Appendix F

Ecology report

Gas Supply Pipeline East West Route Biological Impacts

September, 2008

Macquarie Generation

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Date: 30 September 2008.....

Distribution: Macquarie Generation, PB File.....

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Glossary

Biodiversity	The biological diversity of life is commonly regarded as being made up of the following three components: ▪ genetic diversity — the variety of genes (or units of heredity) in any population ▪ species diversity — the variety of species ▪ ecosystem diversity — the variety of communities or ecosystems.
Bioregion (region)	A bioregion defined in a national system of bioregionalisation. For this study this is the NSW Sydney basin bioregion as defined in the Interim Biogeographic Regionalisation for Australia (Thackway & Cresswell 1995).
Critical habitat	The whole, or any part or parts, of an area, or areas, of land comprising the habitat of an endangered species, an endangered population or an endangered ecological community that is critical to the survival of the species, population or ecological community (Department of Environment and Conservation 2004). Critical habitat is listed under both the *Threatened Species Conservation Act 1995* and the *Environment Protection and Biodiversity Conservation Act 1999* and both the State (Department of Environment and Climate Change) and Commonwealth (Department of the Environment and Water, Heritage and the Arts) Directors-General maintain a register of this habitat. Capitalisation of the term 'Critical Habitat' in this report refers to the habitat listed specifically under the relevant State and/or Commonwealth legislation.
Department of Environment and Climate Change	The NSW Department of Environment and Climate Change formed on 27 April 2007 incorporating the former NSW Department of Environment and Conservation in addition to some functions of the former Department of Natural Resources, Department of Energy, Utilities and Sustainability and the Greenhouse Office.
Department of the Environment and Heritage	The former name for the Commonwealth Department of the Environment, Water, Heritage and the Arts.
Department of the Environment and Water Resources	The former name for the Commonwealth Department of the Environment, Water, Heritage and the Arts.
Department of the Environment, Water, Heritage and the Arts	The Commonwealth Department of the Environment, Water, Heritage and the Arts changed their name from the Department of the Environment and Water Resources in 2007, and was previously known as the Department of the Environment and Heritage. The department develops and implements national policy, programs and legislation to protect and conserve Australia's natural environment and cultural heritage and administers the *Environment Protection and Biodiversity Conservation Act 1999*.
Ecological community	An assemblage of species occupying a particular area.
Environmental weed	Any plant that is not native to a local area that has invaded native vegetation.
Habitat	An area or areas occupied, or periodically or occasionally occupied by, a species, population or ecological community, including any biotic or abiotic components.
Key threatening processes	A process that threatens, or could threaten, the survival, abundance or evolutionary development of native species, populations or ecological communities (Department of Environment and Conservation 2004). Key threatening processes are listed under the *Threatened Species Conservation Act 1995,* the *Fisheries Management Act 1994* and the *Environment Protection and Biodiversity Conservation Act 1999.* Capitalisation of the term 'key threatening processes' in this report refers to those processes listed specifically under the relevant State and/or Commonwealth legislation.
Likely	Taken to be a real chance or possibility (Department of Environment and Conservation 2004).

Local population	The population that occurs within the study area, unless the existence of contiguous or proximal occupied habitat and the movement of individuals or exchange of genetic material across the boundary can be demonstrated (as defined by NSW National Parks and Wildlife Service 1996).
Subject site	The specific area that will be covered by the Project.
Study area	The subject site and any additional areas that are likely to be affected by the Project, either directly or indirectly.
Locality	The area within a 10 kilometre (km) radius of the study area.
Migratory species	Species listed as Migratory under the *Environment Protection and Biodiversity Conservation Act 1999.* Capitalisation of the term 'Migratory' in this report refers to those species listed as Migratory under the *Environment Protection and Biodiversity Conservation Act 1999*.
Protected species	Those species defined as protected under the *National Parks and Wildlife Act 1974*. Includes all native animals, and all native plants listed on Schedule 13 of the *National Parks and Wildlife Act 1974*.
Recovery plan	A plan prepared under the *Threatened Species Conservation Act 1995* or the *Environment Protection and Biodiversity Conservation Act 1999* to assist the recovery of a Threatened species, population or ecological community.
Significant	Important, weighty or more than ordinary (as defined by NSW National Parks and Wildlife Service 1996).
Threatened biodiversity	Threatened species, populations or ecological communities, or their habitats as listed under either the *Threatened Species Conservation Act 1995* or the *Environment Protection and Biodiversity Conservation Act 1999*.
Threatened species, populations and ecological communities	Species, populations and ecological communities listed as Vulnerable, Endangered or Critically Endangered (collectively referred to as Threatened) under the *Threatened Species Conservation Act 1995*, *Fisheries Management Act 1994* or the *Environment Protection and Biodiversity Conservation Act 1999*. Capitalisation of the terms 'Threatened', 'Vulnerable', 'Endangered' and 'Critically Endangered' in this report refers listing under the relevant State and/or Commonwealth legislation.
Viable local population	A population that has the capacity to live, develop and reproduce under normal conditions, unless the contrary can be conclusively demonstrated through analysis of records and references (as defined by NSW National Parks and Wildlife Service 1996).

1. Introduction

This technical paper addresses the biological impacts associated with the east-west route of the Liddell Power Station gas supply pipeline project, which encompasses approximately 22 kms of proposed gas pipeline to Liddell Power Station. This report comprises a technical paper appended to the environmental assessment for the project.

The technical paper examines the existing flora and fauna assemblages and their habitats along the pipeline route, and determines the potential impacts of construction and operation of the project on those features. It summarises the proposed mitigation measures as well as the impact assessments required under the *Environmental Planning and Assessment Act 1979* and the *Environment Protection and Biodiversity Conservation Act 1999*.

1.1 Background

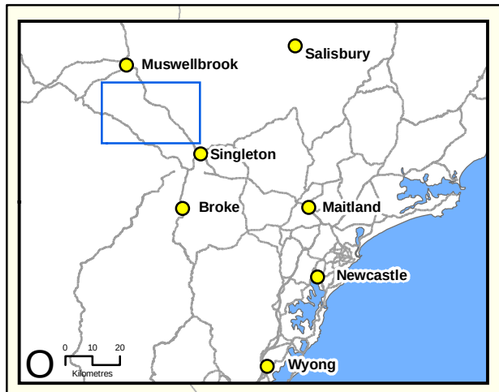
Macquarie Generation is proposing to construct a pipeline to supply coal gas fuel to supplement coal-fired electricity generation that occurs at Liddell Power Station, which is located in the Upper Hunter Valley of NSW. Macquarie Generation is seeking full Project Approval for the proposal under Part 3A of the *Environmental Planning and Assessment Act 1979* (EP&A Act). This report provides a detailed biological assessment of the proposal clearly indicating the scope of the project and an assessment of the key environmental issues.

The purpose of the pipeline is to utilise the currently wasted coal seam mine gas of the neighbouring Upper Hunter coal mines. Coal seam mine gas is of mixed quality with extremely variable composition and delivery rate (quantity), which can restrict the opportunity for use as a fuel in traditional generation technologies such as gas turbines or gas engines. The current management practice is disposal of the waste gas by venting or flaring into the atmosphere.

The pipeline (polyethylene or fibreglass) is anticipated to be constructed over a period of three months. The pipe will be installed in trenches that are excavated to a width of approximately 1 m. It is proposed to have a 20 m easement corridor along the route for construction, maintenance and access purposes. In areas where there are environmental or other constraints the easement will reduce to 10 m in width.

Advice will be sought from the contractor for an appropriate size of pipe section to install in the trench in each excavation. In determining the length of sections, adequate consideration will be given to environmental constraints.

Biosis Research (2007) (refer Appendix F) was commissioned previously to conduct a terrestrial flora and fauna assessment for the original proposed pipeline route (north-south route) that included this current east-west route. The results of the previously biological surveys and assessment have been incorporated within assessments of this report.



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PDF File: 2122755C_2006_Site_Location

- Localities
- Drainage
- Proposed Pipeline
- Local Government Boundary

Title: Study Site

PARSONS BRINCKERHOFF | AGL

		Datum: MGA 94 / Zone 56	Scale: 1:90,000
Project: Gas Supply Pipeline		Drawn: VB	Date: 24 Sept 2008
Client: Macquarie Generation		Designed: VB	Date: 24 Sept 2008
Proj. No. 2122755C	Layout Size: A3	Checked: AC	Date: 24 Sept 2008
GIS Proj: J:\A237 - HUN\PROJ\2122755C__UPL_MacGen_EW_\10_GIS		DWG. No: 2006	Fig. No. 1-1

1.2 Legislative context

The project will be assessed under Part 3A of the *Environmental Planning and Assessment Act 1979*. Part 3A consolidates the assessment and approval regime for major projects addressed previously under Part 4 or Part 5 (Environmental Assessment) of the *Environmental Planning and Assessment Act 1979*.

Other Commonwealth and state legislation and planning policies relevant to the protection of flora, fauna and biodiversity include:

- (Commonwealth) *Environment Protection and Biodiversity Conservation Act 1979*
- *Threatened Species Conservation Act 1995 (TSC Act)*
- *Native Vegetation Act 2003*
- *Water Management Act 2000*
- *Fisheries Management Act 1994*
- *Rivers and Foreshores Improvement Act 1948*
- *National Parks and Wildlife Act 1974*
- *State Environmental Planning Policy No. 44 — Koala Habitat Protection*
- *Noxious Weeds Act 1993.*

Although licences and approvals under these and other state Acts and policies are not required in addition to approval under Part 3A of the *Environmental Planning and Assessment Act 1979*, consideration has been given to their intent. The *Environment Protection and Biodiversity Conservation Act 1999* applies to the project.

1.3 Study area

The proposed east-west pipeline route is approximately 22 km in length (refer to Figure 1.1). The pipeline will conclude at Liddell Power Station, located on the New England Highway, south of Muswellbrook. At Liddell Power Station gas will be received from neighbouring mines to the east and west. The pipeline, contained within Macquarie Generation land, has a western component extending to the boundary near Mt Arthur and an eastern component originating near Ravensworth. The study area is located within Singleton and Muswellbrook Local Government Areas, the Sydney Basin bioregion (Thackway & Cresswell 1995) and between the Central West Slopes and North Coast Botanical Subdivisions (Anderson 1961).

1.4 Study aims

The draft Guidelines for Threatened Species Assessment under Part 3A (Department of Environment and Conservation 2005a) state that the objective of the assessment process under Part 3A is to provide information to enable decision-makers to ensure that developments deliver the following environmental outcomes:

- maintain or improve biodiversity values (i.e. there is no net impact on threatened species or native vegetation)

- conserve biological diversity and promote ecologically sustainable development
- protect areas of high conservation value (including areas of critical habitat)
- prevent the extinction of threatened species
- protect the long-term viability of local populations of a species, population or ecological community
- protect aspects of the environment that are Matters of National Environmental Significance.

With these objectives in mind, the aims of this technical paper are to assess the impacts of the east-west route of the Liddell Power Station Gas Supply Pipeline Project (the project) on the ecological values of the site. Specifically, the assessment aimed to:

- determine and describe the characteristics and condition of the vegetation communities and flora and fauna habitats
- determine the occurrence, or likelihood of occurrence, of Threatened biodiversity listed under the *Threatened Species Conservation Act 1995* and *Environment Protection and Biodiversity Conservation Act 1999* occurring within the study area
- undertake significance assessments for Threatened biodiversity that occur or have potential habitat within the study area
- propose further investigations and/or amelioration measures to mitigate impacts on the ecological values of the study area.

1.5 Report structure

The structure and content of this report is as follows:

- Chapter 2 details the desk-based and field methods used in surveying the current environment as well as the assessment methods.
- Chapter 3 describes the study area and locality in terms of the existing environment, including vegetation communities and flora and fauna, based on the results of the desk-based and field assessments.
- Chapter 4 describes the Threatened biodiversity occurring within the study area, as well as other significant ecological features requiring consideration, such as those covered under the *Environment Protection and Biodiversity Conservation Act 1999*.
- Chapter 5 describes the potential impacts of the project on the biological environment, including loss of vegetation and habitats and impacts on Threatened species.
- Chapter 6 describes potential mitigation measures that would be incorporated into the final design and construction program.
- Chapter 7 summarises the impact assessments of the potential impacts following the requirements of the *Environmental Planning and Assessment Act 1979* and the *Environment Protection and Biodiversity Conservation Act 1999*.
- Chapter 8 presents conclusions and recommendations.

2. Methods

The assessment included desk-based searches of databases and historical records as well as field survey within the study area. A survey of a previous gas supply pipeline route (north-south) completed by Biosis Research (2007) incorporated the 22 km section of pipeline subject to this assessment. These surveys have been reviewed and results incorporated into this study. Where considered useful, reference is made to other surveys in the project locality, including surveys undertaken for various mine infrastructure projects, adjoining and within the study area (Umwelt 2006, 2007; ERM 2008).

2.1 Definitions

For the purpose of this report, the following definitions apply:

- **Subject site:** the specific area that is proposed for the gas connection pipeline and inlet facility. This is a 20 m wide corridor centred on the 22 km of proposed pipeline.
- **Study area:** the subject site and any additional areas that could potentially be affected by the proposal either directly or indirectly. This is a 100 m wide corridor centred on the proposed pipeline.
- **Locality:** the area within 10 km of the study area.
- **Region:** a bioregion defined in a national system of bioregionalisation. For this study this is the Sydney Basin bioregion as defined in the Interim Biogeographic Regionalisation for Australia (Thackway & Cresswell 1995).

2.2 Personnel

The contributors to the preparation of this report, their qualifications and roles are listed in Table 2-1.

Table 2-1 Contributors and their roles

Name	Qualification	Role
Alex Cockerill	BSc(Hons)	Botanist -Ecologist - surveys, report preparation
Dr Martin Predavec	BSc (Hons) PhD	Ecologist - review
Nathan Cooper/ Veronica Black	BEnvSc.	GIS operator

All work was carried out under the appropriate licences, including a scientific licence as required under Clause 22 of the National Parks and Wildlife Regulations 2002 and Section 132C of the *National Parks and Wildlife Act 1974,* and an Animal Research Authority issued by the Department of Primary Industries (Agriculture).

2.3 Nomenclature

Names of plants used in this document follow Harden (Harden 1992, 1993, 2000, 2002) with updates from PlantNet (Royal Botanic Gardens 2008). Scientific names are used in this report for species of plant. Scientific and common names (where available) are provided in plant lists in Appendices A and C.

Names of vegetation communities used in this report are based on the dominant species and structure of the community. Where practical, the names follow those used in the existing local vegetation mapping ('The Vegetation of the Central Hunter Valley, New South Wales', *A Report on the Findings of the Hunter Remnant Vegetation Project, Final Draft Version 1* (Peake 2005), or Threatened community listings under the *Threatened Species Conservation Act 1995* and/or the *Environment Protection and Biodiversity Conservation Act 1999*.

Names of vertebrates follow the Census of Australian Vertebrates (CAVS) database maintained by the Department of the Environment, Water, Heritage and the Arts (Department of the Environment Water Heritage and the Arts 2008a; Wintle *et al.* 2004) and as used in the Atlas of NSW Wildlife (Department of Environment and Climate Change 2008a). Common names are used in the report for species of animal. Scientific names are included in species lists found in Appendices C and D.

2.4 Database searches and literature reviews

Records of Threatened species known or predicted to occur were obtained from a range of databases as detailed in Table 2-2.

Table 2-2 Databases searched for records of Threatened Species

Database	Search date	Area searched	Reference
Atlas of NSW Wildlife	10 July 2008	Singleton Local Government Area (fauna) 10 km buffer around subject site (flora)	(Department of Environment and Climate Change 2008a)
Threatened species, populations and communities database	10 July 2008	Hunter/Central Rivers Catchment Management Authority area (fauna) 10 km buffer around subject site (flora)	(Department of Environment and Climate Change 2008c)
Bionet	10 July 2008	Singleton Local Government Area (fauna) 10 km buffer around subject site (flora)	(Department of Environment and Climate Change 2008b)
Protected Matters Search Tool	10 July 2008	10 km buffer around subject site	(Department of the Environment Water Heritage and the Arts 2008b)

Broad scale vegetation mapping of the study area by Peake (2005) and Biosis Research (2007) were reviewed to determine the vegetation community types most likely to occur on site.

Further records of Threatened biodiversity were obtained from various literature sources that are cited throughout this document (see Reference section for a full reference list). In particular, the following detailed ecological investigations from within areas adjoining the subject site were reviewed:

- Terrestrial Flora and Fauna Impact Assessment: Gas Supply Pipeline, Liddell Power Station (Biosis Research 2007).
- Ecological Assessment for Downcast Ventilation Shaft Facility, Mt Arthur Coal (Umwelt Pty Ltd 2006 2006).
- Flora and Fauna Assessment for modifications of Glendell Mine Operations (Umwelt Pty Ltd 2007).
- HVO South Coal Project, Ecological Assessment Report (ERM 2008).

A brief description of these studies is provided below.

2.4.1 HVO South Coal Project, Ecological Assessment Report (ERM 2008)

This study is located approximately 500 m south of the study area and is connected to the subject site be the riparian corridor. Fauna surveys were completed in accordance with the Threatened species guidelines and included terrestrial and arboreal fauna trapping, and nocturnal surveys.

2.4.2 Ecological Assessment for Downcast Ventilation Shaft Facility - Mt Arthur Coal Mine (Umwelt Pty Ltd 2006)

This study is located <200 m metres west of the study areas western boundary. Fauna surveys were completed in accordance with the Threatened species guidelines and included terrestrial and arboreal fauna trapping, and nocturnal surveys.

2.4.3 Flora and Fauna Assessment for Modification of the Glendell Mine Operations (Umwelt Pty Ltd, 2007)

This study was located approximately 200 m north of the study area and is connected to the subject site by the riparian corridor of Swamp Creek. Fauna surveys included fauna hair tubes (arboreal and terrestrial), amphibian, aquatic and reptile searches and nocturnal and anabat surveys.

The results of these database and literature searches are presented in sections 3 and 4 and Appendix B and D.

2.5 Field survey

Surveys of the study area were carried between 25 and 29 July 2007 (Biosis Research 2007) and 14 and 17 July 2008 (Parsons Brinckerhoff (PB)). The surveys sought primarily to

assess the extent and condition of vegetation communities and potential flora and fauna habitat, especially for Threatened species. Sites surveyed included the proposed construction footprint and surrounding areas potentially affected by the construction of the project.

Survey effort and design considered the *Threatened Biodiversity Survey and Assessment: Guidelines for Developments and Activities (Working Draft)* (Department of Environment and Conservation 2004).

2.5.1 Aerial Photographic Interpretation (API)

The study areas vegetation community boundaries were assessed using aerial-photo interpretation. Analysis of the aerial-photographs identified past land use practices, disturbance and native vegetation regrowth, changes in vegetation structure and floristics throughout the study area. This provided an initial split of vegetation communities into simple structural and disturbance classifications.

2.5.2 Existing vegetation mapping

Vegetation within the study area and project locality has been mapped at both the local (Biosis Research 2007) and regional scale (Peake 2005). Field validation (ground-truthing) of the initial vegetation classification identified from aerial photograph interpretation and existing vegetation mapping (Tindall *et al.* 2004) was initially undertaken to determine the site specific classification of the vegetation structure, dominant species, native diversity and condition.

2.5.3 Condition of vegetation communities

The quality of vegetation was assessed using parameters such as intactness, diversity, history of disturbance, weed invasion and health. Three categories were used to describe the condition of vegetation communities:

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

2.5.4 Species of plant

The floristic diversity and possible presence of Threatened species was assessed using a combination of random meander and plot-based (quadrat) surveys in accordance with the *Threatened Biodiversity Survey and Assessment: Guidelines for Development and Activities (Working Draft)* (Department of Environment and Conservation 2004).

Due to the linear nature of the proposal, random meander surveys were completed along the entire length of the proposal. Random meander surveys are a variation of the transect type survey and were completed in accordance with the technique described by Cropper (1993), whereby the recorder walks in a random manner throughout the site recording all species observed, boundaries between various vegetation communities and condition of vegetation. The time spent in each vegetation community was generally proportional to the size of the community and its species richness.

Survey of 13 quadrats was completed along the proposed pipeline route. Vegetation quadrats were 400 square metres (20 x 20 m) and the number of vegetation quadrats surveyed in the study area was determined in accordance with the suggested minimum survey effort specified by the *Threatened Biodiversity Survey and Assessment Guidelines* (see Table 2-3).

Table 2-3 Suggested survey technique and effort for plant quadrats

Survey technique	Suggested minimum effort per stratification unit	Information recorded
Quadrat	1 quadrat for areas <2 ha	Floristics, structure, Threatened species
	2 quadrat for area 2-50 ha	
	3 quadrats for areas 51-250 ha	
	5 quadrats for areas 251-500 ha	
	10 quadrats for areas 5001-1000 ha, plus 1 additional quadrat for each extra 100 ha thereof	

Source: *Threatened Biodiversity Survey and Assessment: Guidelines for Developments and Activities* (Working Draft) (Department of Environment and Conservation 2004).

The floristic survey area was initially stratified after a review of the biophysical attributes (e.g. landform, geology, elevation, slope, soil type, aspect), aerial photograph interpretation of the broad structural and disturbance characteristics and existing vegetation mapping 'The Vegetation of the Central Hunter Valley, New South Wales*', A Report on the Findings of the Hunter Remnant Vegetation Project, Final Draft Version 1* (Peake 2005) (see Table 2-4). The locations of quadrats are shown in Figure 3.2.

Table 2-4 Stratification units and number of quadrats surveyed

Stratification unit	Area within proposal	Suggested minimum effort per stratification unit[1]	Number of quadrats surveyed
Central Hunter Box - Ironbark Woodland	<2 ha	1	2
Central Hunter Bulloak Forest Regeneration	<2 ha	1	0[2]
Central Hunter Ironbark - Spotted Gum - Grey Box Forest	<2 ha	1	2
Central Hunter Swamp Oak Forest	<2 ha	1	1
Planted areas	2-50 ha	2	2
Cleared/Grassland	2-50 ha	2	2
Hunter Lowland Redgum Forest (EEC)	<2 ha	1	1

Stratification unit	Area within proposal	Suggested minimum effort per stratification unit[1]	Number of quadrats surveyed
Hunter Valley River Oak Forest	<2 ha	1	2
Narrabeen Footslopes Slaty Box Woodland	<2 ha	1	1

1. Suggested minimum effort per stratification unit as per the *Threatened Biodiversity Survey and Assessment: Guidelines for Developments and Activities* (Working Draft) (Department of Environment and Conservation 2004).

2. Community not observed during field surveys within subject site.

Additional sample plots required for homogenous vegetation units identified during the field surveys and not in the initial stratification were located in areas most representative of that unit, giving consideration to avoid bias from edge effects and local disturbances.

The following information was recorded for each quadrat:

- location (easting – northing grid type WGS 84, Zone 56)
- stratification
- dominant canopy species
- condition
- all species observed
- cover abundance of each species.

The cover abundance estimate was based on a modified Braun-Blanquet 1-6 scale assigned to each vascular plant specimen recorded. The cover abundance values for each 1-6 classes are provided in Table 2-5.

Table 2-5 Cover abundance scale 1-6

Class	Cover Abundance
1	<5% - Sparse
2	<5% - Any number
3	5% - 25%
4	25% - 50%
5	50% - 75%
6	75% - 100%

2.5.5 Targeted flora survey

Targeted searches were conducted within the study area as part of the random meander survey for Threatened species considered likely to occur based on findings of the databases searches and literature review. These included:

- **Threatened species:**
  - *Bothriochloa biloba*

- *Eucalyptus glaucina*.

- **Endangered populations:**
  - *Cymbidium canaliculatum*[1]
  - *Eucalyptus camaldulensis*
  - *Acacia pendula.*

The threatened species *Diuris tricolour* is considered to have only marginal potential habitat within the subject site. This species requires targeted survey during its specific flowering period of August-September for identification.

During targeted field surveys for *Eucalyptus glaucina* and *Eucalyptus camaldulensis* a number of fruiting and flowering specimens of red gum were collected from the subject site. These were identified within the field as predominately *Eucalyptus tereticornis* and occasionally *Eucalyptus blakelyi*.

Samples of these red gum specimens were sent to the Royal Botanical Gardens Sydney for confirmation of their identification. These were subsequently confirmed as *Eucalyptus blakelyi* and a hybrid cross between *Eucalyptus blakelyi* and *Eucalyptus tereticornis*.

2.5.6 Photographic site appraisal

The entire length of the subject site has been photographed to provide a clear pictorial reference of the proposed alignment. Photographs were taken at appropriate intervals along the alignment to ensure a comprehensive coverage of the site was completed.

2.6 Terrestrial vertebrate fauna

2.6.1 Fauna habitats

Fauna habitat assessments were undertaken to assess the likelihood of Threatened species of animal (identified from the literature and database review) to occur in the study area and to identify areas where they would be most likely to occur.

Fauna habitat characteristics assessed included:

- structure and floristics of the canopy, understorey and ground vegetation, including the presence of flowering and fruiting trees providing potential foraging resources
- presence of hollow-bearing trees providing roosting and breeding habitat for arboreal mammals and birds
- density of ground cover with shrubs, grasses, or leaf litter and fallen timber to provide protection for ground-dwelling mammals, reptiles and amphibians
- structure and composition of the litter layer
- presence of waterways (ephemeral or permanent) and water bodies.

The assessment of these fauna habitat characteristics enabled an overall assessment of fauna habitat condition within the study area. The following criteria were used to evaluate the condition of fauna habitats:

- **Good**: a full range of fauna habitat components are usually present (e.g. trees, fallen timber, feeding and roosting resources) and habitat linkages to other remnant ecosystems in the landscape are intact.
- **Moderate**: some fauna habitat components may be missing (e.g. old growth trees, fallen timber), although linkages with other remnant habitats in the landscape are usually intact, but sometimes degraded.
- **Poor**: many fauna habitat elements in low quality remnants have been lost, including old-growth trees (e.g. due to past timber harvesting or land clearing) and fallen timber, and tree canopies are often highly fragmented. Habitat linkages with other remnant ecosystems in the landscape have usually been severely compromised by extensive past clearing.

2.6.2 Targeted fauna survey

In addition to the habitat assessment and incident diurnal observations completed during the current surveys, Biosis Research (2007) completed targeted surveys within the study area, to determine the presence of threatened and common animal species such as owls, gliders, possums and bats. A summary of the targeted surveys completed by Biosis Research (2007) are discussed in detail below.

Spotlighting

Spotlighting was undertaken at night to detect nocturnal fauna including mammals, birds, and frogs. This involved the use of at least two 100 watt, 12 volt spotlights. Trails and roads within forest/woodland areas were traversed on foot during the night. Ground areas and tree canopies were searched for mammal and bird activity. Spotlighting surveys were restricted to the larger area of intact Woodland habitat.

Survey effort: 3 hours

Bat call detection (Echolocation analysis)

An Anabat detector (Titley Electronics) with time delay switch was used to record Microchiropteran bat calls (echolocation). Calls can provide information on frequency and call sequence, allowing species identification. The detector was set before dusk within or near a suspected bat fly-way, leaving it to record for a period of time. Fly-ways may include overgrown tracks and roads, beneath the canopy of streams and creeks, over larger water bodies (ponds, lakes) or within gaps or along edges of forest/woodland vegetation. A night switch ensured that recording started at dusk. A hand-held detector was used while spotlighting was undertaken, to record any bats flying past. Bat calls were analysed by Narawan Williams (Ecotone Ecological Consultants) for species identification. Bat call detection was undertaken in areas of woodland habitat with suitable roosting and/or foraging habitat for targeted bat species.

Survey effort: 6 nights

Call playback

Nocturnal species with large home-ranges or those that are particularly cryptic are generally difficult to locate during nocturnal spotlighting but may be detected using call-playback. This technique relies on behavioural responses associated with territory and threat, whereby emitted calls may induce a defending response (either call or display) from individuals of the same species. Owls can be surveyed in this manner (Kavanagh & Peake 1993), as well as other nocturnal vocalising species including mammals and frogs. A JNC MP3 player connected to a TOA megaphone was used to emit the calls. Each session began with a 5-10 minute listening period to detect any species already present in the area. Each species' call was played for five minutes followed by a five minute listening period until all species calls had been emitted. A 10 minute spotlight of the area was conducted following the call-playback. Any animals encountered were identified by direct observation using 10 x 42 field binoculars or by their calls. Call playback was undertaken in larger areas of intact Woodland habitat.

Survey effort: 2 hours and 30 minutes

Incidental Observations

Both indirect and direct evidence of fauna were recorded and used to identify species presence. Direct evidence of fauna species includes actual sightings or identification of the species by calls (e.g. birds, frogs and some nocturnal mammals). Indirect evidence of fauna species includes remains (e.g. bones, skin and fur), scats (droppings), diggings or burrows, and hair or body remains identified from predator scats.

Survey effort: 5 days

2.7 Conservation significance

Assessment of the conservation significance of native terrestrial flora and fauna is generally done according to the hierarchy:

- national
- state
- regional
- local.

Meaningful comparisons of significance or value at a variety of scales rely on widely accepted criteria (International Union for the Conservation of Nature 2001). The following criteria were used to assign the site an appropriate conservation significance category.

2.7.1 National

This category includes matters dealt with under the *Environment Protection and Biodiversity Conservation Act 1999*, including:

- important areas of habitat for migratory species covered under international agreements to which Australia is a signatory, such as the China Australian Migratory Bird Agreement (CAMBA), Japan Australian Migratory Bird Agreement (JAMBA), Republic of Korea Australia Migratory Bird Agreement (RoKAMBA) and the Bonn Convention on the Conservation of Migratory Species of Wild Animals
- Ramsar Wetlands
- World Heritage properties that contain natural heritage considered to be of outstanding value to humanity as listed under the Convention Concerning the Protection of the World Cultural and Natural Heritage
- species populations or communities considered Vulnerable, Endangered or Critically Endangered and listed pursuant to the *Environment Protection and Biodiversity Conservation Act 1999*.

This category also includes:

- flora listed as Threatened and Rare in *Rare or Threatened Australian Plants* (Briggs & Leigh 1996)
- species listed as Endangered, Vulnerable or Rare in Australia in an action plan published by the Department of the Environment, Water, Heritage and the Arts.

2.7.2 State

Remnant ecosystems containing populations of plant or animal species, or vegetation or animal communities considered Threatened in NSW, including species and communities listed pursuant to the *Threatened Species Conservation Act 1995*. This category also includes flora listed as 'poorly known' in *Australia in Rare or Threatened Australian Plants* (Briggs & Leigh 1996).

2.7.3 Regional

There are no widely accepted criteria for regional significance in NSW. The State is divided into bioregions (Thackway & Cresswell 1995) and much of the listing of Endangered Ecological Communities under the *Threatened Species Conservation Act 1995* and the *Environment Protection and Biodiversity Conservation Act* 1999 is based around these regions. NSW Catchment Management Authorities direct natural resource management within 13 general catchments and include information on the extent of various vegetation communities. Also numerous published studies and vegetation mapping projects (e.g. Lower Hunter and Central Coast Regional Environmental Management Strategy 2003) have indicated the importance of vegetation communities and species at various spatial scales.

2.7.4 Local

All remnant native vegetation and fauna habitat that does not fall into the categories above is considered to be of at least local significance, as most of these areas have been reduced in extent since European settlement. The overall significance of the site on a local scale can take into consideration factors such as the size of remnants, degree of intactness and connectivity.

2.7.5 Potentially significant

Often the limitations of field methods, seasonal factors or time constraints make it impossible to confirm the presence of a significant species or a population. However, the habitat of an area being investigated may closely match that used by a significant species in areas near to where it is known to occur. In these circumstances, the level of significance that would otherwise apply is qualified by the term 'potential'. In addition, some species or communities may possess characteristics that make them eligible for listing as Threatened at either the national or the state level, although the listing has not yet taken place. Again, the level of significance for these species and communities is qualified by the term 'potential'.

2.8 Impact assessments

Significance assessments were completed for those species recorded or predicted to occur within the project locality based on the database searches (see Section 2.4) and that were considered likely to occur in the study area based on the presence of suitable habitat. An additional search was completed for Threatened species likely to occur within the Hunter/Central Rivers Catchment area (Department of Environment and Conservation 2008), for which potential habitat occurs in the study area and for which records exist outside the project locality.

For species, populations and communities listed under the *Threatened Species Conservation Act 1995* and the *Fisheries Management Act 1994* that have the potential to occur in the study area, the significance of impacts was assessed based on the Department of Environment and Conservation's *Draft Guidelines for Threatened Species Assessment under Part 3A* (2005a). Under these guidelines, impacts are considered more significant if:

- areas of high conservation value are affected
- individual animals and/or plants and/or subpopulations that are likely to be affected by a proposal play an important role in maintaining the long-term viability of the species, population or ecological community
- habitat features that are likely to be affected by a proposal play an important role in maintaining the long-term viability of the species, population or ecological community
- the duration of the impacts would be long-term the impacts would be permanent and irreversible (Department of Environment and Conservation 2005a).

For species listed under the *Environment Protection and Biodiversity Conservation Act 1999,* significance assessments were completed in accordance with the 'EPBC Act Policy', *Statement 1.1 Significant Impact Guidelines* (Department of the Environment and Heritage 2006b).

Species listed under both the *Threatened Species Conservation Act 1995* and the *Environment Protection and Biodiversity Conservation Act 1999* were assessed using both assessment guidelines separately, although there is considerable overlap between the two assessment processes.

2.9 Limitations

On all sites, varying degrees of non-uniformity of flora and fauna habitats are encountered. Hence no sampling technique can totally eliminate the possibility that a species is present on a site (e.g. species of plant present in the seed bank).

The conclusions in this report are based upon data acquired for the site and the environmental field surveys and are, therefore, merely indicative of the environmental condition of the site at the time of preparing the report, including the presence or otherwise of species. Also, it should be recognised that site conditions, including the presence of threatened species, can change with time.

Where survey was done outside the optimal time for detecting species (e.g. flowering periods of terrestrial cryptic orchids and amphibians active in spring/summer), a precautionary approach was taken and it was assumed that the species was present if suitable habitat was observed.