Appendix C

Community Consultation Responses – Concept Design Review

Detailed Analysis of the Community Consultation Responses received during the Concept Design Review Process

Q1. For the Brunswick River Section, which road design option do you think is most appropriate: Approved design / Alternative design?

Of those respondents who indicated a preference:

- 61% (153) favoured the alternative road design (half interchange on the southern side of the Brunswick River, a new four lane highway bridge and retention of the existing two lane Brunswick River Bridge for local traffic use).
- 39% (97) favoured the EIS approved road design.

Typical comments included:

- the alternative option is a lot better;
- alternative option is simpler;
- commence as soon as possible;
- prefer one river crossing only;
- the alternative option is simpler and has less social and environmental impact;
- still prefer VA2; and
- combine the approved and alternative designs with Bridge Option D and remove the existing bridge.

Q2. Which bridge type do you think is the most appropriate?

Of the 153 respondents who favoured the Alternative road design at the Brunswick River:

- 6% (9) indicated Option 2B Super T Girder (alternative) as the most appropriate;
- 9% (14) indicated Option 2C Incrementally Launched as the most appropriate;
- 65% (100) indicated Option 2D Balanced Cantilever as the most appropriate;
- 1% (1) indicated Option 2E Twin Tower Cable Stayed as the most appropriate;
- 8% (13) indicated Option 2F Single Tower Cable Stayed as the most appropriate;
- 5% (8) indicated Option 2G Single Steel Arch as the most appropriate; and
- 5% (8) indicated a bridge option (eg., 2A—Super T Girder Approved) which was not possible with the alternative design.

Of the 97 respondents who indicated support for the Approved road design at the Brunswick River:

- 48% (47) indicated Option 2A Super T Girder (approved) as the most appropriate;
- none indicated Option 2C Incrementally Launched as the most appropriate;
- 45% (44) indicated Option 2D Balanced Cantilever as the most appropriate; and
- 6% (6) indicated a bridge option (eg., Single Steel Arch) which was not possible with the approved design.

Typical comments included:

- balanced cantilever looks best;
- balanced cantilever is pleasing to the eye and seems less obtrusive to the surroundings;
- balanced cantilever better fits into the Brunswick River;
- single steel arch—disturbance to river minimised due to no piers;
- bridge option needs to be least visually intrusive;

- fewer piers in the river is a much better solution;
- need less obstruction in the river;
- one bridge crossing is better than two; and
- prefer low set bridges to lessen visual impacts.

Q3. For the alternative road design, what do you think is the most appropriate for the existing bridge: Retain existing bridge / Replace existing bridge?

Of those respondents who indicated a preference:

- 59% (136) indicated that it was most appropriate to replace the existing bridge; and
- 41% (95) indicated that it was most appropriate to retain the existing bridge.

An analysis of the 153 respondents who opted for the Alternative Road Design at the Brunswick River indicated an equal 50% split between either retaining or replacing the existing Brunswick River Bridge.

Typical comments included:

- use the existing asset;
- retain existing bridge and reduce costs;
- eliminate existing bridge, don't replace it;
- the existing bridge is too low at high tide and the river is too shallow (silted at low tide);
- existing bridge will need too much repair now & in the future;
- what about the remaining life of the existing bridge;
- existing bridge is ugly and has concrete cancer;
- replacement service road bridge should match new highway bridge;
- the existing bridge makes the river almost unnavigable;
- retaining the existing bridge has least impact.

Q4. For the Billinudgel section, which design option do you think is most appropriate: Approved design / Alternative design?

Of those respondents who indicated a preference:

- 85% (218) indicated that the alternative design (improved highway access arrangements to and from Billinudgel) was most appropriate; and
- 15% (39) indicated that the approved design was most appropriate.

Typical comments included:

- much simpler and better access to Billinudgel;
- a great alternative, less cost, more function;
- Billinudgel needs to be easily accessed;
- alternative design is a much better outcome for locals;
- alternative design has less social impact, less visual impact and is better for the local community;
- may increase traffic through Ocean Shores.

Q5. For the Yelgun section, which design option do you think is most appropriate: Approved design / Alternative design?

Of those respondents who indicated a preference:

- 79% (196) indicated that the alternative design (simpler interchange layout) was most appropriate; and
- 21% (53) indicated that the approved design was most appropriate.

Typical comments included:

- reduced footprint of road is commendable;
- alternative design is less complex;
- alternative has simplified interchange;
- alternative has too many access roads;
- alternative represents a simplified interchange and improved traffic flows;
- the alternative road design is better for everyone.

Appendix D

Threatened Flora and Fauna Assessments

Contents of Appendix D

Assessment of threatened flora and fauna species listed under the EPBC and TSC Acts

A search of the Atlas of NSW Wildlife (NPWS 2002; September Update) for a 15km radius from the approximate mid point of the route was undertaken to identify threatened flora and fauna species that are known to occur in the local area. A 10km radius usually defines the local area, however in this case five kilometres have been added to the radius to account for the length of the route. The threatened flora species identified by the process are detailed in Table D1. The threatened fauna species are detailed in Table D2.

Flora

Locally occurring threatened flora species have been assessed in the original EIS (SKM, 1998) and since project planning approval in August 1999. Threatened species listed under both the EPBC and TSC Acts at the time of the original EIS and subsequently are detailed and discussed in Section 8.2 of the EIS/REF. Extensive field surveys have been conducted as part of the original EIS and subsequent investigations (refer Section 8.3 of this EIS/REF). All of the surveys have been undertaken by a professional ecologist with extensive local knowledge of the threatened plants that occur in area. Due to the very high level of survey effort between 1997 and 2002 it is considered that any threatened flora species not already located within the footprint of the modified alternative design are unlikely to occur within the footprint. As such, no further assessment of species that may potentially occur is required. However, a summary of the locally occurring threatened flora species is provided in Table D1 (the vegetation communities referred to are detailed in the original EIS). Further detailed discussion of threatened flora species known to occur within the footprint of the modified alternative design is provided in Sections 6 and 8 of the EIS/REF.

It is considered that the design modifications associated with modified alternative design would not cause a significant impact to any threatened flora species.

Fauna

Additional fauna surveys were not considered to be necessary given:

- that previous surveys have been undertaken for the original EIS (SKM, 1998);
- the very small design differences between the modified alternative and approved designs;
- the fact that the modified alternative design would result in a reduction in road footprint of 3.5 ha;
- the positive nature of the modified alternative design changes; and
- that the highly mobile nature of most fauna species would minimise their potential exposure to the very minor design modifications being assessed.

The assessment of the impact of the modified alternative design on fauna species has been based on the following:

- the modified alternative design is essentially very similar to the approved design (from a faunal assessment perspective);

- the modified alternative design would reduce the footprint of the road in Sections 2, 4 and 5 by 3.5 ha, resulting in a reduction in the impacts to habitats suitable for threatened fauna species;

- the modified alternative design includes features that are beneficial for wildlife, including the deletion of the link road around the saltmarsh and the provision of space for a

fauna movement corridor underneath the southern abutment of the Brunswick River bridge, both of which improve habitat connectivity from the approved design; and

- the majority of threatened fauna species are highly mobile and would consequently not be affected by minor design modifications.

The original EIS identified and assessed 73 threatened fauna species as potentially occurring in the locality (10km^2). However, the approved design footprint was considered not to have provided habitat suitable for many of these species (i.e. for pelagic species, or habitat that was present was highly modified or degraded, etc). None of the 73 threatened species were considered to be impacted significantly by the approved design.

The likely impacts of the modified alternative design on two threatened species not considered in the original EIS (Grey-headed Flying Fox and Mitchell's Rainforest Snail) have been fully assessed in this EIS/REF and found to be non-significant.

Given the very minor and (essentially benign or beneficial) nature of the design modifications and the overall reduction in footprint, it is considered to be highly unlikely that the modified alternative design would exert an increased impact on any of the threatened species that were previously assessed (in the original EIS) as not being significantly impacted by the approved design. Consequently, it is considered that the modified alternative design would not cause a significant impact on any threatened fauna species.

Table D1 - Threatened flora species listed under the EPBC and TSC Acts known to occur in the locality (15km^2) of the study area (as at October 2002)

Broad Habitat Type	Species	Status in Study Area
Rainforest (Vegetation Community 1 in SKM 1998)	*Acalypha eremorum, Amorphospermum whitei, Angiopteris evecta, Archidendron hendersonii, Austromyrtus fragrantissima, Bosistoa transversa, Cassia brewsteri var. marksiana, Choricarpia subargentea, Corokia whiteana, Dendrocnide moroides, Desmodium acanthocladum, Diospyros major var. ebenus forma australiensis, Diploglottis campbellii, Drynaria rigidula, Elaeocarpus sp. 'Rocky Creek', Elaeocarpus williamsianus, Endiandra floydii, Floydia praealta, Fontainea australis, Harnieria hygrophiloides, Hicksbeachia pinnatifolia, Isoglossa eranthemoides, Macadamia tetraphylla, Marsdenia longiloba, Ochrosia moorei, Owenia cepiodora, Plectranthus nitidus, Sarcochilus fitzgeraldii, Symplocos baeuerlenii, Syzygium hodgkinsoniae, Tinospora tinosporoides*	• Suitable habitat present within the footprint of the modified alternative design. • Repeated detailed surveys between 1997 and 2002 failed to locate these species within the footprint of the modified alternative design. • No substantial change in habitat area affected by the modified alternative design compared against the approved design. • Species considered unlikely to be impacted and will not be assessed further.
Rainforest (Vegetation Community 1 in SKM 1998)	*Acacia bakeri, Acronychia littoralis, Cryptocarya foetida, Davidsonia jerseyana, Endiandra floydii, Endiandra hayesii, Endiandra muelleri subsp. bracteata, Grevillea hilliana, Randia moorei, Syzygium moorei, Xylosma terrae-reginae*	• Species have been located within the footprint of the modified alternative design (See Figures 8.1a-f of the EIS/REF). • Species likely to be affected and are assessed further in Section 8 of the EIS/REF.

Wet sclerophyll forest / Rainforest (Vegetation Communities 1,2 in SKM 1998)	*Davidsonia johnsoni*	• Suitable habitat present within the footprint of the modified alternative design. • Repeated detailed surveys between 1997 and 2002 failed to locate this species within the footprint of the modified alternative design. • No substantial change in habitat area affected by the modified alternative design compared against the approved design. • Species considered unlikely to be impacted and will not be assessed further.
Dry sclerophyll forest (Vegetation Community 2c in SKM 1998)	*Diuris sp. aff. chrysantha, Geodorum densiflorum, Sarcochilus hartmannii*	• Suitable habitat present within the footprint of the modified alternative design. • Repeated detailed surveys between 1997 and 2002 failed to locate this species within the footprint of the modified alternative design. • No substantial change in habitat area affected by the modified alternative design compared against the approved design. • Species considered unlikely to be impacted and will not be assessed further.
Swamps (Vegetation Communities 3a, b in SKM 1998)	*Phaius tankervilliae*	• Suitable habitat present within the footprint of the modified alternative design. • Repeated detailed surveys between 1997 and 2002 failed to locate this species within the footprint of the modified alternative design. • No substantial change in habitat area affected by the modified alternative design compared against the approved design. • Species considered unlikely to be impacted and will not be assessed further.
Tall heath (Not present within the footprint of the modified alternative design (SKM 1998)	*Allocasuarina defungens*	• No suitable habitat within the footprint of the modified alternative design (SKM, 1998). • Repeated detailed surveys between 1997 and 2002 failed to locate this species within the footprint of the modified alternative design. • No substantial change in habitat area affected by the modified alternative design compared against the approved design. • Species considered highly unlikely to be impacted and will not be assessed further.
Coastal scrub / heath (Not present within the footprint of the modified alternative design (SKM 1998)	*Pterostylis nigricans*	• No suitable habitat within the footprint of the modified alternative design (SKM, 1998). • Repeated detailed surveys between 1997 and 2002 failed to locate this species within the footprint of the modified alternative design. • No substantial change in habitat area affected by the modified alternative design compared against the approved design. • Species considered highly unlikely to be impacted and will not be assessed further.

Table D2 - Threatened fauna species listed under the EPBC and TSC Acts known to occur in the locality (15km^2) of the study area (as at October 2002)

Amphibians & Reptiles	Habitat Associations	Status in Study Area
Assa darlingtoni Pouched Frog TSC – V	Highlands and uplands of the eastern Great Dividing Range (300 to 1180 MASL). Cool temperate and Subtropical Rainforest (Ehmann 1997).	• No suitable habitat within the footprint of the modified alternative design. • Surveys capable of detecting species failed to locate species within the footprint of the modified alternative design. • Species considered unlikely to be impacted and will not be assessed further.
Crinia tinnula Wallum Froglet TSC – V	Wallum swamps and associated low land meandering watercourses on coastal plains (Ehmann 1997).	• Lack of suitable or significant habitat (SKM 1998). • Surveys capable of detecting this species failed to locate species within the footprint of the modified alternative design, although species known to occur close to site. • Considering the habitat requirements of this species, habitat essentially unaffected by the modified alternative design compared against the approved design. • Species considered unlikely to be impacted and will not be assessed further.
Litoria aurea Green and Golden Bell Frog TSC – E; EPBC – V	Large ephemeral bodies of water exhibiting well-established fringing vegetation adjacent to open grassland areas for foraging.	• Lack of suitable or significant habitat (SKM 1998). • Surveys capable of detecting this species failed to locate species within the footprint of the modified alternative design. • Considering the habitat requirements of this species, habitat essentially unaffected by the modified alternative design compared against the approved design. • Species considered unlikely to be impacted and will not be assessed further.
Litoria olongburensis Wallum Sedge Frog TSC – V; EPBC – V	Wallum and woodlands on costal swamps. Swamps are typically acidic (Ehmann 1997).	• Lack of suitable or significant habitat (SKM 1998). • Surveys capable of detecting this species failed to locate species within the footprint of the modified alternative design. • Considering the habitat requirements of this species, habitat essentially unaffected by the modified alternative design compared against the approved design. • Species considered unlikely to be impacted and will not be assessed further.

Mixophyes fleayi TSC – E; EPBC – E	Riparian vegetation, subtropical and cool temperate rainforest. Known only from areas where water is flowing and of high quality (Ehmann 1997).	• No suitable habitat within the footprint of the modified alternative design. • Surveys capable of detecting species failed to locate species within the footprint of the modified alternative design. • Species considered unlikely to be impacted and will not be assessed further.
Mixophyes iteratus Giant Barred Frog TSC – E; EPBC – E	Found on forested slopes of the escarpment and adjacent ranges in riparian vegetation, subtropical and dry rainforest and wet sclerophyll forests. This species is associated with flowing streams with high water quality, though habitats may contain weed species (Ehmann 1997).	• No suitable habitat within the footprint of the modified alternative design. • Surveys capable of detecting species failed to locate species within the footprint of the modified alternative design. • Species considered unlikely to be impacted and will not be assessed further.
Philoria loveridgei Masked Mountain Frog TSC – V	A rainforest frog known from two large areas of rainforest, Border Ranges / Lamington National Park and the Mt Warning / Caldera area (Ehmann 1997). Records located within large areas of vegetation, at higher altitudes than the site.	• No suitable habitat within the footprint of the modified alternative design. • Surveys capable of detecting species failed to locate species within the footprint of the modified alternative design. • Species considered unlikely to be impacted and will not be assessed further.
Cacophis harriettae White-crowned Snake TSC – V	Typically found in coastal and near coastal areas (1996), usually in wet sclerophyll forests and rainforests (Swan 1999).	• Suitable habitat within the footprint of the modified alternative design (Communities 1, 2) • Surveys capable of detecting species failed to locate species within the footprint of the modified alternative design. • No substantial change in habitat area affected by the modified alternative design compared against the approved design. • Habitat essentially unaffected, therefore species unlikely to be impacted and will not be assessed further.
Coeranoscincus reticulatus Three-toed Snake-tooth Skink TSC – V; EPBC – V	Inhabits rainforests and adjacent wet sclerophyll forests, where it is usually found in rotting logs or under fallen timber (Cogger 1996)	• Suitable habitat within the footprint of the modified alternative design (Communities 1, 2). • Surveys capable of detecting species failed to locate species within the footprint of the modified alternative design. • No substantial change in habitat area affected by the modified alternative design compared against the approved design. • Habitat essentially unaffected, therefore species unlikely to be impacted and will not be assessed further.

Hoplocephalus stephensii Stephen's Banded Snake TSC – V	Wet Sclerophyll and rainforest (Cogger 1992). This species is threatened by fragmentation, with a low reproductive rate and late reproductive age (Shine 1993 in SFNSW 1995) indicates continued occupation of isolated fragments unlikely. Recorded in Orara State Forest (Hugget pers. com.)	• Suitable habitat within the footprint of the modified alternative design (Communities 1, 2). • Surveys capable of detecting species failed to locate species within the footprint of the modified alternative design. • No substantial change in habitat area affected by the modified alternative design compared against the approved design. • Habitat essentially unaffected, therefore species unlikely to be impacted and will not be assessed further.
Avifauna	**Habitat Associations**	**Status in Study Area**
Amaurornis olivaceus Bush-hen TSC – V	Densely overgrown margins of permanent terrestrial freshwater wetlands, such as creeks and rivers, billabongs, ponds, swamps, dams, lakes and roadside ditches (Marchant and Higgins 1993).	• Suitable habitat within the footprint of the modified alternative design in vicinity of Marshall Creek (SKM 1998); has been recorded close to site. Has not been recorded within the footprint of the modified alternative design. • Species considered unlikely to occur due to disturbance and noise associated with existing highway (SKM, 1998). • Significant impact considered unlikely under approved route (SKM, 1998). As the modified route is not considered to differ significantly from the approved route, this species will not be assessed further.
Anseranas semipalmata Magpie Goose TSC – V	Terrestrial wetlands, activities centred on wetlands; mainly those on floodplains of rivers (Marchant and Higgins 1993).	• No suitable habitat within the footprint of the modified alternative design. • Surveys capable of detecting species failed to locate species within the footprint of the modified alternative design. • Species considered unlikely to be impacted and will not be assessed further.
Atrichornis rufescens Rufous Scrub-bird TSC – V	Rainforest and adjacent eucalypt forest where undergrowth is particularly thick (Blakers et al. 1984).	• Suitable habitat within the footprint of the modified alternative design (Communities 1, 2). • Surveys capable of detecting species failed to locate species within the footprint of the modified alternative design. • No substantial change in habitat area affected by the modified alternative design compared against the approved design. • Habitat essentially unaffected, therefore species unlikely to be impacted and will not be assessed further.
Botaurus poiciloptilus Australasian Bittern TSC – V	Terrestrial wetlands with tall dense vegetation, occasionally estuarine habitats (Marchant and Higgins 1993).	• Lack of suitable or significant habitat (SKM 1998). • Surveys capable of detecting this species failed to locate species within the footprint of the modified alternative design. • Considering the habitat requirements of this species, habitat essentially unaffected by the modified alternative design compared against the approved design. • Species considered unlikely to be impacted and will not be assessed further.

Burhinus grallarius Bush Stone-curlew TSC – E	Associated with dry open woodland with grassy areas (SFNSW, 1995), dune scrubs, in savanna areas, the fringes of mangroves, golf courses and open forest / farmland (Pittwater Council 2000, Marchant & Higgins, 1999). Forages in areas with fallen timber, leaf litter, little undergrowth and where the grass is short and patchy (Environment Australia 2000; Marchant & Higgins, 1999). Is thought to require large tracts of habitat to support breeding, in which there is a preference for relatively undisturbed in lightly disturbed habitat (in SFNSW 1995).	• No suitable habitat within the footprint of the modified alternative design. • Surveys capable of detecting species failed to locate species within the footprint of the modified alternative design. • Species considered unlikely to be impacted and will not be assessed further.
Calyptorhynchus banksii Red-tailed Black-Cockatoo TSC – V	This species is noted to feed mainly on seeds, especially of eucalypts, casuarinas, acacia and banksias. May also take berries, nectar, flowers and occasionally insects and their larvae Higgins (1994).	• Suitable habitat within the footprint of the modified alternative design (Communities 2, 3). • Surveys capable of detecting species failed to locate species within the footprint of the modified alternative design. • No substantial change in habitat area affected by the modified alternative design compared against the approved design. • Habitat essentially unaffected, therefore species unlikely to be impacted and will not be assessed further.
Calyptorhynchus lathami Glossy Black-Cockatoo TSC – V	Associated with a variety of forest types containing *Allocasuarina* species (Environment Australia 2000, NPWS 1997 and SFNSW 1995). Nests in large trees with large hollows (Environment Australia, 2000).	• Suitable habitat within the footprint of the modified alternative design (Community 2). • Surveys capable of detecting species failed to locate species within the footprint of the modified alternative design. • No substantial change in habitat area affected by the modified alternative design compared against the approved design. • Habitat essentially unaffected, therefore species unlikely to be impacted and will not be assessed further.
Coracina lineata Barred Cuckoo-shrike TSC – V	Associated with rainforests and moist forests, often in creek lines located in gullies (SFNSW 1995).	• Suitable habitat within the footprint of the modified alternative design (Communities 1, 2). • Surveys capable of detecting species failed to locate species within the footprint of the modified alternative design. • No substantial change in habitat area affected by the modified alternative design compared against the approved design. • Habitat essentially unaffected, therefore species unlikely to be impacted and will not be assessed further.
Cyclopsitta diophthalma Double-eyed Fig-Parrot TSC – E; EPBC - E	Associated with upland (to 1200masl) to lowland rainforests, tropical semi-deciduous vine thickets and gallery forests, usually containing fig trees. Usually in large tracks of forests, particularly near edges, rarely in partly cleared or fragmented rainforest (Marchant and Higgins 1999).	• Suitable habitat within the footprint of the modified alternative design (Communities 1, 2). • Surveys capable of detecting species failed to locate species within the footprint of the modified alternative design. • No substantial change in habitat area affected by the modified alternative design compared against the approved design. • Habitat essentially unaffected, therefore species unlikely to be impacted and will not be assessed further.

Ephippiorhynchus asiaticus Black-necked Stork TSC – E	Associated with tropical and warm temperate terrestrial wetlands, estuarine and littoral habitats, and occasionally woodlands and grasslands. Forages in fresh or saline waters up to 0.5m deep, mainly in open fresh waters, extensive sheets of shallow water over grasslands or sedgeland, shallow swamps with short emergent vegetation and permanent billabongs and pools on floodplains (Marchant and Higgins 1999).	• Lack of suitable or significant habitat (SKM 1998). • Surveys capable of detecting this species failed to locate species within the footprint of the modified alternative design. • Considering the habitat requirements of this species, habitat essentially unaffected by the modified alternative design compared against the approved design. • Species considered unlikely to be impacted and will not be assessed further.
Erythrotriorchis radiatus Red Goshawk TSC – V; EPBC - V	Associated with forests and woodlands with a mosaic of vegetation types, an abundance of birds and permanent water. In NSW, this species is thought to favour mixed subtropical rainforest, Melaleuca Swamp Forest, and open eucalypt forest along rivers, often in rugged terrain (Marchant and Higgins 1999). Is thought to require contiguous tracts of woodland / forest and a sustainable supply of pesticide free prey (Debus 1993 in SFNSW 1995).	• Suitable habitat within the footprint of the modified alternative design (Communities 2, 3). • Surveys capable of detecting species failed to locate species within the footprint of the modified alternative design. • No substantial change in habitat area affected by the modified alternative design compared against the approved design. • Habitat essentially unaffected, therefore species unlikely to be impacted and will not be assessed further.
Esacus neglectus Beach Stone-curlew TSC – E	Beaches, mudflats and reefs, especially islands (Blakers et al. 1984).	• Suitable habitat located within the footprint of the modified alternative design (Community 5). • Surveys capable of detecting species failed to locate species within the footprint of the modified alternative design. • No substantial change in habitat area affected by the modified alternative design compared against the approved design. • Habitat essentially unaffected, therefore species unlikely to be impacted and will not be assessed further.
Grus rubicundus Brolga TSC – V	During breeding season mostly near shallow freshwater marshes or freshwater meadows. During non-breeding seasons congregates near deep, permanent freshwater marshes, mostly foraging in nearby field, pastures and fallow fields and occasionally foraging in littoral zones of marshes (Marchant and Higgins 1999).	• No suitable habitat within the footprint of the modified alternative design. • Surveys capable of detecting species failed to locate species within the footprint of the modified alternative design. • Species considered unlikely to be impacted and will not be assessed further.
Haematopus fuliginosus Sooty Oystercatcher TSC – V	A coastal species that inhabits rock coastlines, coral cays, reefs and occasionally sandy beaches (Marchant and Higgins 1993).	• No suitable habitat within the footprint of the modified alternative design. • Surveys capable of detecting species failed to locate species within the footprint of the modified alternative design. • Species considered unlikely to be impacted and will not be assessed further.

Haematopus longirostris Pied Oystercatcher TSC – V	Roosts and forages on sandy beaches and mudflats and sand banks (Marchant and Higgins 1993).	• Suitable habitat located within the footprint of the modified alternative design (Community 5). • Observed along the mudflats on the Brunswick River (SKM 1998). • Significant impact considered unlikely under approved route (SKM, 1998). As the modified route is not considered to differ significantly from the approved route, this species will not be assessed further.
Irediparra gallinacea Comb-crested Jacana TSC – V	Freshwater wetlands, such as lagoons, billabongs, swamps, lakes and reservoirs, generally with abundant floating aquatic vegetation (Marchant and Higgins 1999).	• No suitable habitat within the footprint of the modified alternative design. • Surveys capable of detecting species failed to locate species within the footprint of the modified alternative design. • Species considered unlikely to be impacted and will not be assessed further.
Ixobrychus flavicollis Black Bittern TSC – V	Associated with the margins of wetlands and quiet watercourses flowing through coastal forest, woodland, mangroves and Melaleuca swamps (NPWS 1997, SFNSW 1995).	• Suitable habitat within the footprint of the modified alternative design (Communities 3, 5). • Surveys capable of detecting this species failed to locate species within the footprint of the modified alternative design. • No substantial change in habitat area affected by the modified alternative design compared against the approved design. • Habitat essentially unaffected, therefore species unlikely to be impacted and will not be assessed further.
Lathamus discolor Swift Parrot TSC – E; EPBC - E	Associated with dry open eucalypt forests and woodlands with winter flowering eucalypts (Marchant and Higgins 1999). In the local area, this species has utilised Spotted Gum (*Corymbia maculata*), Banksias (*Banksia integrifolia* and *B. serrata*) (SFNSW 1995). Winter flowering eucalypts in the study area include Blackbutt (*Eucalyptus pilularis*), Swamp Mahogany (*E. robusta*) and the Forest Red Gum (*E. tereticornis*) (Law et al. 2000). Often located in urban areas and farmlands with remnant eucalypts.	• Suitable habitat within the footprint of the modified alternative design (Communities 3, 5). • Surveys capable of detecting species failed to locate species within the footprint of the modified alternative design. • No substantial change in habitat area affected by the modified alternative design compared against the approved design. • Habitat essentially unaffected, therefore species unlikely to be impacted and will not be assessed further.
Lichenostomus fasciogularis Mangrove Honeyeater TSC – V	Lives in mangroves, frequently visiting flowering shrubs in towns adjacent to mangroves. Spends some of its' time feeding close to the mud in mangroves (Blakers et al. 1984).	• Suitable habitat within the footprint of the modified alternative design (Community 5). • Surveys capable of detecting species failed to locate species within the footprint of the modified alternative design, but has been recorded in the Brunswick River Estuary (SKM, 1998). • Significant impact considered unlikely under approved route (SKM 1998). As the modified route is not considered to differ significantly from the approved route, this species will not be assessed further.

Lophoictinia isura Square-tailed Kite TSC – V	In coastal areas associated tropical and temperate forests and woodlands on fertile soils with an abundance of passerine birds (Marchant and Higgins 1999, NPWS 1999). Likely to require a large area for foraging (Marchant and Higgins 1999).	• Suitable habitat within the footprint of the modified alternative design (Communities 2, 3). • Surveys capable of detecting species failed to locate species within the footprint of the modified alternative design. • No substantial change in habitat area affected by the modified alternative design compared against the approved design. • Habitat essentially unaffected, therefore species unlikely to be impacted and will not be assessed further.
Menura alberti Albert's Lyrebird TSC – V	Lives in rainforest or areas transitional from rainforest and eucalypt forest, with adequate cover, which sometimes includes Lantana (Blakers et al. 1984).	• Suitable habitat within the footprint of the modified alternative design (Communities 1, 2a). • Surveys capable of detecting species failed to locate species within the footprint of the modified alternative design. • No substantial change in habitat area affected by the modified alternative design compared against the approved design. • Habitat essentially unaffected, therefore species unlikely to be impacted and will not be assessed further.
Monarcha leucotis White-eared Monarch TSC – V	Associated with lowland subtropical rainforest edges and remnants; littoral and floodplain rainforest, swamp sclerophyll with mesomorphic mid storey, coastal wet sclerophyll. Appears to prefer rainforest with edges. Is thought to avoid moving into small remnants; preferring to move through areas of continuous forest cover (Environment Australia 2000).	• Suitable habitat within the footprint of the modified alternative design (Communities 1, 2, 3). • Surveys capable of detecting species failed to locate species within the footprint of the modified alternative design. • No substantial change in habitat area affected by the modified alternative design compared against the approved design. • Habitat essentially unaffected, therefore species unlikely to be impacted and will not be assessed further.
Oxyura australis Blue-billed Duck TSC – V	Terrestrial wetlands, preferring deep water in large permanent waterbodies where conditions are stable and aquatic vegetation is abundant (Marchant and Higgins 1999).	• No suitable habitat within the footprint of the modified alternative design. • Surveys capable of detecting species failed to locate species within the footprint of the modified alternative design. • Species considered unlikely to be impacted and will not be assessed further.
Pachycephala olivacea Olive Whistler TSC - V	Elevated (>500 MASL), cool temperate rainforest and moist eucalypt forest in the northern part of their range. This species appears to favour large tracts of undisturbed and densely vegetated forest (SFNSW 1995).	• No suitable habitat within the footprint of the modified alternative design. • Surveys capable of detecting species failed to locate species within the footprint of the modified alternative design. • Species considered unlikely to be impacted and will not be assessed further.

Pandion haliaetus Osprey TSC – V	Associated with waterbodies including coastal waters, inlets, lakes, estuaries, beaches, offshore islands and sometimes along inland rivers (Schodde and Tidemann 1986; Clancy 1991; Olsen 1995). Osprey may nest on the ground on sea cliffs or in trees (Olsen 1995). Osprey generally prefer emergent trees, often dead or partly dead with a broken off crown (Olsen 1995).	• Suitable habitat within the footprint of the modified alternative design (Communities 2, 3). • Surveys located species flying overhead. • Significant impact considered unlikely under approved route (SKM 1998). As the modified route is not considered to differ significantly from the approved route, this species will not be assessed further.
Pezoporus wallicus Ground Parrot TSC – V	Predominantly restricted to heath that provides a high density of cover and food foraging resources (Blakers et al. 1984).	• No suitable habitat within the footprint of the modified alternative design. • Surveys capable of detecting species failed to locate species within the footprint of the modified alternative design. • Species considered unlikely to be impacted and will not be assessed further.
Podargus ocellatus Marbled Frogmouth TSC – V	Tropical and subtropical rainforests, usually with luxuriant epiphytic growth. Rarely seen outside of rainforests (Marchant and Higgins 1999).	• Suitable habitat within the footprint of the modified alternative design (Community 1). • Surveys capable of detecting species failed to locate species within the footprint of the modified alternative design. • No substantial change in habitat area affected by the modified alternative design compared against the approved design. • Habitat essentially unaffected, therefore species unlikely to be impacted and will not be assessed further.
Pomatostomus temporalis Grey-crowned Babbler TSC – V	Acacia scrub, woodland and farmland. Avoids very wet areas (Blakers et al. 1984). Drier, more open forests, scrubby woodlands (Simpson and Day 1996).	• No suitable habitat within the footprint of the modified alternative design. • Surveys capable of detecting species failed to locate species within the footprint of the modified alternative design. • Species considered unlikely to be impacted and will not be assessed further.
Ptilinopus magnificus Wompoo Fruit-Dove TSC – V	Associated with large, undisturbed patches of tall tropical or subtropical rainforest, at all altitudes. Occasionally located in patches of monsoon rainforest, closed gallery forest, wet sclerophyll forest, tall open forest, open woodland or vine thickets near rainforest (Marchant and Higgins 1999).	• Suitable habitat within the footprint of the modified alternative design (Community 1). • Surveys capable of detecting species failed to locate species within the footprint of the modified alternative design, but has been recorded in the Brunswick River Valley (SKM 1998). • Significant impact considered unlikely under approved route (SKM 1998). As the modified route is not considered to differ significantly from the approved route, this species will not be assessed further.

Ptilinopus regina Rose-crowned Fruit-Dove TSC – V	Tall tropical and subtropical, evergreen or semi-deciduous rainforests, especially with a dense growth of vines. Also located in closed wet sclerophyll forest, gallery forests or sclerophyll woodlands with abundant fruiting trees, near or next to rainforest. Is thought to prefer large areas of vegetation, but has been located in patches and occasionally in parks and gardens with fruiting trees (Marchant and Higgins 1999).	• Suitable habitat within the footprint of the modified alternative design (Community 1). • Surveys capable of detecting species failed to locate species within the footprint of the modified alternative design, but has been recorded in the Ocean Shores area (SKM 1998). • Significant impact considered unlikely under approved route (SKM 1998). As the modified route is not considered to differ significantly from the approved route, this species will not be assessed further.
Ptilinopus superbus Superb Fruit-Dove TSC – V	Lives mainly within rainforests but will feed in adjacent mangroves or eucalypt forests (Blakers et al. 1984). Nests are well hidden within the rainforest habitat and are built in trees from 10 to 30m off the ground (Recher et al. 1995).	• Suitable habitat within the footprint of the modified alternative design (Community 1, 2, 5). • Surveys capable of detecting species failed to locate species within the footprint of the modified alternative design. • Significant impact considered unlikely under approved route (SKM 1998). As the modified route is not considered to differ significantly from the approved route, this species will not be assessed further.
Stictonetta naevosa Freckled Duck TSC – V	Associated with a variety of wetlands, such as heavily vegetated, large open lakes and their shores, creeks, farm dams, sewerage ponds and floodwaters (in: NPWS 1999).	• No suitable habitat within the footprint of the modified alternative design. • Surveys capable of detecting species failed to locate species within the footprint of the modified alternative design. • Species considered unlikely to be impacted and will not be assessed further.
Todiramphus chloris Collared Kingfisher TSC – V	Virtually confined to mangrove lining sheltered coastal embayment, inlets, estuaries and adjacent tidal flats (Marchant and Higgins 1999).	• Suitable habitat within the footprint of the modified alternative design (Community 5). • Surveys capable of detecting species failed to locate species within the footprint of the modified alternative design, but has been recorded in the Brunswick River Estuary (SKM 1998). • Significant impact considered unlikely under approved route (SKM 1998). As the modified route is not considered to differ significantly from the approved route, this species will not be assessed further.
Turnix melanogaster Black-breasted Button-quail TSC – E; EPBC - V	Drier rainforests with dense overhead cover and a thick dry litter layer. Observations in Lantana thickets and hoop pine plantations indicate this species maybe able to utilise human modified environments (Blakers et al. 1984).	• Suitable habitat within the footprint of the modified alternative design (Communities1d,e and 2a). • Surveys capable of detecting species failed to locate species within the footprint of the modified alternative design. • No substantial change in habitat area affected by the modified alternative design compared against the approved design. • Habitat essentially unaffected, therefore species unlikely to be impacted and will not be assessed further.

Xanthomyza phrygia Regent Honeyeater TSC – E; EPBC - E	The Regent Honeyeater primarily feeds on nectar from box and ironbark eucalypts and occasionally from banksias and mistletoes (NPWS 1995). Associated with temperate eucalypt woodland and open forest including forest edges, wooded farmland and urban areas with mature eucalypts, riparian forests of River Oak (*Casuarina cunninghamiana*) (SFNSW 1995, Garnett 1993). Reliant on locally abundant nectar sources, especially flowering eucalypts that occur mainly in dry open woodland (SFNSW 1995), on richer soil types with different flowering times to provide reliable supply of nectar (Environment Australia 2000). Areas containing Swamp Mahogany (*Eucalyptus robusta*) in coastal areas have bee observed to be utilised (NPWS 1997, SFNSW 1995).	• Suitable habitat within the footprint of the modified alternative design (Communities 2, 3). • Surveys capable of detecting species failed to locate species within the footprint of the modified alternative design. • No substantial change in habitat area affected by the modified alternative design compared against the approved design. • Habitat essentially unaffected, therefore species unlikely to be impacted and will not be assessed further.
Ninox connivens Barking Owl TSC – V	Associated with a variety of habitats such as savanna woodland, open eucalypt forests, wetland and riverine forest. Kavanagh et al. (1995) suggests that the species is particularly associated with coastal lowland or riparian woodland dominated by various red gum species. The diet of the Barking Owl consists of mammals, birds and insects, the percentage of which depends largely on seasonal availability (Debus 1997). Species rich habitats, such as woodlands and ecotones, are considered to important habitat for this species due to its' diverse diet (Environment Australia 2000). Usually nests in large tree hollows with entrances averaging 2-29 metres above ground, depending on the forest or woodland structure and the canopy height (Debus 1997).	• Suitable habitat within the footprint of the modified alternative design (Communities 2, 3). • Surveys capable of detecting species failed to locate species within the footprint of the modified alternative design. • No substantial change in habitat area affected by the modified alternative design compared against the approved design. • Habitat essentially unaffected, therefore species unlikely to be impacted and will not be assessed further.
Ninox strenua Powerful Owl TSC – V	Powerful Owls are associated with a wide range of wet and dry forest types with a high density of prey, such as arboreal mammals, large birds and flying foxes (Environment Australia 2000, Debus & Chafer 1994). Large trees with hollows at least 0.5m deep are required for shelter and breeding (Environment Australia 2000).	• Suitable habitat within the footprint of the modified alternative design (Communities 1d,e, 2, 3). • Surveys capable of detecting species failed to locate species within the footprint of the modified alternative design. • No substantial change in habitat area affected by the modified alternative design compared against the approved design. • Habitat essentially unaffected, therefore species unlikely to be impacted and will not be assessed further.
Tyto capensis Grass Owl TSC – V	In NSW the Grass Owl is rarely recorded and is strictly tied to the occurrence of suitable habitat. Compared with other owls, the Grass Owl is unusual in that it nests on the ground within dense tall grass, sedges, reeds and even sugarcane plantations. Reported habitats include tall grass, swampy, sometimes tidal areas, mangrove fringes, grassy plains, coastal heaths, grassy woodland, cane grass, lignum, sedges, cumbungi, cane fields and grain stubble (Pizzey and Knight, 1997). The Grass Owl primarily feeds on rodents, hunting on the wing over heathland, grassland and sedgeland, as well as along the edge of sugar cane, crops and pastureland.	• Suitable habitat within the footprint of the modified alternative design (Communities 1d,e, 2, 3). • Surveys capable of detecting species failed to locate species within the footprint of the modified alternative design. • No substantial change in habitat area affected by the modified alternative design compared against the approved design. • Habitat essentially unaffected, therefore species unlikely to be impacted and will not be assessed further.
Tyto novaehollandiae Masked Owl TSC – V	Associated with forest with sparse, open, understorey, particularly the ecotone between wet and dry forest, and non forest habitat (Environment Australia 2000). Known to utilise forest margins and isolated stands of trees within agricultural land (Hyem 1979) and heavily disturbed forest where its prey of small and medium sized mammals can be readily obtained (Kavanagh and Peake 1993).	• Suitable habitat within the footprint of the modified alternative design (Communities 2, 3). • Surveys capable of detecting species failed to locate species within the footprint of the modified alternative design. • No substantial change in habitat area affected by the modified alternative design compared against the approved design. • Habitat essentially unaffected, therefore species unlikely to be impacted and will not be assessed further.

Tyto tenebricosa Sooty Owl TSC – V	Sooty Owls are associated with tall wet old growth forest on fertile soil with a dense understorey and emergent tall Eucalyptus species (Environment Australia 2000, Debus, 1994). Pairs roost in the daytime amongst dense vegetation, in tree hollows and sometimes in caves. The Sooty Owl is typically associated with an abundant and diverse supply of prey items and a selection of large tree hollows (Debus, 1994, Garnett 1993, Hyem 1979).	• Suitable habitat within the footprint of the modified alternative design (Communities 1, 2a). • Surveys capable of detecting species failed to locate species within the footprint of the modified alternative design. • No substantial change in habitat area affected by the modified alternative design compared against the approved design. • Habitat essentially unaffected, therefore species unlikely to be impacted and will not be assessed further.
Mammals	**Habitat Associations**	**Status in Study Area**
Aepyprymnus rufescens Rufous Bettong TSC – V	Associated with grassy open forests and woodland, typically with an absence of shrub layer, but may also occur on grassy ridges with a dense shrub layer (in: SFNSW 1995). Has been observed more commonly in forests characterised by the Spotted Gum (*Corymbia maculata*) in northern eastern NSW (in: SFNSW 1995). This species has been positively related to high food plant density, moderate topography and grazing (in: SFNSW 1995).	• No suitable habitat within the footprint of the modified alternative design. • Surveys capable of detecting species failed to locate species within the footprint of the modified alternative design. • Species considered unlikely to be impacted and will not be assessed further.
Cercartetus nanus Eastern Pygmy-possum TSC – V	Pygmy-Possums feed mostly on the pollen and nectar from banksias, eucalypts and understorey plants and will also eat insects, seeds and fruit. Small tree hollows are favoured as day nesting sites, but nests have also been found under bark, in old birds nests and in the branch forks of tea-trees (Turner and Ward, 1995).	• Suitable habitat within the footprint of the modified alternative design (Community 3). • Surveys capable of detecting species failed to locate species within the footprint of the modified alternative design. • No substantial change in habitat area affected by the modified alternative design compared against the approved design. • Habitat essentially unaffected, therefore species unlikely to be impacted and will not be assessed further.
Dasyurus maculatus Spotted-tailed Quoll TSC – V; EPBC - V	The Spotted-tailed Quoll inhabits a range of forest communities including wet and dry sclerophyll forests and rainforests (Mansergh 1984), more frequently recorded near the ecotones of closed and open forest (SFNSW 1995). Maternal den sites are logs with cryptic entrances; rock outcrops; windrows; burrows (Environment Australia 2000).	• Suitable habitat within the footprint of the modified alternative design (Communities 1, 2, 3). • Surveys capable of detecting species failed to locate species within the footprint of the modified alternative design. • No substantial change in habitat area affected by the modified alternative design compared against the approved design. • Habitat essentially unaffected, therefore species unlikely to be impacted and will not be assessed further.
Macropus parma Parma Wallaby TSC - V	Associated with dry and mesic sclerophyll forests and occasionally in rainforest. Optimum habitat appears to be mesic eucalypt forests with a mosaic of open and closed thick shrubby understorey patches (in SFNSW 1995).	• Suitable habitat within the footprint of the modified alternative design (Communities 1, 2, 3). • Surveys capable of detecting species failed to locate species within the footprint of the modified alternative design. • No substantial change in habitat area affected by the modified alternative design compared against the approved design. • Habitat essentially unaffected, therefore species unlikely to be impacted and will not be assessed further.

Petaurus australis Yellow-bellied Glider TSC – V	Associated with a range of forest types; more common at ecotone between dry and wet sclerophyll forests. Habitats are characterised by a mosaic of tree species including some that flower in winter (Environment Australia 2000, Braithwaite 1984, Davey 1984, Kavanagh 1984). Large hollows within mature trees are required for nesting and breeding (Henry and Craig 1984).	• Suitable habitat within the footprint of the modified alternative design (Communities 2, 3). • Surveys capable of detecting species failed to locate species within the footprint of the modified alternative design. • No substantial change in habitat area affected by the modified alternative design compared against the approved design. • Habitat essentially unaffected, therefore species unlikely to be impacted and will not be assessed further.
Petaurus norfolcensis Squirrel Glider TSC – V	Associated with dry hardwood forest and woodlands (Menkhorst et al. 1988, Quin 1993, Traill 1991). Habitats typically include gum barked and high nectar producing species, including winter flower species (Menkhorst et al. 1988). The presence of hollow bearing eucalypts is a critical habitat value (Quin 1995). Recorded locally in Wedding Bells SF and Moonee Beach Nature Reserve.	• Suitable habitat within the footprint of the modified alternative design (Communities 2, 3). • Surveys capable of detecting species failed to locate species within the footprint of the modified alternative design in Section 2, 4 or 5. • No substantial change in habitat area affected by the modified alternative design compared against the approved design. • Habitat essentially unaffected, therefore species unlikely to be impacted and will not be assessed further.
Phascogale tapoatafa Brush-tailed Phascogale TSC – V; EPBC - V	Preferred habitat is Dry Open forest with a sparse open understorey, however, has been located in heath, swamps and rainforest and wet sclerophyll forest (NPWS 1999).	• Suitable habitat within the footprint of the modified alternative design (Communities 3a, b and 1, 2). • Surveys capable of detecting species failed to locate species within the footprint of the modified alternative design. • No substantial change in habitat area affected by the modified alternative design compared against the approved design. • Habitat essentially unaffected, therefore species unlikely to be impacted and will not be assessed further.
Phascolarctos cinereus Koala TSC – V	Associated with both wet and dry Eucalypt forest that contains a canopy cover of approximately 10 to 70% (Reed et al. 1990), with acceptable Eucalypt food trees.	• Suitable habitat within the footprint of the modified alternative design (Communities 2, 3). • Surveys capable of detecting species located species west of site. • Significant impact considered unlikely under approved route (SKM 1998). As the modified route is not considered to differ significantly from the approved route, this species will not be assessed further.
Planigale maculata Common Planigale TSC – V	A range of habitats from rainforest to sclerophyll forest to grasslands (Strahan 1995).	• Suitable habitat within the footprint of the modified alternative design (all communities). • Surveys capable of detecting species failed to locate species within the footprint of the modified alternative design. • No substantial change in habitat area affected by the modified alternative design compared against the approved design. • Habitat essentially unaffected, therefore species unlikely to be impacted and will not be assessed further.

Potorous tridactylus Long-nosed Potoroo TSC -V; EPBC - V	Associated with dry coastal heath and dry and wet sclerophyll forests with relatively thick ground cover and light sandy soils (Strahan 1995).	• No suitable habitat (soil type unsuitable) within the footprint of the modified alternative design. • Surveys capable of detecting species failed to locate species within the footprint of the modified alternative design. • Species considered unlikely to be impacted and will not be assessed further.
Thylogale stigmatica Red-legged Pademelon TSC - V	Predominantly a rainforest species, also in wet sclerophyll forest and deciduous vine thickets. Requires a dense understorey for cover (SFNSW 1995).	• Suitable habitat within the footprint of the modified alternative design (Communities 1, 2). • Surveys capable of detecting species failed to locate species within the footprint of the modified alternative design. • No substantial change in habitat area affected by the modified alternative design compared against the approved design. • Habitat essentially unaffected, therefore species unlikely to be impacted and will not be assessed further.
Pteropus alecto Black Flying-Fox TSC – V	Mangroves, paperbark forests and occasionally patches of rainforest are most commonly utilised for camp sites. Preferred food includes blossoms (such as eucalypts, paperbarks and turpentines), also introduced fruits and blossoms (Strahan 1995).	• Suitable habitat within the footprint of the modified alternative design (Communities 1, 2, 3). • Surveys capable of detecting species failed to locate species within the footprint of the modified alternative design. • No substantial change in habitat area affected by the modified alternative design compared against the approved design. • Habitat essentially unaffected, therefore species unlikely to be impacted and will not be assessed further.
Pteropus poliocephalus Grey-headed Flying-Fox TSC – V; EPBC - V	Inhabits a wide range of habitats including rainforest, mangroves, paperbark forests, wet and dry sclerophyll forests and cultivated areas (Eby 1998).	• Suitable habitat within the footprint of the modified alternative design (Communities 1, 2, 3). • Surveys capable of detecting species detected this species within the footprint of the modified alternative design. • Species considered unlikely to be significantly impacted due to the negligible difference in habitat impacts associated with the modified alternative design when compared with the approved design, the mobility of this species, and its behaviour of foraging over large areas. Consequently this species will not be assessed further.
Syconycteris australis Common Blossom-bat TSC – V	Breeding and sheltering habitats are in subtropical and littoral rainforests. This species requires a diverse range of nectar producing plant communities year round; will occasionally eat some rainforest fruits (Environment Australia 2000).	• Suitable habitat within the footprint of the modified alternative design (Community 1, 2a). • Surveys capable of detecting species located species west of site. • Significant impact considered unlikely under approved route (SKM 1998). As the modified route is not considered to differ significantly from the approved route, this species will not be assessed further.

Chalinolobus dwyeri Large Pied Bat TSC – E; EPBC - V	The Large-eared Pied Bat has been recorded in a variety of habitats, including dry sclerophyll forests, woodland, sub-alpine woodland, edges of rainforests and wet sclerophyll forests. This species roosts in caves (Churchill 1998).	• Suitable foraging habitats within the footprint of the modified alternative design (all communities). • No suitable breeding habitat. • Surveys capable of detecting species failed to locate species within the footprint of the modified alternative design. • No substantial change in habitat area affected by the modified alternative design compared against the approved design. • Habitat essentially unaffected, therefore species unlikely to be impacted and will not be assessed further.
Kerivoula papuensis Golden-tipped Bat TSC – V	The most favoured habitat for this species is moist closed forests often with a rainforest influence, however, some captures have been made in dry forests some distance from any rainforest (Lunney et. al., 1986, Parnaby and Mills, 1994). It has been suggested that the amount of vines and complex tree layers allows for increased numbers of spiders and webs and such areas are sought by the Golden-tipped Bat (Schulz & Eyre, 2000). This species is often caught over streams within rainforest are known to frequently roost within the pendulous nests of Yellow-throated and Large-billed Scrub Wrens and Brown Gerygone in such areas. (Schulz, & Eyre, 2000).	• Suitable habitat within the footprint of the modified alternative design (Communities 1, 2). • Surveys capable of detecting species failed to locate species within the footprint of the modified alternative design. • No substantial change in habitat area affected by the modified alternative design compared against the approved design. • Habitat essentially unaffected, therefore species unlikely to be impacted and will not be assessed further.
Miniopterus australis Little Bent-wing Bat TSC – V	Breeding occurs in caves, usually in association with *M. schreibersii.* This species shelter in a range of structures including culverts, drains, mines and caves. Foraging is associated with forested areas, predominantly moist eucalypt forests, rainforests, and some dry forest types (Environment Australia 2000).	• Suitable habitat within the footprint of the modified alternative design (all communities). • Species located (tentative record) near Banana Road, close to the study area. • Significant impact considered unlikely under approved route (SKM 1998). As the modified route is not considered to differ significantly from the approved route, this species will not be assessed further.
Miniopterus schreibersii Common Bent-wing Bat TSC – V; EPBC - V	Associated with a range of habitats, typically well timbered areas where it forages above and below the tree canopy on small insects (Australian Museum Business Services, 1995; Dwyer, 1995, 1981). Will utilise caves, old mines, and stormwater channels, under bridges and occasionally buildings for shelter (Environment Australia 2000, Dwyer 1988). This species has been reported utilising bushland remnants in urban areas and is estimated to forage within a 20km radius in a single night.	• Suitable foraging habitats within the footprint of the modified alternative design (all communities). • No suitable breeding habitat. • Surveys capable of detecting species failed to locate species within the footprint of the modified alternative design. • No substantial change in habitat area affected by the modified alternative design compared against the approved design. • Habitat essentially unaffected, therefore species unlikely to be impacted and will not be assessed further.

Mormopterus norfolkensis East Coast Freetail Bat TSC -V	Although the habitat preferences are unclear, most records of this species have been reported from dry eucalypt forest and woodland on the eastern side of the Great Dividing Range. Individuals have, however, been recorded flying low over a rocky river in rainforest and wet sclerophyll forest and foraging in clearings at forest edges (Environment Australia 2000, Allison & Hoye 1998). Primarily roosts in hollows or behind loose bark in mature eucalypts, but have been observed roosting in the roof of a hut (Environment Australia 2000, Allison & Hoye 1998). Examination of wing morphology indicate that cleared or open habitats are favoured, such as open habitats (woodlands), cleared forest edges and tracks through forests as well as areas above the forest canopy (Ecotone 2002).	• Suitable habitat within the footprint of the modified alternative design (all communities). • Surveys capable of detecting species failed to locate species within the footprint of the modified alternative design. • No substantial change in habitat area affected by the modified alternative design compared against the approved design. • Habitat essentially unaffected, therefore species unlikely to be impacted and will not be assessed further.
Myotis adversus Southern Myotis TSC - V	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 their roost site. Movements of up to 20km between roost and foraging site have however, been recorded (Caddle and Lumsden, 1999). The species apparently has specific roost requirements, and only a small percentage of available caves, mines, tunnels and culverts are used (Richards 1998). While roosting is most commonly associated with caves, this species has been observed to roost in tree hollows (Churchill 1998).	• Suitable habitat within the footprint of the modified alternative design (all communities). • Surveys capable of detecting species failed to locate species within the footprint of the modified alternative design. • No substantial change in habitat area affected by the modified alternative design compared against the approved design. • Habitat essentially unaffected, therefore species unlikely to be impacted and will not be assessed further.
Nyctimene robinsoni Eastern Tube-nosed Bat TSC – V	Associated with rainforests and open forest, foraging on flowers and fleshy fruits (Churchill 1998).	• Suitable habitat within the footprint of the modified alternative design (Communities 1, 2). • Surveys capable of detecting species failed to locate species within the footprint of the modified alternative design. • No substantial change in habitat area affected by the modified alternative design compared against the approved design. • Habitat essentially unaffected, therefore species unlikely to be impacted and will not be assessed further.
Nyctophilus bifax Eastern Long-eared Bat TSC - V	In NSW, this species is associated with rainforest and mesic eucalypt forest (in: SFNSW 1995).	• Suitable habitat within the footprint of the modified alternative design (all communities). • Species located close to the study area. • Significant impact considered unlikely under approved route (SKM 1998). As the modified route is not considered to differ significantly from the approved route, this species will not be assessed further.
Scoteanax rueppellii Greater Broad-nosed Bat TSC – V	Associated with moist gullies in mature coastal forest, or rainforest, east of the Great Dividing Range (Churchill, 1998), tending to be more frequently located in more productive forests. Within denser vegetation types use is made of natural and man made openings such as roads, creeks and small rivers, where it hawks backwards and forwards for prey (Hoye & Richards 1995).	• Suitable habitat within the footprint of the modified alternative design (all communities). • Surveys located species within the footprint of the modified alternative design. • Significant impact considered unlikely under approved route (SKM 1998). As the modified route is not considered to differ significantly from the approved route, this species will not be assessed further.

Invertebrates	Habitat Associations	Status in Study Area
Thersites mitchellae Mitchell's Rainforest Snail TSC – E	Lowland subtropical rainforest, typically on alluvial soils and swamp sclerophyll forest with a rainforest understorey between the Richmond and Tweed Rivers (NPWS 2001).	• No suitable habitat within the footprint of the modified alternative design • Surveys capable of detecting this failed to locate species within the footprint of the modified alternative design. • No change in habitat area affected by the modified alternative design compared against the approved design. • Species considered unlikely to be impacted and will not be assessed further.

Assessment under the Environment Protection and Biodiversity Conservation Act 1999

The *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) was introduced on 16 July 2000 and requires that Commonwealth approval be sought for certain actions. These actions are those that have, may have, or are likely to have, a significant impact on a matter of national environmental significance (NES) or Commonwealth land. Matters of national environmental significance are declared World Heritage areas, declared Ramsar wetlands, listed nationally threatened species and ecological communities, listed migratory species, nuclear actions, and the environment of Commonwealth marine areas.

Under the EPBC Act, an assessment of the impact of a proposal on any matter of national environmental significance and Commonwealth land must be undertaken to demonstrate whether there is likely to be a significant impact. If the assessment concludes that there is likely to be a significant impact then it will become a controlled action under the EPBC Act and the proposal must be referred to the Commonwealth. Environment Australia is the agency responsible for making the decision as to whether an action is likely to have a significant impact.

An assessment of NES Matters is given below.

World Heritage Properties
The modified alternative design would not impact on any World Heritage property. There would not be any effect on this matter of National Environmental Significance.

Wetlands of International Importance
There are no wetlands of international importance within the study area. There would not be any effect on this matter of National Environmental Significance.

Nuclear Actions
The modified alternative design does not constitute a nuclear action.

Commonwealth Marine Areas
The modified alternative design would not impact on any Commonwealth Marine Areas. There is unlikely to be any effect on this matter of national environmental significance.

Commonwealth Land
The proposal would not impact directly or indirectly on any Commonwealth land. No Commonwealth Land is directly affected by the proposal and no Commonwealth land is located adjacent to the proposed route.

Commonwealth Listed Threatened Species and Ecological Communities
The administrative guidelines for determining whether an action has, will have, or is likely to have a significant impact on a matter of environmental significance under the EPBC Act list a number of criteria which must be addressed in respect of the following categories of species:

- Extinct in the wild
- Critically endangered
- Endangered
- Vulnerable

One Endangered species listed on the EPBC Act, *Davidsonia jerseyana* (Davidson's Plum*)*, was found within the study area and is likely to be subject to a different level of impact by the modified alternative design when compared with that of the approved design. An assessment under the 'administrative guidelines' of the Act has been undertaken for this species in order to determine whether the proposal should be referred to Environment Australia for a decision as to whether the proposal constitutes a controlled action requiring the approval of the Minister. The assessment has been prepared below with consideration of the relevant criteria.

From data collected during surveys conducted in 1999 and 2002:

- Approximately 24 plants (9 and 15 in Sections 2 and 5 respectively) were located in the road reserve;
- Under the approved design, 19 plants (7 and 12 in Sections 2 and 5 respectively) are thought likely to be impacted;
- Under the modified alternative design, 8 plants (8 and 0 in Sections 2 and 5 respectively) are thought likely to be impacted; and
- Approximately 69 plants have been located outside of the road reserve.

The surveys for this species outside of the road corridor were not exhaustive, and as such estimates of plants outside of the corridor may be an underestimate.

Of the 12 plants in Section 5 that would have been affected by the approved design, all would be retained by the modified alternative design. Consequently, no further assessment is required for Section 5. Of the eight plants in Section 2 that would be affected by the modified alternative design, seven would also have been impacted by the approved design. As such, these plants are among those assessed in the original EIS, upon which the approved design was considered to potentially to have a significant impact.

The additional *Davidsonia jerseyana* that would be adversely affected by the modified alternative design is located on the western side of the highway north of Rajah Road, close to the group of seven other *Davidsonia jerseyana* that would have been affected by the approved design. This additional plant is located approximately one meter from the toe of the batter and is approximately 20cm in height. The most appropriate management measure to minimise the impact on this plant would be to translocate it to a suitable habitat outside the road reserve, as juvenile plants have been more successfully translocated than mature plants (refer to Section 8 of the EIS/REF).

An alternative to translocating the additional plant impacted by the modified alternative design might be to locally steepen the batter slope to avoid harming the plant. The location of this plant would be clearly identified throughout the construction process by brightly coloured fencing, and would therefore be protected from harm. However, given the very small size of this plant, translocation is considered to be the most appropriate option.

Davidsonia jerseyana has been located in several conservation reserves in the local area and region. Gunninah (1995) document the presence of this species in Billinudgel, Brunswick Heads (70 plants located in vicinity of Brunswick River) and Inner Pocket (100 - 200 individuals) Nature Reserves. *Davidsonia jerseyana* has also been located in Mooball State Forest.

***Davidsonia jerseyana* (Davidson's Plum)**

An action has, will have, or is likely to have a significant impact on an endangered species if it does, will, or is likely to:

(a) Lead to a long-term decrease in the size of a population of the species; or
It is considered unlikely that the modified alternative design would lead to a long-term decrease in the size of a population. This is due to the small level of impact (one additional plant) in relation to the 69 plants that occur adjacent to the road reserve and approximately 70 plants in Brunswick Heads Nature Reserve.

(b) Reduce the area of occupancy of a population of the species; or
The proposal would slightly reduce the area of occupancy, as one additional plant in the road reserve and its habitat would be removed. However, this would be a small reduction in relation to the 69 plants that occur adjacent to the road reserve and approximately 70 plants in Brunswick Heads Nature Reserve and the overall distribution of the species.

(c) Fragment an existing population into two or more populations; or
This species would be retained in a single area of habitat west of the existing highway. Further, seed vectors for this species (namely the Grey-headed Flying-Fox) are highly mobile and would not be likely to be impeded by the modified alternative design. This, combined with the small area of habitat in question, indicates that the additional impact associated with the modified alternative design would not be likely to fragment an existing population into two or more populations.

(d) Adversely affect habitat critical to the survival of a species; or
It is considered unlikely that the modified alternative design would adversely affect habitat critical to the survival of a species. This is due to the relatively small level of impact (one additional plant) in relation to the 69 plants that occur adjacent to the road reserve and approximately 70 plants in Brunswick Heads Nature Reserve.

(e) Disrupt the breeding cycle of a population; or
It is considered unlikely that the modified alternative design would disrupt the breeding cycle of a population. This is due to the relatively small level of impact (one additional plant) in relation to the 69 plants that occur adjacent to the road reserve and approximately 70 plants in Brunswick Heads Nature Reserve.

(f) Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline; or
It is considered unlikely that the modified alternative design would affect the availability or quality of habitat to the extent that the species is likely to decline. This is due to the relatively small level of impact (one additional plant) in relation to the 69 plants that occur adjacent to the road reserve and approximately 70 plants in Brunswick Heads Nature Reserve.

(g) Result in invasive species that are harmful to a vulnerable species becoming established in the endangered species' habitat; or
As part of the proposal, several environmental management actions would be undertaken. Amongst these are the removal of weeds and rehabilitation of this species habitat where weed invasion is present.

(h) Interfere with the recovery of the species.
No recovery plan has been released at the time of this study. However, the low level of impact

indicates that the proposal would be unlikely to interfere substantially with the recovery of the species.

Commonwealth Listed Migratory Species

The current list of migratory species includes well over 100 bird and mammal species including those listed on the Japan-Australian Migratory Birds Agreement (JAMBA) and the China-Australia Migratory Bird Agreement (CAMBA), and from the Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention).

Several listed migratory species are known to occur in the local area (Environment Australia Online Database Search August 2002). A small number of these have been observed during survey, as noted in Table D1. Neither of these species is considered likely to be significantly impacted by the proposal and it is considered that there is unlikely to be any effect on this matter of National Environmental Significance.

The administrative guidelines for determining whether an action has, will have, or is likely to have a significant impact on a matter of environmental significance under the EPBC Act list a number of criteria which must be addressed in respect of migratory species. An assessment is required to determine whether an action will, or is likely to:

1. substantially modify, destroy or isolate an area of *important habitat*;
2. seriously disrupt the lifecycle of an ecologically significant proportion of the population of the species; or
3. result in invasive species that are harmful to the migratory species becoming established in an area of important habitat of the migratory species.

An area of *important habitat* is defined as:

- habitat utilised by a migratory species occasionally or periodically within a region that supports an ecologically significant proportion of the population of the species;
- habitat utilised by a migratory species which is at the limit of the species range; or
- habitat that is within an area where the species is declining.

For the purposes of this assessment species that have suitable habitat in the study area are assumed to occur. It is assumed that the NSW North Coast region supports an ecologically significant proportion of the population of the species and as a consequence suitable habitat in the study area is therefore likely to constitute ' important habitat'.

Factors 1 and 2 above are addressed for each species in Table D3. With respect to Factor 3 (invasive species) several environmental management actions would be undertaken as part of the proposal to minimise the impact of invasive species. Amongst these are the removal of weeds and rehabilitation of these species habitats where weed invasion is present.

Conclusion

Based upon the assessment under the EPBC Act detailed above, it is concluded that the modified alternative design ('the proposal') would not need to be referred to Environment Australia as it would not have a significant impact on any matter of National Environmental Significance.

Table D3 Locally occurring Commonwealth listed migratory species (JAMBA / CAMBA) and the anticipated level of impact of the modified alternative design

Species	Habitat Associations	Anticipated impact
Gallinago hardwickii Latham's Snipe	A variety of permanent and ephemeral wetlands, preferring open fresh water wetlands with nearby cover. Occupies a variety of vegetation around wetlands (Marchant and Higgins 1999).	**No impact anticipated due to lack of suitable habitat**
Haliaeetus leucogaster White-bellied Sea-Eagle	Forages over large open waterbodies and open terrestrial areas. Breeding habitat consists of tall trees, mangroves, cliffs, rocky outcrops, silts, caves and crevices and is located along the coast or major rivers. Breeding habitat is usually close to water, but may occur up to a kilometre away (Marchant and Higgins 1999). Has been observed in study area (SKM 1998).	**Low level of impact anticipated** due to: (1) In relation to foraging habitats in the Brunswick River and offshore area the replacement of the existing bridge crossing is highly unlikely to significantly impact important habitat; (2) No breeding habitat located. This, combined with (1) indicates that the modified alternative is unlikely to seriously disrupt the lifecycle of an ecologically significant proportion of the population.
Hirundapus caudacutus White-throated Needletail	Forages aerially over a variety of habitats most likely with a preference for wooded areas. Has been observed roosting in dense foliage of canopy trees, and may seek refuge in tree hollows in inclement weather (Marchant and Higgins 1999). Located in or adjacent to study area (SKM 1998).	**Low level of impact anticipated** due to: (1), (2). A relatively small amount of foraging habitat may be affected.
Monarcha melanopsis Black-faced Monarch	Rainforest and eucalypt forests, feeding in tangled understorey (Blakers et al. 1984).	**Low level of impact anticipated** due to: (1), (2). A relatively small amount of foraging habitat may be affected.
Monarcha trivirgatus Spectacled Monarch	Rainforest and mangroves and occasionally eucalypt forests adjacent to rainforests (Blakers et al. 1984).	**Low level of impact anticipated** due to: (1), (2). A relatively small amount of foraging habitat may be affected.
Myiagra cyanoleuca Satin Flycatcher	Associated with drier eucalypt forests, absent from rainforests (Blakers et al. 1984), open forests, often at height (Simpson and Day 1996).	**Low level of impact anticipated** due to: (1), (2). A relatively small amount of foraging habitat may be affected.
Rhipidura rufifrons Rufous Fantail	Associated with eucalypt forests (Blakers et al. 1984), mesic forests and the edges of mangroves (Simpson and Day 1996).	**Low level of impact anticipated** due to: (1), (2). A relatively small amount of foraging habitat may be affected.
Rostratula benghalensis Painted Snipe	Shallow fresh water for breeding (Blakers et al. 1984) forages in marshes with moderate cover (Simpson and Day 1996).	**No impact anticipated due to lack of suitable habitat**

(1) = substantially modify, destroy or isolate an area of *important habitat*

(2) = seriously disrupt the lifecycle of an ecologically significant proportion of the population of the species

Assessment under the Environmental Planning and Assessment Act (1979)

Section 5A of the EP&A Act sets out eight factors which must be considered when determining whether there is likely to be a significant effect on species, populations, ecological communities or their habitats and whether a Species Impact Statement is required.

The following eight part tests have been completed for *Davidsonia jerseyana* (Davidson's Plum) and *Acacia bakeri* (White Marblewood), as these species have been observed in the study site and would be likely to be subject to a slightly greater impact under the modified alternative design in Section 2 than with the approved design. However there would be a overall net reduction in impact on these species in Sections 2, 4 and 5.

There are several other threatened species in the local area that have suitable habitat in the study area. Detailed surveys in 1997, 1999 and 2002 failed to locate these species. The absence of these species indicates that they are highly unlikely to occur on the study site, are unlikely to be affected by the modified alternative design and are consequently not assessed further.

Davidsonia jerseyana (Davidson's Plum)

At the time of the Gunninah (1995) survey, *Davidsonia jerseyana* was listed as a threatened species under TSC Act. The assessment according to Section 5A of the EP&A Act by Gunninah (1995) concluded that the original design (the 'approved design') had the potential to have a significant impact due to the removal of 'several stands' of this species. This assessment was based on all known occurrences of this species along the proposed road.

From data collected during surveys conducted in 1999 and 2002:

- Approximately 24 plants (9 and 15 in Sections 2 and 5 respectively) were located in the road reserve;
- Under the approved design, 19 plants (7 and 12 in Sections 2 and 5 respectively) are thought likely to be impacted;
- Under the modified alternative design, 8 plants (8 and 0 in Sections 2 and 5 respectively) are thought likely to be impacted; and
- Approximately 69 plants have been located outside of the road reserve.

The surveys for this species outside of the road corridor were not exhaustive, and as such estimates of plants outside of the corridor may be an underestimate.

Of the 12 plants in Section 5 that would have been affected by the approved design, all would be retained by the modified alternative design. Consequently, no further assessment to satisfy the requirements of the TSC Act is required for Section 5. Of the eight plants in Section 2 that would be affected by the modified alternative design, seven would also have been impacted by the approved design. As such, these plants are among those assessed in the original EIS, upon which the approved design was considered to potentially to have a significant impact.

The additional *Davidsonia jerseyana* that would be adversely affected by the modified alternative design is located on the western side of the highway north of Rajah Road, close to the group of seven other *Davidsonia jerseyana* that were to be affected by the approved design. This additional plant is located approximately one meter from the toe of the batter and is approximately 20cm in height. The most appropriate management measure to minimise the impact on this plant would be to translocate it to a suitable habitat outside the road reserve, as juvenile plants have been more successfully translocated than mature plants (refer to Section 8 of the EIS/REF).

An alternative to translocating the additional plant impacted by the modified alternative design might be to locally steepen the batter slope to avoid affecting the plant. The location of this plant would be clearly identified throughout the construction process by brightly coloured fencing, and could therefore be protected from harm. However, given the very small size of this plant translocation is considered the most appropriate option.

Davidsonia jerseyana has been located in several conservation reserves in the local area and region. Gunninah (1995) document the presence of this species in Billinudgel, Brunswick Heads (70 plants located in vicinity of Brunswick River) and Inner Pocket (100 - 200 individuals) Nature Reserves. *Davidsonia jerseyana* has also been located in Mooball State Forest.

(a) In the case of a threatened species, whether the life cycle of the species is likely to be disrupted such that a viable population of the species is likely to be disrupted such that a viable population of the species is likely to be placed at risk of extinction.

As detailed above, the modified alternative design would involve the removal of one plant in addition to the seven removed under the approved design. It is considered that the potential to translocate or propagate this additional individual and the small number involved (one) indicates that the additional impact of the modified alternative design is not likely to be significant. As such, the additional impact of the modified alternative design is not considered likely to place a viable population of the species at risk of extinction.

(b) In the case of an endangered population, whether the life cycle of the species that constitutes the endangered population is likely to be disrupted such that the viability of the population is likely to be significantly compromised.

Not applicable.

(c) In relation to regional distribution of a habitat of a threatened species, population or ecological community, whether a significant area of known habitat is to be modified alternative or removed.

The original EIS did not consider the removal / modification of habitat under the approved design to be a regionally significant area of known habitat for this species. When comparing this with the removal of an additional single individual and associated habitat it is not considered that the additional impact associated with the modified alternative design is likely to represent the modification or removal of a regionally significant area of known habitat.

(d) Whether an area of known habitat is likely to become isolated from currently interconnecting or proximate areas of habitat for a threatened species, population or ecological community.

In Section 2, this species will be retained in a single area of habitat. Further, seed vectors for this species (namely the Grey-headed Flying-fox) are highly mobile and are not likely to be impeded by either the approved or modified alternative design. This, combined with the small area of habitat in question, indicates that the additional impact associated with the modified alternative design is not likely to result in area of known habitat to become isolated from currently interconnecting or proximate areas of habitat for this species.

(e) Whether critical habitat will be affected.

No critical habitat, as listed in the TSC Act, occurs in or adjacent to the modified alternative design.

(f) Whether a threatened species, population or ecological community, or their habitats, are adequately represented in conservation reserves (or similar protected areas) in the region.

Davidsonia jerseyana has been located in several conservation reserves in the local area and

region. Gunninah (1995) document the presence of this species in Billinudgel, Brunswick Heads (70 plants located in vicinity of Brunswick River) and Inner Pocket (100 - 200 individuals) Nature Reserves. *Davidsonia jerseyana* has also been located in Mooball State Forest.

Despite the presence of this species in several conservation reserves, many records for this species are outside of conservation reserves and are fragmented occurrences. As such, it is not likely that this species, or its habitats, are adequately represented in conservation reserves (or similar protected areas) in the region.

(g) Whether the development or activity proposed is of a class of development or activity that is recognised as a threatening process.

The clearing of native vegetation is a listed 'Key Threatening Process' that is relevant to the design. As the modified alternative design would involve the removal of one additional plant, it is not considered likely that it constitutes a threatening process to this species.

(h) Whether any threatened species, population or ecological community is at the limit of its known distribution.

Records from the Atlas of NSW Wildlife (Online database, September) indicate that the modified alternative design is located within the far south of this species range, with the most southerly records occurring west of Byron Bay.

Eight Part Test Conclusion

The additional impact posed by the modified alternative design is not considered likely to be a significant impact on this species, due to:

- the small number (one) of this species affection by the modified alternative design in Section 2;
- the ability to translocate this individual;
- the small area of habitat in question; and
- the fact that overall, the modified alternative design reduces the impacts associated with the approved design by 11 plants.

Acacia bakeri (Marblewood)

The NSW Scientific Committee listed *Acacia bakeri* as a threatened species under TSC Act in 2000, after the SKM (1998) survey. This species was listed as a vulnerable species due to its restricted geographical and ecological distribution, the past clearing of habitat and ongoing threats of further clearing and disturbance (NSW Scientific Committee 2000).

Acacia bakeri is one of the few rainforest acacias, and is associated with sclerophyll eucalypt forest and rainforest (NSW Scientific Committee 2000). *Acacia bakeri* has a restricted distribution in north-east New South Wales and south-east Queensland. Specimens have been collected from Mt Banks (in the Blue Mountains) and Yennora, which may be the result of escape from cultivation (NSW Scientific Committee 2000). Rainforest in lowland north-east New South Wales has been extensively cleared, leaving the remaining habitat for *Acacia bakeri* fragmented. Most surviving plants occur on private land. However, some plants occur in Brunswick Heads Nature Reserve and Mooball and Mt Jerusalem National Parks.

Gunninah (1995) document the presence of over 500 *Acacia bakeri* in Brunswick Heads Nature Reserve, 10 to 20 in Billinudgel Nature Reserve, 50 to 100 in Black Scrub Flora Reserve and 20 to 30 in the Mooball State Forest.

From data collected during surveys conducted in 1999 and 2002:

- 45 plants were located in the road reserve in Section 2;
- Under the approved design, 45 plants were thought likely to be impacted;
- Under the modified design 43 plants are thought likely to be impacted; and
- Approximately 35 plants have been located in the vicinity of, but outside, the road reserve.

The surveys for this species outside of the road corridor were not exhaustive, and as such estimates of plants outside of the corridor may be an underestimate.

Of the 43 plants in Section 2 that would be affected by the modified alternative design, all would have been impacted by the approved design. In fact the modified alternative design results in a net reduction in impact of two plants.

(a) In the case of a threatened species, whether the life cycle of the species is likely to be disrupted such that a viable population of the species is likely to be disrupted such that a viable population of the species is likely to be placed at risk of extinction.

As detailed above, the modified alternative design would involve the removal of two fewer plants to those removed under the approved design. As such, it is considered that the impact of the modified alternative design is not likely to differ significantly from the approved design.

Further, when considering the 500 or more plants in the adjacent Brunswick Heads Nature Reserve, the removal of 43 plants under the modified alternative design is not considered likely to place a viable population of the species at risk of extinction.

(b) In the case of an endangered population, whether the life cycle of the species that constitutes the endangered population is likely to be disrupted such that the viability of the population is likely to be significantly compromised.

Not applicable.

(c) In relation to regional distribution of a habitat of a threatened species, population or ecological community, whether a significant area of known habitat is to be modified or removed.

When comparing the removal of 43 plants and associated habitat to the regional distribution of the species, the impact of the modified design is not considered likely to represent the modification or removal of a regionally significant area of known habitat.

(d) Whether an area of known habitat is likely to become isolated from currently interconnecting or proximate areas of habitat for a threatened species, population or ecological community.

The existing highway is currently situated between occurrences of this species. As the modified design is situated adjacent to the existing highway, it is not considered likely to result in known habitat becoming isolated from currently interconnecting or proximate areas of habitat for a this species.

(e) Whether critical habitat will be affected.

No critical habitat, as listed in the TSC Act, occurs in or adjacent to the modified design.

(f) Whether a threatened species, population or ecological community, or their habitats, are adequately represented in conservation reserves (or similar protected areas) in the region.

Gunninah (1995) document the presence of over 500 *Acacia bakeri* in Brunswick Heads Nature Reserve, 10 to 20 in Billinudgel Nature Reserve, 50 to 100 in Black Scrub Flora Reserve and 20 to 30 in the Mooball State Forest.

Despite the presence of this species in several conservation reserves, the rainforest habitats for this species in lowland north-east New South Wales have been extensively cleared, leaving the remaining habitat for *Acacia bakeri* fragmented. Most surviving plants occur on private land. As such, it is not likely that this species, or its habitats, are adequately represented in conservation reserves (or similar protected areas) in the region.

(g) Whether the development or activity proposed is of a class of development or activity that is recognised as a threatening process.

The clearing of native vegetation is a listed 'Key Threatening Process' that is relevant to the design. As the modified alternative design would not involve the removal of additional plants to those in the approved design, it is not considered likely that it constitutes a threatening process to this species. Further, when considering the 500 or more plants in the adjacent Brunswick Heads Nature Reserve, the removal of 43 plants under the modified design is not considered likely to constitute a threatening process in relation to this species.

(h) Whether any threatened species, population or ecological community is at the limit of its known distribution.

Records from the Atlas of NSW Wildlife (Online database, September 2002) indicate that the modified alternative design occurs at or approaches the southern limits of this species distribution.

Eight Part Test Conclusion

The impacts posed by the modified alternative design are not considered likely to be a significant impact on this species, due to, due to:

- the relatively small number of this species (43) to be removed by the modified alternative design in relation to the 500 or more plants in the adjacent Brunswick Heads Nature Reserve;
- the ability to translocate affected plants;
- the small area of habitat in question; and
- the fact that overall, the modified alternative design reduces the impacts associated with the approved design by 2 plants.

Survey for the land snail *Thersites mitchellae* (Mitchell's Rainforest Snail)

Pacific Highway Upgrade, Brunswick Heads to Yelgun

Report

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12 September 2002

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SURVEY FOR THE LAND SNAIL *THERSITES MITCHELLAE*

PACIFIC HIGHWAY UPGRADE, BRUNSWICK HEADS TO YELGUN

SCOPE OF THE STUDY

This report details a survey for the land snail *Thersites mitchellae* (Cox, 1864) [Mitchell's Rainforest Snail, hereafter MRS] in lowland subtropical rainforest on the floodplain near the Brunswick River, Brunswick Heads, northeastern New South Wales. MRS is listed under the New South Wales ***Threatened Species Conservation Act, 1995*** as an endangered species, and is also listed as critically endangered under the Commonwealth ***Environment Protection and Biodiversity Conservation Act***. Records held in the Australian Museum, Sydney and Queensland Museum, Brisbane indicate that the species was formerly common in moist lowland forest on the New South Wales north coast from Ballina north to the Tweed River. Much of this habitat has been cleared (Bishop, 1978) and there have been comparatively few recordings of the snail over the past 70 years. The proposed Pacific Highway Upgrade, Brunswick Heads to Yelgun, will pass through or near to lowland rainforest that may be suitable habitat for MRS.

A detailed survey of remnant rainforest patches between the Richmond and Tweed Rivers by the author in late 1998 established the presence of this species in several marginal localities within its historical range (Stanisic, 1998). Each of these habitats was characterised by subtropical lowland rainforest, usually adjacent to wetlands. An additional survey for the species on Stotts Island (Stanisic, 1999) confirmed the preferred habitat of the species as lowland rainforest. Stanisic (1998) confirmed the presence of this species adjacent to the Cumbebin Swamp, and subsequent recordings (Stanisic, 2001; specimens and records held at the Queensland Museum) have established the lowland rainforest in and around this wetland as a pivotal habitat for the species.

This report has been prepared for Consultancy firm 'Connell Wagner' following a request from the New South Wales Roads and Traffic Authority to provide more information on the likely presence of MRS in the rainforest patches likely to be affected by the proposed upgrade of the Pacific Highway between Brunswick Heads and Yelgun. This study deals with a survey for MRS along route option A2.

Key Tasks

To carry out a ground survey for MRS within:

- the subtropical lowland rainforest on alluvium in Brunswick Heads Nature Reserve;
- the dry gallery rainforest along Marshalls Creek; and
- any other vegetation communities or habitats along the length of the route that may provide suitable habitat for MRS, based on knowledge of the species' habitat requirements.

FIELD SURVEY

Description of survey area

The Brunswick Heads-Yelgun section of the Pacific Highway passes through and adjacent to some remnant patches of rainforest, particularly in the vicinity of the Brunswick River where lowland rainforest occurs on alluvial soils of the floodplain. Some of this rainforest represents regrowth following early clearing for cattle grazing. However, some of the more intact remnant patches have the potential to be of significance to MRS.

MRS is highly selective in its habitat (Stanisic 1998, 1999, 2000) showing preference for lowland rainforest dominated by a combination of *Archontophoenix, Ficus* and *Erythrina* spp particularly in areas adjacent to wetlands dominated by *Melaleuca* spp. Hence, the fig/palm association is considered to be a significant indicator of MRS habitat (Stanisic, 1998). On the basis of the vegetation types identified in previous botanical surveys there was a possibility of locating MRS provided that the ground-truthing of the vegetation mapping established the presence of suitable habitat.

Survey methodology and description of site

The field survey for MRS was undertaken on 10-11 September 2002 by Dr John Stanisic accompanied by ecologist and botanist, Mr Andrew Benwell. Access to the survey sites was gained from the existing Pacific Highway.

Weather and moisture conditions were good for snail collecting. Rain had fallen previous to the survey and on one of the survey days occasional rainstorms (high humidity) occurred. The terrestrial habitat in the areas searched was not particularly moist, probably a result of prolonged dry conditions prior to the recent wet. MRS is an obligate rainforest snail and requires fairly high environmental moisture levels. Hence, the most suitable habitat for the species was identified as 'lowland subtropical rainforest patches' located along watercourses, in gullies and beside wetlands. Areas in the Brunswick Heads Nature Reserve, and possibly along Marshalls Creek, were identified from the vegetation mapping as the most preferable habitats for MRS. After closer inspection however, it became obvious that while lowland rainforest existed in the vicinity of route option A2, this was not considered similar to the preferred habitat of the species as previously observed by Stanisic (1998, 1999, 2000). Nonetheless, a ground search was undertaken in all likely habitats along route A2

Preferred habitat in relation to MRS encompasses a very specific type of lowland subtropical rainforest on alluvium, usually with palms and figs (Stanisic, 1998). However, swamp sclerophyll forest in which rainforest elements are minimal has also been identified as a secondary habitat for the species. But importantly, vegetation other than *Melaleuca* spp. must be present and can include non-rainforest species as Swamp Mahogany, *Eucalyptus robusta*.

Most of the subtropical rainforest along the A2 route is situated on metasediments, a combination of vegetation and geology in which MRS has yet to be found. Based solely on the structural features of the rainforest, only a small amount of this habitat could be considered possible potential habitat for MRS. This was situated on the east

side of the road, almost adjacent to the Brunswick River and within the Brunswick Heads Nature Reserve. Here bangalow palms and figs provide an almost closed canopy forest with ample forest-floor microhabitat (root buttresses, palm fronds etc) for MRS. This area was searched in line with recommendations in the MRS recovery plan. The author had already searched this area previously (on three separate occasions in his capacity as Senior Curator, Queensland Museum) as part of a general survey of snails in eastern Australian rainforests. No trace of MRS has ever been found although other terrestrial snail species are present.

On the west side of the road lowland rainforest on alluvium was present adjacent to mangroves. This small area was also considered potential habitat and was searched for MRS. But the area was almost devoid of ground litter and not regarded as optimal snail habitat. This forest type graded into a Swamp Oak forest. However, the presence of *Casuarina glauca* was identified as a factor mitigating against the presence of MRS. Casuarina habitat has been found by the author to be singularly snail-depauperate. Reasons for this are not clear but may be related to the relatively poor breakdown of Casuarina litter. Most Australian native snails are detrital feeders relying on good litter decomposition for the promotion of prolific fungal growth for food. This area was searched for snails (including MRS) but none were found.

In an historic sense all rainforest may be considered potential habitat for MRS given that rainforest structure and distribution may change in response to climatic shifts and that the environmental requirements of species may also change over time. However, the contemporary environmental limits of MRS, as indicated by recent survey work on the species, appear to be very narrow, and possibly a contributing factor to its relative uncommoness within its range. Such habitat specificity usually infers little tolerance to environmental change-natural or otherwise. Similar restrictive environmental limits are shown by a number of other eastern Australian land snail species.

Sampling procedure included searching preferred snail microhabitat such as under fig-root buttresses, under logs and under fallen palm fronds. All sites identified in the scoping brief were searched. The section of the Brunswick Heads Nature Reserve to the east of the existing highway had been previously searched on several occasions by the author in his capacity as Senior Curator of Molluscs, Queensland Museum. No record of MRS had been obtained on those occasions. MRS (like all land snails) is nocturnal and seeks shelter under palm fronds and logs during the day where it seals to such objects by secreting a mucus seal around the shell aperture. This minimises moisture loss during periods of inactivity. However, no night collecting was undertaken since experience has shown this not to be necessary in locating snail species. The recent wet conditions should have ensured that the snails would be 'high' up in the debris. Under drier condition snails tend to seek shelter in deeper crevices.

A search for live animals as well as dead shells and fragments of shells of MRS was undertaken by walking several transects of the rainforest patches. In addition, other land snail species present were also collected and recorded. Approximately 6 hours were spent on searching for snails on the A2 route option. Approximately 1 hour was spent searching on the VA2 route option.

RESULTS

No MRS (dead or alive) was found in the rainforest patches adjacent to the current Pacific Highway that are likely to be affected by the upgrade (route option A2). Although the broad vegetation data provided to the author indicated possible MRS habitat, the ground-truthing revealed that this was not of the specific type preferred by the snail.

The only other land snail found in these habitats was the large relatively common and widespread *Sphaerospira fraseri* which is a well known co-habitant of MRS. This species is also an obligate rainforest dweller similar to MRS but displays a broader habitat preference within the spectrum of this vegetation type.

However, a search of suitable habitat adjacent to the VA2 route *[precise location details removed at the request of NPWS]* revealed the presence of MRS. Three shells, two recently dead, were collected. No live specimens were found but the good condition of two shells was a positive indication of living snails being present. This patch of *[removed at request of NPWS]* had all the structural characteristics of MRS' preferred habitat and extended to the alignment of the VA2 route. Other land snails recovered here included the non-conservationally significant semislug *Fastosarion superbus, Sphaerospira fraseri* and *Ramogenia challengeri* . All three species are known co-habitants of MRS elsewhere in its range. The presence of MRS and these latter species reinforces both the significance of this remnant as an important refuge for land snails as well as its overall high biodiversity value. This remnant will be impacted if route option VA2 was progressed.

STATUS OF *THERSITES MITCHELLAE* IN THE BRUNSWICK HEADS RAINFOREST REMNANTS

The inability to find MRS in some of the patches surveyed in itself is not an absolute indication that the species is not present. Land snails are very cryptic in the landscape and generally occupy a complex and diverse part of the habitat-forest floor/litter zone-which is impossible to search definitively without substantial additional time and causing major environmental damage. Nonetheless, remains such as dead shells and fragments could be expected to be present if large numbers of the species were living there. This was not the case and not even suspicious slime trails and faeces were noted. Hence, the negatives are considered to be true negatives.

The ability of MRS to persist in very marginalised preferred habitat amidst largely disturbed areas (Stanisic, 1998) also meant that there was a high probability of finding the species if it was present. This was borne out by the ready discovery of three shells in what was identified as ideal habitat on *[details removed at the request of NPWS]*.

The discovery of MRS in *[removed at request of NPWS]* is the first record of the species for the Brunswick Heads area and is a significant addition to its range. The absence of historical records from the area (Stanisic, 1998) is a puzzle but may relate to early clearing of suitable habitat by settlers of Brunswick Heads. Indications from soil types and older remnant trees in the area suggest that the preferred habitat may have been more extensive in the area in the past. Hence, the resident individuals of

MRS in the *[removed at request of NPWS]* are extremely important as possibly the only survivors of a once larger population.

EXECUTIVE SUMMARY

- the field survey of the rainforest along the Pacific Highway Upgrade, Brunswick Heads toYelgun (route option A2), did not establish the presence of MRS;
- the absence of MRS from these rainforest patches is considered a real absence that is reinforced by both the apparent lack of dead shells and the ground-truthing of the vegetation which revealed the absence of the species' very specific preferred habitat as has been recorded elsewhere;
- MRS was located in a patch of *[removed at request of NPWS]* situated along the alternative route (option VA2). This represents the first record of the species for the Brunswick Heads area.

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JOHN STANISIC

Position: Senior Curator of Molluscs, Queensland Museum
Date of Birth: 16 December 1950
Nationality: Australian

Professional Qualifications

1972: Batchelor of Science (Honours), University of Sydney.
1978: Master of Science, University of Sydney.
1988: Doctor of Philosophy (Zoology), University of Queensland.

Specialist Expertise

John is a biodiversity scientist and is Australia's foremost expert on land snails. He has published on the systematics, distribution and biogeography of land snails and on their associations with specific habitats particularly rainforest and limestone. His central focus of research at the museum is the documentation of land snail biodiversity in eastern Australia and the potential use of land snails as environmental indicators in regional ecosystem management. He has considerable field experience having surveyed more than 2000 sites in eastern Australia from the islands of the Torres Strait to southern Victoria. John also has a strong general background in both vertebrate and invertebrate taxonomy with teaching experience in these subjects at Sydney University. He has experience in freshwater ecology and has published several papers on freshwater sponges. He has undertaken faunal consultancies for the Australian National Parks and Wildlife Service, New South Wales National Parks and Wildlife Service, Wet Tropics Management Authority, Kuku Djungan Aboriginal Corporation, Queensland Department of Natural Resources and private firms such as Hyder Environmental, Montgomery Watson and PPK Environment & Infrastructure Pty Ltd.

Professional Experience

1973-1977: Part-time tutor and demonstrator in vertebrate and invertebrate zoology in the School of Biological Sciences at Sydney University.
Duties: Demonstrating vertebrate and invertebrate zoology (morphology, systematics and diversity) to second year undergraduate students; leading tutorials; arranging audio-visual material; leading field courses.

1977: Curator of the Haswell Museum, Department of Zoology, Sydney University.
Duties: Curation and maintenance of biological specimens for use in undergraduate teaching; arranging audio-visual display units for weekly classes; setting up of teaching displays in the Macleay Museum at Sydney University.

1978-1979: Technical Assistant in the Department of Malacology, Australian Museum, Sydney.
Duties: Curation of land and freshwater mollusc collections; identifications; public enquiries; field trips; assisting in the organisation of the 1979 International Symposium on the Biology and Evolution of the Mollusca at the Australian Museum.

1980- Present: Curator (Senior Curator as from 16.12.1988), Malacology Section, Queensland Museum**.
Duties: Curation of the mollusc collections; research, dissemination of information to the public through displays, enquiries and publications; field work; environmental consultancy.

Field Experience

1972-1978
Freshwater sponge collecting and ecological survey of Thirlmere Lakes, Sydney.
1977
Deep water dredging for marine Molluscs off the coast of Queensland in association with staff of the Australian Museum.
Land snail Collecting
1979
Limestone areas of the Jenolan region, New South Wales (1 week).
Rainforests of northern New South Wales (1 week).
1980
Subtropical rainforests of SEQ. (2 weeks).
Tropical rainforests of NEQ. (3 weeks).
1981
Subtropical rainforests of northern New South Wales and SE Queensland (2 weeks).
Bellenden Ker Expedition An altitudinal transect of the invertebrates of the Bellenden Ker Range, North Queensland (4 weeks).
1982
Sub-tropical rainforests of south-east Queensland (2 weeks).
Sub-tropical rainforests of mid-east Queensland (2 weeks).
1983
Rainforests of Cape York Peninsula (6 weeks).
Sub-tropical rainforests of northern New South Wales (2 weeks).
Sub-tropical rainforests of south-east Queensland (4 weeks).
Torres Straits Islands (2 weeks).
Sub-tropical rainforests of south-east Queensland (4 weeks).
1986
Border Ranges rainforests (2 weeks).
1987
Sub-tropical rainforests of north New South Wales (2 weeks).
Mid-east Queensland rainforests (1 week).
1988
Rainforests of Cape York Peninsula, Cooktown and Townsville (7 weeks).
Rainforests of south-east Queensland (1 week).
1989
Rainforests of south-east Queensland including Carnarvon Gorge (2 weeks).
Rainforests of northern New South Wales (1 week).
1990
Rainforests and limestone areas of southern New South Wales (3 weeks).
Rainforests of mid-east Queensland (4 weeks).
Rainforests of south-east Queensland (1 week).
1991
Rainforests and limestone areas of central New South Wales (3 weeks).
Rainforests of northern New South Wales (1 week).
1992
Rainforests and limestone areas of mid-coast New South Wales (2 weeks).
Vine thickets of south-central Queensland (2 weeks).
Rainforests and limestone areas of southern and mid-coast New South Wales (3 weeks).
1993
Rainforests and limestones of central New South Wales (2 weeks).
Vine thickets of the Central Highlands, Queensland (4 weeks).
1994
Rainforests and limestones of northeastern New South Wales (3 weeks).
Mt Mulligan and the vine thickets of Chillagoe and the Central Highlands, Queensland (4 weeks).
1995
Rainforests and limestones of northeastern New South Wales (3 weeks).
Boggomoss environments of Taroom (1 week).
Mt Mulligan and mideastern Queensland (3 weeks).

1996
Rainforests and limestones of northeastern New South Wales (2 weeks).
Boggomoss environments of Taroom (2 weeks).
Palmerville limestones and tropical rainforests of northeastern Queensland (4 weeks).
1997
Rainforests and limestones of northeastern New South Wales (2 weeks).
Boggomoss environments of Taroom (1 week).
Mt Mulligan and the vine thickets of Chillagoe and the Central Highlands, Queensland (4 weeks).
1998
Rainforests and limestones of eastern Victoria (2 weeks).
Vine thickets of the Monto-Marlborough area, Qld (1 week).
Vine thickets opf mideastern Queensland (2 weeks).
Vine thickets of the Callide and Boyne Ranges, Qld (1 week).
Rainforests of northeastern New South Wales (1 week).
1999
Vine thickets of southeastern Queensland (1 week).
Vine thickets of the Rockhampton area, Qld (1 week).
Vine thickets of Whitsunday Island, Qld (1 week).
Vine thickets of Townsville -Cairns hinterland (2 weeks).
2000
Stotts Island, Tweed River
Littoral rainforests of the New South Wales central and north coast (2 weeks).
2001
Rainforests of NSW/Qld border region (1 week)
Rainforests of central eastern Queensland and off-lying islands (1 week).

Publications

Journal Articles

Stanisic, J. 1979.Freshwater sponges from the Northern Territory (Porifera: Spongillidae). Proceedings of the Linnean Society of New South Wales 103(2): 123-130.
Stanisic, J. 1981. The land Mollusca of Lord Howe Island. Occasional Papers of the Australian Museum 1: 43.
Stanisic, J. 1981. *Helix parramattensis* Cox, 1864: A synonym of *Euconulus (Euconulus) fulvus* (Muller, 1774) (Pulmonata: Euconulidae). Journal of the Malacological Society of Australia 5(1-2): 81-83.
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Stanisic, J. 1987. Studies on the Charopidae of tropical and subtropical Australia. I. *Oreokera*: A primitive genus from the high mountains of north Queensland (Mollusca: Pulmonata: Charopidae). Journal of the Malacological Society of Australia 8: 1-21.
Stanisic, J. 1988. A re-evaluation of the relationships of *Helix (Thalassia) gayndahensis* Brazier, 1875 (Mollusca, Pulmonata, Helicarionidae). Memoirs of the Queensland Museum 25(2): 475-479.
Stanisic, J. 1990. Systematics and biogeography of eastern Australian Charopidae (Mollusca, Pulmonata) from subtropical rainforests. Memoirs of the Queensland Museum 30(1): 1-241.
Stanisic, J. 1991. The Colliver shell collection. The Queensland Naturalist 31(3-4): 54-57.
Stanisic, J. 1993. The identity of *Helicarion semoni* Marten, 1894: a large semi-slug from the Wet Tropics, northeastern Queensland (Pulmonata: Helicarionidae). Memoirs of the Queensland Museum 34(1): 1-9.
Stanisic, J. 1993. *Danielleilona* gen. nov., from the Wet Tropics, northeastern Queensland (Pulmonata: Charopidae). Memoirs of the Queensland Museum 34(1): 11-20.
Stanisic, J. 1993. *Lenwebbia paluma* sp. nov., from the Wet Tropics, northeastern Queensland (Pulmonata: Charopidae). Memoirs of the Queensland Museum 34(1): 21-26.
Stanisic, J. 1993. *Eungarion mcdonaldi* gen. et sp. nov., a montane semi-slug from mideastern Queensland rainforests (Pulmonata: Helicarionidae). Memoirs of the Queensland Museum 34(1): 27-34.
Stanisic, J. 1994. An ecologic and biogeographic study of a new Tertiary land snail from mideastern Queensland. Memoirs of the Queensland Museum 35(1): 241-247.
Stanisic, J. 1994. The distribution and patterns of species diversity of land snails in eastern Australia. Memoirs of the Queensland Museum 36(1): 207-214.
Stanisic, J. 1996. New land snails from boggomoss environments in the Dawson Valley, southeastern Queensland (Eupulmonata: Charopidae and Camaenidae). Memoirs of the Queensland Museum 39(2): 343-354.

Stanisic, J. 1996. A new camaenid land snail from the Wet Tropics Biogeographic Region, northeastern Queensland (Eupulmonata: Camaenidae). Memoirs of the Queensland Museum 39(2): 355-363.
Stanisic, J. 1997. An area of exceptional land snail diversity: The Macleay Valley, northeastern New South Wales. Memoirs of the Museum of Victoria 56: 441-448.
Stanisic, J. 1998. A new semi-slug from Tamborine Mountain, southeastern Queensland (Mollusca: Eupulmonata: Helicarionidae. Memoirs of the Queensland Museum 42: 597-603.
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Stanisic, J. 2000. Taxonomy of the Australian rainforest snail *Helix bellendenkerensis* Brazier, 1875 (Mollusca: Eupulmonata: Camaenidae). Memoirs of the Queensland Museum 46: 337-348.
Stanisic, J. In Press. Fire and biodiversity: a land snail perspective. Proceedings of the 7th Annual Fire Management Workshop.
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Stanisic, J. 2000. Land snails. Pp. 9-19. In Ryan, M. (ed.), `Wildlife of Tropical North Queensland'. (Queensland Museum : Brisbane).

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Stanisic, J. 1995. Land snails of the Wet Tropics biogeographic region, northeastern Queensland - Part II. Australasian Shell News 88: 1-2.
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Stanisic, J. 1996. The large camaenids of mideastern Queensland. Australasian Shell News 92: 1-2.
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Stanisic, J. 1997. Land snail diversity in Queensland : An overview. Part 2. Australasian Shell News 95: 6.
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Stanisic, J. 1998. Review of 'Bivalves of Australia, Volume 2' by Kevin Lamprell and John Healy. Molluscan Research 19: 155.
Stanisic, J. 1998. Sculpture in Chillagoe land snails. Australian Shell News 98: 7.
Stanisic, J. 2000. Pitter patter of little feet. Wildlife Australia (Winter 2000) 37(2): 36-37.
Stanisic, J. 2000. Invertebrates as bioindicators. How green is your valley? Wildlife Australia, (Spring 2000) 37(3): 36.
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Stanisic, J. & Potter, D. 1988. Garden snails and slugs of the Brisbane region: a pictorial guide. The Moreton Bay Radula 8(3): 4-5.
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Potter, D. & Stanisic, J. 1989. Turners tree snail. The Papustyla 11: 2.

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Stanisic, J. 1998. A survey of the land snails of the Queensland Brigalow Lands: Their distribution, conservation status and close association with vine thickets'. For the Queensland Deparment of Environment.21pp, 28maps, appendices A-F. (Queensland Museum, Brisbane).
Stanisic, J. 1998. Land snail survey of Port and Bishop Drives, Fisherman Islands, Brisbane. 4pp, 1 map. For Moreton Bay Container Park Pty Ltd. (Queensland Museum, Brisbane).
Stanisic, J. 1998. Survey for the land snail *Thersites mitchellae* in northern New South Wales. For the New South Wales National Parks and Wildlife Service. (Queensland Museum: Brisbane).
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Stanisic, J. 2001. Survey for the land snail *Thersites mitchellae* in the proposed Byron Bay Town Centre Bypass Route. 5pp, 6figs+Appendix. For Sandpiper Ecological Surveys. (Brisbane).
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Consultancies

1985
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1991
Review of the Wildlife Protection (Regulation of Exports and Imports) Act 1982: evaluation of responses concerning export of mollusc shells. (For Australian National Parks and Wildlife Service).
1994
The distribution of land snails occurring within the Wet Tropics area. (For the Wet Tropics Management Authority).
1994-1995
The land snails and slaters of Ngarrabullgan. (For the Kuku Djungan Aboriginal Corporation). [with Dr G.J. Ingram].
1996-1997
Faunal survey of the boggomosses (mound springs) of the Taroom area, southeastern Queensland. (For the Queensland Department of Natural Resources). [with Dr G.J. Ingram].
1997
Awoonga-Callide pipeline extension. Impact assessment scoping study. Fauna. (For Hyder Consulting, Brisbane).[with Dr G.J. Ingram].
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Upper Burnett River catchment. Preliminary fauna assessment. Vertebrates, land snails and isopods. (For Hyder Consulting, Brisbane).[with Dr G.J. Ingram].
1998
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Appendix G

Study Team

Study Team

This Environmental Impact Assessment was prepared on behalf of the RTA by Connell Wagner Pty Ltd and a team of specialist subcontractors. The following key personnel (and their teams) contributed to the study:

NSW Roads and Traffic Authority (Northern Regional Office)

Peter Borrelli	Senior Project Manager, Strategic Projects
Ron Holmes	Project Support Officer

Connell Wagner Pty Ltd

Project Management

Tony Barry	Project Principal
Graeme Wood	Project Manager
Jason Gillard	Project Support

EIS/REF

Chris Masters	Environmental Investigations Leader
James Ellaway	Senior Environmental Scientist/Ecologist

Investigations and Design

Barry Hancock	Investigations Leader & Road Design Leader
John Hilton	Bridge Design Leader
Brett Hawkins	Geotechnical Investigations Leader
David Gaskell	Drainage and Hydrology Leader
John Baker	Survey Investigations Leader

Technical Support

Cameron Schrijvers	Road Designer
Noni Schrijvers	Project Drafter
Martin Russell	GIS
Ross Carey	Graphics

Wilkinson Murray Pty Ltd	Noise and Vibration Assessment
Conybeare Morrison Pty Ltd	Visual Impact Assessment and Urban Design
Andrew Benwell	Botanist / Ecologist
John Stanisic & Associates	Rainforest Snail Ecology