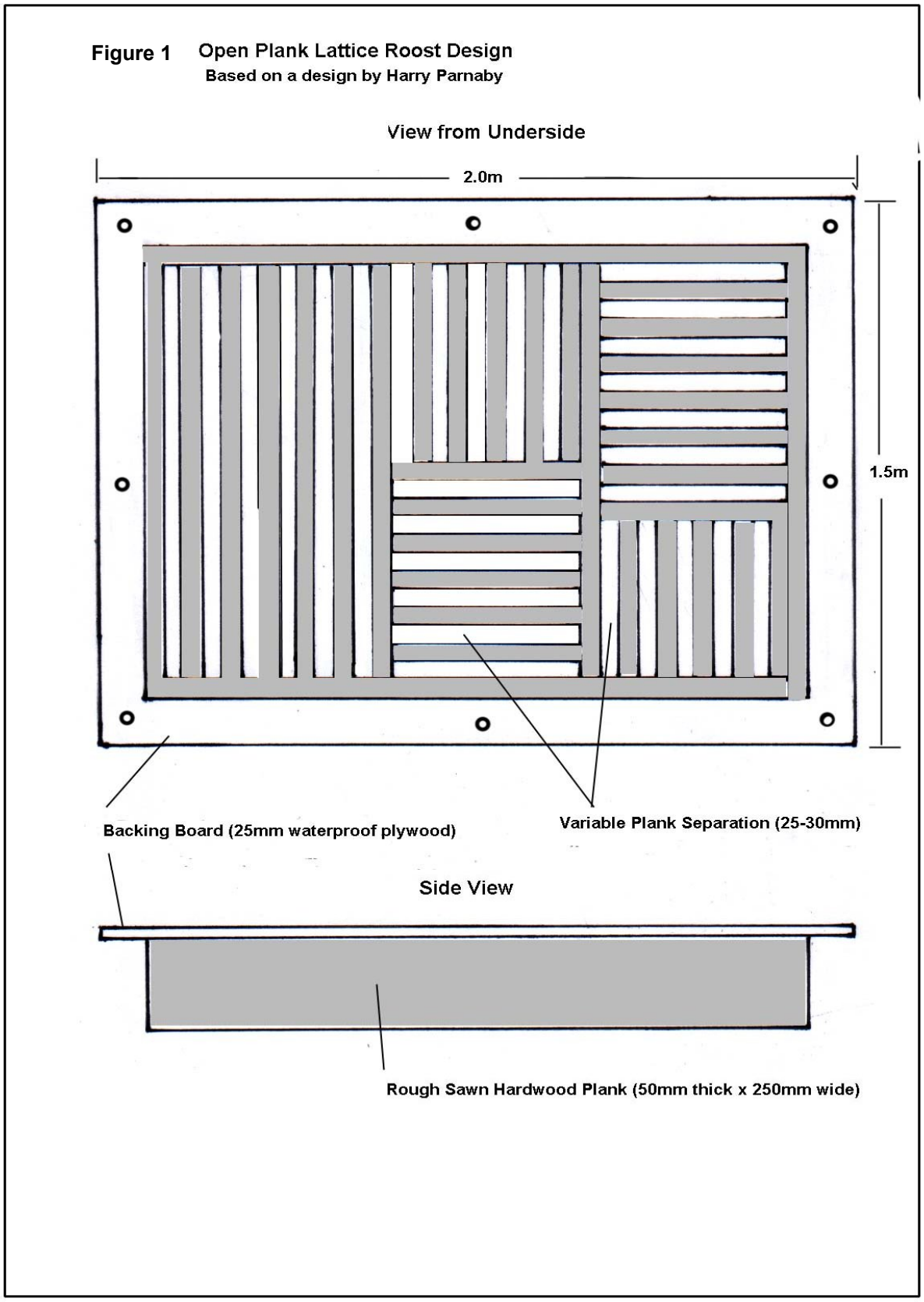

Figure 2. Concrete Shaft Roost Design

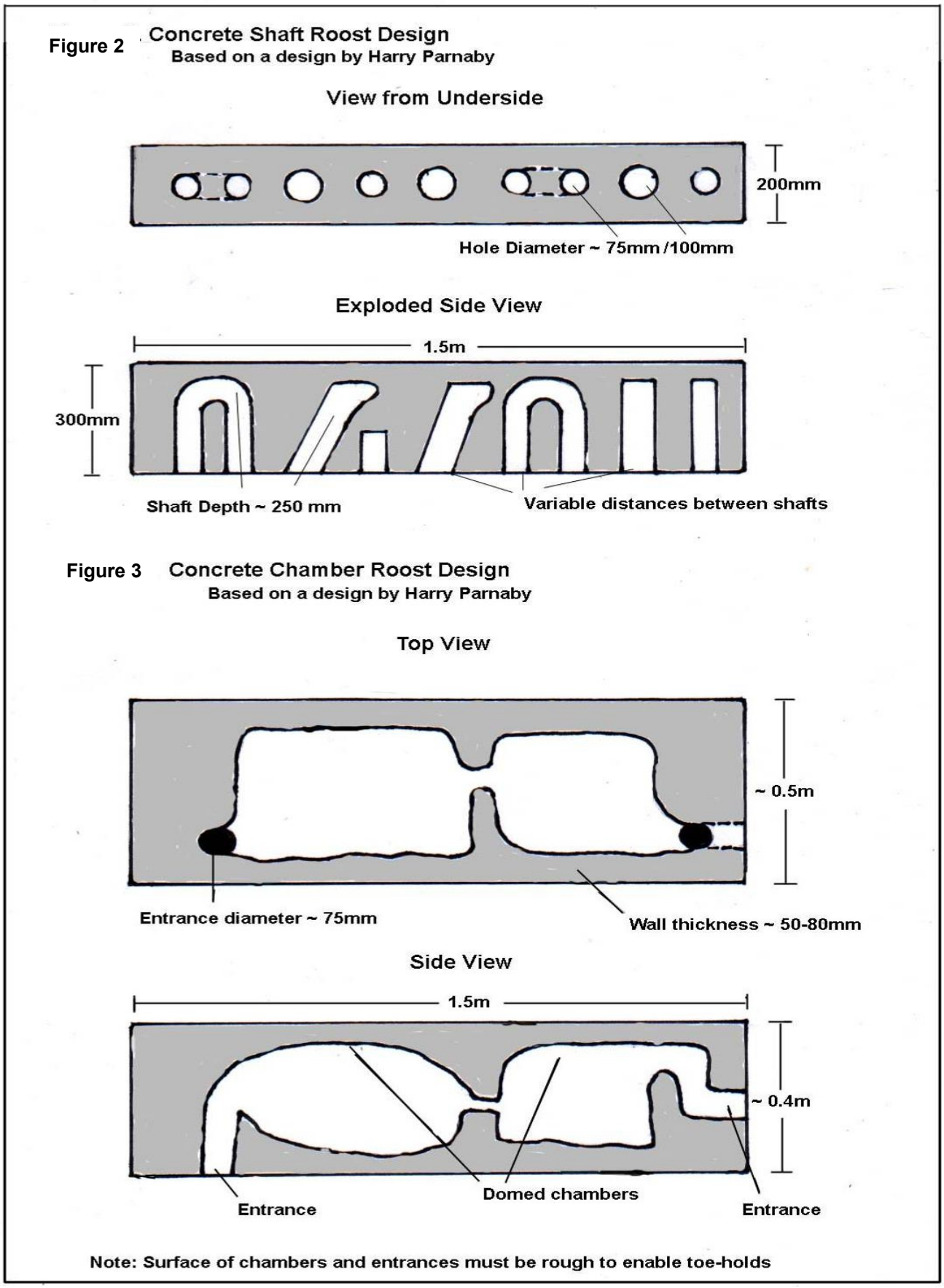

Plate 4. Timber Lattice Roost between Super 'T' Girders at Millfield Bridge (note concrete shaft roost in RH corner)

Plate 5. Concrete Shaft Roost (note bats roosting in recess)

Plate 6. Hollow Corbel used as the main breeding roost at Millfield Bridge

Plate 7. Main Southern Myotis corbel roost at Millfield Bridge

Roost Boxes for Tree Roosting Bat Species

In order to compensate for the loss of natural tree hollows as a result of the proposal, roost boxes could be installed in areas to be revegetated, particularly where hollow bearing trees are rare or absent. The success of the use of bat boxes has been found to be limited with some species taking several years to occupy the boxes and other species appear to avoid them. Recent changes to roost box design aim to improve occupancy rates and boxes made from hardwood are being currently trialed by Ecotone Ecological Consultants and are shown in **Plates 8 and 9**. The east-coast freetail bat is known to use nest boxes but it can take a few years for a population to become established (Glenn Hoye pers. comm.).

It is suggested that boxes be installed in the following two stages:

- Within retained habitat remnants in the Tillegra TSR following the clearing of vegetation for the dam wall and spillway. Boxes should be erected prior to the removal of vegetation.

- Within regenerating forest above the full supply level. Boxes should be erected prior to the removal of habitat trees within the inundation area

The number of boxes to be erected is still to be determined and would depend on the availability of hollow bearing trees within the retained vegetation.

Plate 8. Example of a tree mounted bat box

Plate 9. A free hanging bat box

6.3 Monitoring Requirements

The monitoring of any identified bat colony before, during and after the bridge replacement is one of the most important aspects of the study and should be carried out by a bat specialist. The results will provide important information on the level of disturbance that the southern myotis will endure, whether the artificial roosts under the new bridge are used and which roost design and location is most successful. The use of other roost sites away from the bridge and relationships between other colonies, should they occur, may also be established. Monitoring can be divided into the following sections:

- Prior to the demolition of the old Tillegra Bridge establish whether any bats are roosting in the hollow corbels and girders and determine the extent of use of the bridge as a roost site. A survey between late October and early March would determine whether a maternity roost occurs.

- Monitor any use of the alternate roost sites under the new bridge prior to the removal of the old bridge.

- Monitor the use of roost sites under the new bridge following the removal of the old bridge and relocation of any corbels. This should be carried out on a seasonal basis for at least two years or when a successful breeding colony has taken up residence.

- Monitor tree mounted roost boxes six months after their erection and twice a year after the first inspection. The length of the monitoring period should be over at least three years. It is expected that each monitoring session would be over 2-3 days depending on the number of boxes used.

6.4 Action Plan

An action plan has been prepared and is shown in **Appendix 1** of this Bat Management Plan. This plan aims to set out the timing of events, the person who will carry out the action and a general description of the work required.

7.0 References

Ecotone Ecological Consultants, 2006. *Bat exclusion and relocation, Millfield Bridge Replacement*, *Wollombi Brook, Millfield, NSW*. Report prepared for the NSW Roads and Traffic Authority.

Fly by Night Bat Surveys, 1996. *The exclusion and subsequent re-establishment of a colony of Fishing Bats Myotis adversus at Stockton Creek Bridge near Morisset, New South Wales*. Report to Lake Macquarie City Council. November 1996.

Fly by Night Bat Surveys, 1998. *Monitoring of a Colony of Fishing Bats (Myotis adversus) Following their Exclusion and Subsequent Re-establishment at Stockton Creek Bridge near Morisset, New South Wales*. Report to Lake Macquarie City Council. December 1998.

Marshall, C. & Macfarlane, J., 2000. *Creating Bat Friendly Bridges.* Abstract of Poster Paper presented at the 9th Australasian Bat Conference, Tocal College, Paterson, NSW.

Appendix 1. Bat Action Plan

No	ACTION/EVENT	PERSON RESPONSIBLE	TIMING	COMMENTS	OUTPUT
1	Bridge design to incorporate bat roosts and environmental protection factors	Bridge designers +Bat Specialist	Current	Includes attachment methods, location and final design of nest boxes, protection of Williams River (sedimentation and erosion control during construction and drainage from completed bridge to retention basins).	Incorporated into REF and detailed bridge design
2	Appropriate requirements of BMP included in the Contract Documents	Hunter Water	Construction contracts	Could be included in the Construction Contractor's Environmental Management Plan	Incorporated into contract documents
3	Organise the construction of alternate roosts to be placed under the new bridge.	Bat Specialist and/or contractor	During bridge construction	If supplied by the Contractor, prototypes of the artificial roosts to be approved by the Bat Specialist	Prototypes, approvals
4	Attach bat roosts to underside of the new bridge	Contractors under the supervision of a bat specialist	Near to the completion of construction		
5	Monitor of roost sites at both the old and new Tillegra Bridges	Bat Specialist	Prior to start of the demolition of the old bridge	Monitor current status of any bat colony roosting under both the old and new bridges	Monitoring reports
6	Exclude any bats roosting under the bridge	Bat Specialist	Immediately prior to the demolition work or prior to the breeding season October - March	Exclusion is only to take place after the roosts are installed under the new bridge. If demolition is to take place during the breeding season then the exclusion work would need to be brought forward	Demolition approval granted
7	Meeting on site	HWC, demolition workers and Bat Specialist	Prior to the start of demolition	Discuss the possibility that bats may still be roosting in the timbers and the procedure to be followed if bats are found	Minutes of meeting
8	Demolish the old Tillegra Bridge	Demolition workers	After new bridge and access road is completed	If required retain any roost corbels for transfer to the new bridge	

No	ACTION/EVENT	PERSON RESPONSIBLE	TIMING	COMMENTS	OUTPUT
9	If required install roost corbel(s) under the new bridge	Construction Co. Bat Specialist	During demolition	Predetermined anchor points to be built into the bridge construction plans	Report
10	Monitor the roost sites at the new Tillegra Bridge	Bat Specialist	3 months after the bridge demolition and then every 3 months for two years or prior to this if a bat colony is in residence	Less frequent monitoring of the roosts could be carried out after residency if the activity is included in the overall management plan for the land owned by HWC.	Reports
11	If required, attach tree mounted roosts to selected trees in forest remnants to be retained around the dam wall construction area	Bat Specialist	Prior to tree removal for the construction of the dam wall	Roosts made out of hardwood preferred although most commercial boxes are made out of painted plywood and may require more maintenance.	Location maps and report
12	Monitor the tree roost sites near the dam wall.	Bat Specialist	6 months after their erection. Then every 6 months for 3 years.	It may take more than 6 months for some species of bat to find and use the roost boxes. This activity could be included in the overall management plan for the land owned by HWC.	Monitoring reports
13	If required, attach tree mounted roosts to selected trees in forest remnants to be retained above the full supply level	Bat Specialist	Prior to tree removal in the inundation area	Roosts made out of hardwood preferred although most commercial boxes are made out of painted plywood and may require more maintenance.	Location maps and report
14	Monitor the tree roost sites near the dam wall.	Bat Specialist	6 months after their erection. Then every 6 months for 3 years. Each session likely to be 2-3 days depending on number of boxes.	It may take more than 6 months for some species of bat to find and use the roost boxes. This activity could be included in the overall management plan for the land owned by HWC.	Monitoring reports

Appendix 8. Supplementary Threatened Frog Habitat Assessment

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THREATENED FROG ASSESSMENT

PROPOSED DAM SITE and INUNDATION AREA TILLEGRA DAM

Introduction

In 2006, the New South Wales state government initiated a program to construct a new dam in the upper Hunter region to secure water resources for the future growth of the area (Hunter Water 2007). Hunter Water was appointed as the agency to plan and oversee the construction of the dam. Part of the planning process included a range of environmental considerations that would arise as a result of the construction of the dam, the inundation of low-lying areas and changes to the flow regimes of the Williams River.

In 2007-2008, Ecotone Ecological Consultants Pty Ltd undertook an extensive flora and fauna survey of the areas likely to be impacted by the construction of the dam. This included some frog surveys in parts of the impact area (hereafter referred to as the Study Area). Assessments were also made of the likelihood of other threatened frog species occurring in the area (Ecotone 2008). As a result of the initial surveys, a number of frog species were detected but no threatened frog species were found. The Commonwealth's Department of the Environment and Water Resources' data base listed four threatened frog species that may occur in the study area: these were:

Green and Golden Bell Frog	*Litoria aurea*
Booroolong Frog	*Litoria booroolongensis*
Stuttering Frog	*Mixophyes balbus*
Giant Barred Frog	*Mixophyes iteratus*

The States' Wildlife Data base listed an additional threatened frog species (threatened at the state level only) as possibly being in the impact area: this was:

Green-thighed Frog	*Litoria brevipalmata*

Ecotone (2008) noted that the frog surveys that were carried out were comprehensive, however, the extensive size of the inundation area (21 km^2) prevented a detailed survey of every component of the project area. Their analysis indicated that subject to expert verification, habitat for some threatened frog species may be present in the study area; in particular, habitat of the Stuttering frog.

In July 2008, Biosphere Environmental Consultants Pty Ltd were engaged to undertake a habitat assessment of the study site to better resolve the likelihood of habitat for any of the threatened frog species being present. An inspection of the study site was carried out in late July 2008 and the results of that inspection are reported herein.

Study Site

The study site included the proposed dam site, inundation area and sites along the Williams River below the dam. The total area proposed for inundation is about 2100 ha and covers most of the low-lying areas Williams River valley from the current Tillegra Bridge northwards to Underbank. Less extensive inundation will occur in the low lying areas of Quart Pot Creek and Native Dog Creek valleys (Figure 1). Approximately twenty kilometres of river frontage will be inundated as a result of the creation of the dam and storage lake.

Much of the land alongside the Williams River in the study site is pasture land. Extensive clearing and pasture improvement has cleared the bulk of the inundation area of native vegetation and in many places only a very narrow strip of riparian vegetation has been retained along the river edges.

Methods

The study site was traversed by vehicle and on foot in late July with the aims of visiting all potential frog habitat areas that may provide habitat for threatened frog species. Not all of the area could be access as some properties denied access for this work, however these properties accounted for less than 5% of the total areas of the study site and many of them could be viewed with binoculars from boundary roads or from vantage points nearby.

The Booroolong Frog was excluded from this assessment as this species did not historically occur in the Williams River valley and there are no records of the species in the immediate area.

Areas of potential habitat were identified on the basis of the following criteria:

Green-thighed Frog Habitat: (based on Ehmann 1997)

- Woodland or forest areas comprising either rainforest pockets, wet or dry sclerophyll forest.
- Site elevations from 10 to 500 m asl
- Breeding sites consists of ephemeral sites in flood-prone areas, such as billabongs, overflow dams, ditches or waterholes in creeks.
- Breeding sites often shallow (20-40 cms), and fully exposed to sunlight.
- Water temperatures in breeding sites may reach 30°.
- Breeding sites often lined with dense leaf litter, branches or twigs or flooded vegetation.
- Breeding sites may be artificial in origin.

Giant Barred Frog Habitat: (based on Mahony *et al*. 1997a, White 2008)

- Second, third or fourth order streams in relatively flat gully sites
- Water flow must be permanent and slow moving.
- Site elevation from 20 m ASL to 200 m asl
- Water depths may vary between 30 cm and several metres in depth.
- Fish may be present
- Banks clay or soil lined; may be bare along water's edge or contain dense leaf litter, or contain widely spaced low mesic plants.
- Closed or open forest above comprising warm, temperate rainforest, wet sclerophyll or dry sclerophyll forest.

Stuttering Frog Habitat: (based on Mahony *et al*. 1997b; White *et al*. 2008)

- First order or second order creeks in sheltered gully sites; gullies may be steep.
- Water flow must be permanent or near-permanent (10 months in the year)
- Water depths shallow (1-50 cms)
- Water temperatures range between 15° and 18°.
- Overhanging clay banks
- Site elevation at least 150 m asl
- Creek sides bare or leaf littered or with widely spaced low mesic plants.
- Closed forest above comprising either cool temperature rainforest or wet sclerophyll species.
- Sites fish free.

Green and Golden Bell Frog Habitat: (based on Pyke and White 1996, 2001).

- Still water sites with full or high exposure to direct sunlight, little exposure to direct wind.
- Sites may be natural e.g. ox-bows, depression or artificial e.g. farm dams, quarries, pits.
- Water depths between 30 and 300 cms
- Tall emergent vegetation present in water bodies
- Water bodies either ephemeral or has fluctuating water levels
- Surrounding vegetation dominated by grasses or low herbs
- Water temperatures able to reach 20°
- Water bodies may have low levels of salt (up to 5% sea water) or other soluble minerals.

Results

Giant Barred Frog Habitat:

No habitat was found for this species in the study area. Habitat may have been present along the Williams River floodplain but two existing impacts have removed this habitat: the removal of lowland forest along the Williams River valley has removed potential tree cover from areas where the species may have occurred; changes to the river's flow path has resulted in changes in flooding frequency and a loss of breeding sites for the species.

Green-thighed Frog Habitat:

No habitat was found for this species in the study area. It is highly likely that habitat for this species was present in the study area but has been lost primarily due to changes in the flow characteristics of the Williams River and the removal of riparian vegetation. In particular, old billabongs and ox-bows have been totally isolated or shielded from inundation by the relocation of the river channel or the creation of diversion levees. Areas near Underbank appear to have contained apparently suitable habitat in the past.

Green and Golden Bell Frog Habitat:

No habitat for this species was found in the study area. The changes to the local flooding capacity of the river in low-lying flood-prone areas have meant that potential breeding sites for this species have been lost. Artificial sites, such as farm dams were unsuitable because they either were static water bodies or contained high densities of fish.

Stuttering Frog Habitat:

Habitat for the Stuttering Frog was present in a few sites in the study area as well as some sites just outside of the study area. Habitat for this species, like the others above, has been greatly reduced by land clearing and the changes in river flow, but some pockets of suitable habitat have survived. Two locations within the study site where habitat was present were sites near the Munni Bridge along a small side gully that is crossed by the Heatherbrae Road; and near the Williams River at Underbank. Habitat that was present just outside of the study area was in an un-named creek about 2 km north of the Tunnibuc Bridge on the Chichester Road; at this site a 500 m long section of riparian vegetation, clay banks and stepped pools were present that would appear to be suitable for Stuttering frogs. Figure 1 depicts the locations of these habitat areas.

Discussion

Presence of Threatened Frog Species

The failure to locate any of the potential threatened frog species in the study area is not entirely surprising. The majority of the area demarcated for the construction of the dam and inundation is cleared pastureland; in addition, there have been extensive changes to the course and flow characteristics of the Williams River from historic de-snagging and river training works (Brookes et al 2004) resulting in a substantial loss of habitat area for many frog species, including threatened frog species.

Habitat was identified for the Stuttering Frog but these areas are quite isolated by large stretches of unsuitable, modified riparian habitat. If the Stuttering Frog has managed to survive in these areas, the populations would be constantly vulnerable to any changes in the remnant habitat; natural changes associated with drought would be sufficient to exterminate these frogs from the small refuge areas.

Stuttering Frogs, and some other frogs, will have a better chance of surviving in areas fringing the proposed inundation area. In some of these locations there remains longer stretches of intact riparian vegetation and breeding sites have not been destroyed by flood mitigation measures.

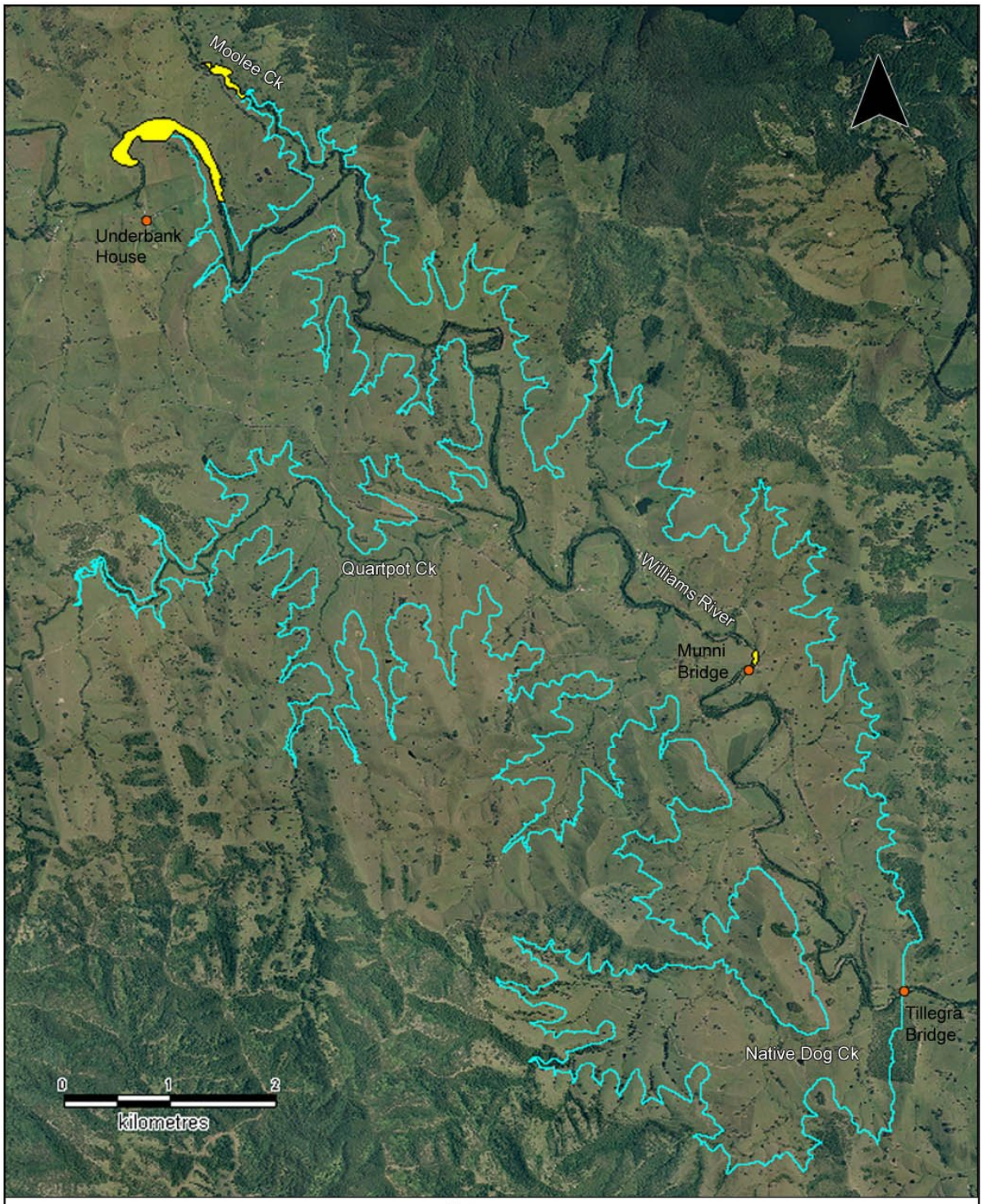

Figure 1. Key Locations and Potential Stuttering Frog Habitat

Impact of Dam and Inundation on Frogs

Three major impacts will arise from the dam construction and inundation of the upriver areas on frogs:

1. Flooding of riparian areas along the Williams River: many of the 16 species of frogs that occur within the study area (Ecotone 2008) breed in still water sites on the floodplain. The inundation of this area will remove these breeding sites and remove large areas of foraging and shelter habitat as well. Most frogs cannot utilize large, open water sites, such as dam lakes. Some frogs will be able to occupy the new fringing habitat areas that will form around the perimeter of the inundation area but most of the relatively flat terrain will be covered by water. As the surrounding areas will be mainly hill slopes, there are fewer locations where rain water can pool and pond breeding species can breed.

2. Changes in fringing vegetation as a result of the establishment of the dam lake: the inundation of the Williams River valley will result in changes to the ground moisture content of the immediate surrounds, as well as smaller changes to the local microclimate of the valley. It is likely that there will be a change in the composition of the vegetation around the periphery of the inundation lake as a consequence. The nature of these vegetation changes will determine which frog species benefit and which frog species may lose further habitat as a result of the dam project.

3. Changes to river flow patterns downstream of the dam: it is intended that the Tillegra Dam will be maintained at 90% or more capacity for most of its operational life (Hunter Water 2007). The dam and the ongoing entrapment of water will result in an altered hydrological regime downstream of the dam. Environmental flows will be maintained but the overall volume of water and discharge patterns will be altered. In some years, less total water will reach downstream as a result of the construction of the dam and there will be fewer high discharge flows. Frogs dependent of periodic flooding will be greatly disadvantaged by the construction of the dam and the loss of high water flow periods. Similarly, frogs dependent on the persistence of standing pools in the lower river may find that pools are not as deep or that the pool habitat is otherwise detrimentally affected; for some species this may be sufficient to prevent spawning.

Conclusion

No threatened frogs have been detected in the dam site or inundation area. Habitat for at least three of the four threatened frog species considered in this report appears to have been present in the Williams River valley but has been lost due to land clearing for agriculture and changes to river flow and flood mitigation. A few small areas of potential habitat exist in the inundation area for the Stuttering Frog and these will be lost to inundation. These sites are already small and isolated due to previous land use activities in the Williams River valley and the persistence of Stuttering Frogs in these sites has already been severely compromised. If any Stuttering Frogs still occur in the proposed inundation area, the populations must be small and quite vulnerable to extinction by a range of natural and man-made impacts. Habitat for the Stuttering frog appears to be present in nearby sites outside of the inundation area. These sites are larger and less impacted by previous land uses and provide a much more secure location for these frogs.

In general, it is recommended that the construction and operation of Tillegra dam be undertaken in a manner that excludes, manages or otherwise mitigates impacts on native frog populations in the Williams River. An environmental flow regime that allows water to be released from the dam to

protect downstream pools, periods of low flows and flow variability and seasonality is recommended. The planting of appropriate native vegetation and exclusion of weeds from riparian vegetation around the dam is also advisable. Any condition of development consent for the dam requiring ecologicial monitoring or as otherwise may be incorporated as part of the water licensing process administered by the NSW Government should also consider including as an element of the process, the monitoring of the diversity and abundances of frogs within the Williams Catchment, pre and post dam.

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Dr Arthur White

1st August 2008.

Appendix 9. Project Personnel

REPORT COMPONENT	STUDY TEAM MEMBERS	QUALIFICATIONS	RELEVANT EXPERIENCE
Project Manager	Brian Wilson	B. Appl. Sc. (Env. Biol.) Adv. Dip. Bus. Mgmt MAIBiol, MEIANZ, MECA	>30 years Flora and Fauna Survey, Impact Assessment and Project Management Experience
Flora Field Surveys, Report Writing	Stefan Rose	B.Sc. (Biol. Sci.), M.Env.Stud., MAIBiol, MECA	>25 years Botanical experience >15 years Flora Survey and Impact Assessment Experience
Fauna Field Surveys, Report Writing	Ray Williams	Biol. Tech. Cert., MECA	>30 years Fauna Survey and Impact Assessment Experience
Fauna Field Surveys, Report Writing, Figures	Jenny Lewis	B.Sc. (Res. & Env. Mgt.), Cert II (Conserv. & Land Mgt. Nat. Area Rest.)	>5 years Fauna Survey, GIS and Impact Assessment Experience
Fauna Field Surveys, Bat Call Analysis	Narawan Williams	Cert II (Conserv. & Land Mgt. Nat. Area Rest.)	>10 years Fauna Survey
Fauna Field Surveys	Anne Williams		>30 years Fauna Survey and Wildlife Care & Handling Experience
Review and modification of platypus assessment section of the report	Dr Tom Grant	B.Sc, PhD (UNSW)	30 years research on the biology of the platypus and environmental consultant

Relevant licences held by Ecotone Ecological Consultants

TYPE	FOR	LICENCE NO	NAME	DATE VALID TO	ORGANISATION	LOCATION
Animal Research Authority	Vertebrate Fauna Surveys	AW94/082	Brian Wilson	15-Nov-08	Animal care and ethics committee of the Director-General of NSW Agriculture	NSW
Certificate of Approval	Vertebrate Fauna Surveys	DG's ACEC 94/082	Brian Wilson	15-Nov-08		
Licence to	Access NPWS Wildlife Atlas Data Base	CON93002	Brian Wilson	31-Jan-09	NSW Department of Environment and Climate Change	
Scientific Licence	Harm/ trap/ release: protected fauna; pick/ hold: native flora	S10555	Brian Wilson Stefan Rose Amy Williams Narawan Williams Anne Williams	30-Jun-08		
	As above plus bat banding	S10556	Ray Williams	31-Dec-08		