Appendix F

Photographic montage

Photograph 1- Looking west

Photograph 1- Looking east

Photograph 2 - Looking east

Photograph 3 - Looking east

Photograph 4 - Looking east

Photograph 4 - Looking south

Photograph 5 - Looking east

Photograph 6 - Looking east

Photograph 7 - Looking east

Photograph 8 - Looking east

Photograph 9 - Looking east

Photograph 10 - Looking east

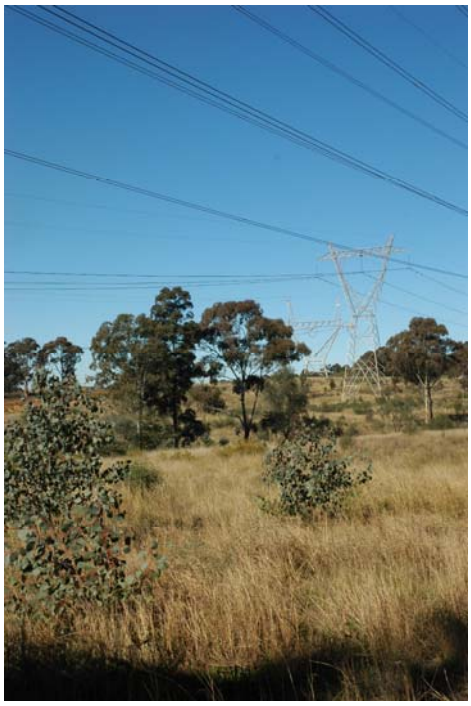
Photograph 11 - Looking east

Photograph 12 - Looking east

Photograph 13 - Looking east

Photograph 14 - Looking east

Photograph 15 - Looking west



Photograph 16 - Looking east

Photograph 17 - Looking east

Photograph 18 - Looking west

Photograph 19 -Looking east

Photograph 20 - Looking east

Photograph 21 - Looking east

Photograph 22 - Looking east

Photograph 23 - Looking east

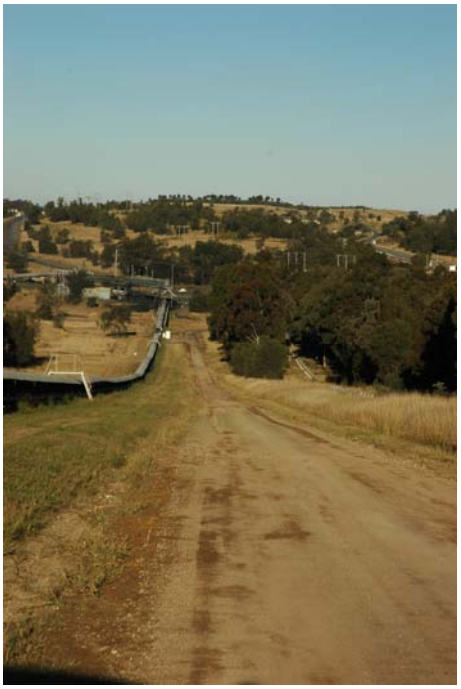
Photograph 24 - Looking east

Photograph 25 - Looking south

Photograph 26 - Looking west

Photograph 27 - Looking east

Photograph 29 - Looking east



Photograph 29 - Looking east

Photograph 30 - Looking east

Photograph 31 - Looking east

Photograph 32 - Looking east

Photograph 33 - Looking east

Photograph 34 - Looking east

Photograph 35 -Looking southeast

Photograph 36 - Looking west

Photograph 37 - Looking west

Photograph 38 - Looking east

Photograph 39 - Looking east

Photograph 40 - Looking east

Photograph 41 - Looking east

Photograph 42 - Looking south

Photograph 42 - Looking west

Photograph 43 - Looking east

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Terrestrial Flora and Fauna Impact Assessment: Gas Supply Pipeline, Liddell Power Station

August 2007

Natural & Cultural Heritage Consultants 15-17 Henrietta St Chippendale NSW 2008

BIOSIS
RESEARCH

Report for
Parsons Brinckerhoff

Terrestrial Flora and Fauna Impact Assessment: Gas Supply Pipeline, Liddell Power Station

August 2007

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ABBREVIATIONS

DECC	NSW Department of Environment and Climate Change, (formerly NSW Department of Environment and Conservation, DEC)
DEW	Commonwealth Department of Environment and Water Resources
DP	NSW Department of Planning
DNR	NSW Department of Natural Resources
EP&A Act	NSW *Environmental Planning and Assessment Act* 1979
EPBC Act	Commonwealth *Environment Protection and Biodiversity Conservation Act* 1999
LGA	Local Government Area
MNES	Matter of National Environmental Significance (under the EPBC Act)
NPWS	NSW National Parks and Wildlife Service (now part of DECC)
ROTAP	Rare or Threatened Australian Plant as listed by Briggs and Leigh (1996)
SIS	Species Impact Statement
SEPP	NSW State Environmental Planning Policy
TSC Act	NSW *Threatened Species Conservation Act* 1995
sp.	Species (singular)

spp.	Species (plural)
ssp.	Subspecies
var.	Variety

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1.0 SUMMARY

Biosis Research was commissioned by Parsons Brinckerhoff (PB) to conduct a terrestrial flora and fauna assessment for the proposed gas supply pipeline between singleton and Muswellbrook in the Upper Hunter Valley. The project is part of Macquarie Generations proposal to construct a pipeline to supply gas to supplement coal-fired electricity generation at Liddell Power Station.

The study area supports various alluvial and clay based plant communities typical of the Central Hunter and Upper Hunter Valley. The most significant of the plant communities recorded in the study area is the Endangered Ecological Community under the TSC Act Warkworth Sands Woodland, which is restricted to aeolian sand within the locality.

Much of the study area passes through grazing and reclaimed mining land that contains no native vegetation including areas revegetated following mining. The study area also passes through remnant native vegetation in Good to Moderate condition, having regenerated well following historical clearing and grazing. Many of the vegetation remnants are partially fragmented by tracks, roads or easements.

The proposal will involve clearing and /or modifying approximately 42.9 hectares of native vegetation, including 10.6 hectares of Warkworth Sands Woodland, which is listed as an Endangered Ecological Community (EEC) under the Threatened Species Conservation Act 1995 (TSC Act). As such, an impact assessment under Part 3 of the EP&A Act was carried out for this EEC, which concluded that the proposal is likely to have a high impact on this EEC.

Eucalyptus camaldulensis trees that are part of the *River Red Gum population in the Hunter catchment* (endangered population of *Eucalyptus camaldulensis*) were recorded in the study area. A previous record of *Acacia pendula*, part of the *Weeping Myall population in the Hunter catchment* (endangered population of *Acacia pendula*), was previously recorded occurs in the study area. Potential habitat for the Pine Donkey Orchid population in the Muswellbrook local government area **(**endangered population of *Diuris tricolor)* and the Hunter Valley endangered population of *Cymbidium canaliculatum* also occurs in the study area.

No threatened plant species were recorded within the study area, however a previous record of the threatened plant species *Eucalyptus glaucina* and potential habitat for three threatened plant species (*Diuris tricolor, Goodenia macbarronnii* and *Pterostylis gibbosa*) occurs in the study area. As such, impact assessments following the Guidelines for Threatened Species Assessment under Part 3A of the EP&A Act and/or Assessments of Significance following the Significant Impact Guidelines under the EBBC Act were undertaken for these

threatened plant species and populations. These assessments concluded that the proposal is unlikely to have a high impact on any of these threatened species or endangered populations, as:

- there is a large area of suitable good quality habitat that occurs in the locality,
- none of these species were recorded during surveys of the study area and
- the species is unlikely to be affected by the proposal.

One threatened bird, Grey-crowned Babbler and one migratory bird, Brown Falcon were recorded within the study area. In addition two threatened bats species, Eastern Bentwing Bat and Eastern Cave Bat were possibly recorded (on the Anabat detector). The study area provides potential habitat for a further 31 threatened and/or migratory species listed on the TSC and/or EPBC Act. The proposal is likely to modify and/or remove approximately 31 hectares of potential habitat for 21 of these species. Based on the impact assessment, given the extent of potential habitat within the locality it is unlikely that the proposal would have a substantial impact on this species. A Referral is not recommended for any of these species.

In addition, it is likely that creeks and drainage lines which are potential habitat for the Green and Golden Bell Frog will be impacted by the proposal. This species was not detected during the current surveys. If this species does occur within the creeks or drainage lines within the study area, however, it is likely that the proposal will have a significant impact on this species. It is therefore recommended that targeted surveys for the Green and Golden Bell Frog be undertaken prior commencement of the proposed works.

It is recommended that the following mitigation measures be implemented to minimise any disturbances on the ecological values of the study area:

- Implement best practice sediment and erosion control measures on all sites to minimise erosion and sedimentation during and after construction. This should include installation and maintenance of siltation fencing during construction and rehabilitation as part of an erosion and sedimentation control plan. This is discussed in more detail in Section 6.0 of this report. Particular emphasis should be given to the areas around areas of Warkworth Sands Woodland
- Utilise pre-existing tracks and access points wherever possible to minimise disturbance to native vegetation
- Excavate soil, in areas containing native vegetation, by stripping and stockpiling the top 100 millimetres of topsoil containing the soil-stored

seed back, and replacing back over its original position upon completion of the works. This will reduce damage to the natural soil seed bank and increase the amount of natural regeneration to occur following completion of the proposed works

- Avoid impacting any hollow bearing trees and implement the following procedure:

    1. Mark hollow bearing trees before commencing clearing of surrounding trees

    2. Retain hollow-bearing trees while the surrounding trees are being cleared

    3. Leave hollow bearing trees for 24 – 48 hours before clearing to allow fauna to escape these areas

- Retain and relocate all hollow limbs removed from trees to other locations within the study area to provide fauna habitat

- Minimising the length of installation trench open at any one time and provide fauna egress points every 50 metres of open trench to allow any animals which fall into the trench to escape. Any trapped animals should be removed before back filling trenches

- Stockpiling all native shrubs, logs, scattered timber or bush-rock and spreading back over the site following completion of the proposed works

- Avoiding disturbing riparian areas (creeklines, wetlands, drainage lines) by implementing directional boring techniques for laying of pipes

- Restricting installation of pipes through creeks and riparian areas dry periods to further minimise erosion and sedimentation

- Minimising the footprint of machinery footprint, turning circle and access zones Where possible large vehicles should reverse off each work site, to minimise additional clearing that may be required for vehicle access

- Cleaning all machinery and equipment before entering site from another site, or from outside of the immediate area, in order to prevent the spread of weed seed and soil pathogens into the site and between sites.

- Implementing appropriate weed control and bush regeneration strategies within the study area such as areas of native vegetation, especially Warkworth Sands Woodland

- Mulching all native vegetation that is cleared or trimmed within the site and spreading on-site, provided the material is native and contains no significant weeds. If vegetation is weedy this should be removed off-site and disposed of appropriately

- Limiting disturbance to the tree canopy by removing minimal amounts of canopy material to minimise any potential increase in size of gaps in the tree canopy

- Restoring the original soil surface profile to pre-construction levels to ensure the natural surface hydrology is not disturbed. This is especially important within areas of habitat for *Eucalyptus camaldulensis,* which are located within Wambo Colliery land.

- Altering the alignment of the proposal to avoid the Warkworth Sands Woodland remnant located between Wallaby Scrub Road and Wollombi Brook

- Maintaining a no impact zone around *Eucalyptus camaldulensis* trees of a size of two times the radius of the tree canopy

- A Qualified ecologist should survey the route for the following threatened species, so that occurrences are avoided by the proposal and any impacts upon these species minimised:

    1. *Eucalyptus camaldulensis* and *Acacia pendula* within the Wambo Colliery area

    2. *Eucalyptus glaucina* within the remnant between Wallaby Scrub Rd and Wollombi Brook

    3. Green and Golden Bell Frog (*Litoria aurea*) should be surveyed along creek and drainage lines that are likely to be traversed by the proposed pipeline

These mitigation measures are likely to minimise the impacts of the proposal. With the implementation of these mitigation measures the proposal is unlikely to have a long-term impact on threatened species and/or populations within the study area. However, the proposal is likely to have a long-term impact on the EEC Warkworth Sands Woodland. It is recommended that the proposed route be altered to avoid impacting upon the Warkworth Sands Woodland remnant located between Wallaby Scrub Road and Wollombi Brook.

2.0 INTRODUCTION

Biosis Research was commissioned by Parsons Brinckerhoff (PB) to conduct a terrestrial flora and fauna assessment for the proposed gas supply pipeline between Singleton and Muswellbrook in the Upper Hunter Valley. The project is part of Macquarie Generations proposal to construct a pipeline to supply gas to supplement coal-fired electricity generation that occurs at Liddell Power Station. The proposal would provide a means of methane gas disposal and reduce the greenhouse impacts of both coal mining process and electricity generation.

The proposal has been assessed under Part 3A of the NSW *Environmental Planning and Assessment Act* 1979 (EP&A Act) with reference to threatened biota listed on the NSW *Threatened Species Conservation Act* 1995 (TSC Act) and the Commonwealth *Environment Protection and Biodiversity Conservation Act* 1999 (EPBC Act).

2.1 Aims

The specific aims of this assessment are to:

1. Conduct a literature review and database search for the locality
2. Undertake targeted field surveys for habitat of threatened terrestrial flora and fauna, populations or ecological communities that are listed on the TSC Act and the EPBC Act and have been identified as potentially occurring in the locality
3. Provide an assessment of the habitat values of the study area
4. Assess the impact of the proposal on threatened species , endangered populations and Endangered Ecological Communities listed on the TSC and EPBC Act (Significant Impact Criteria) that exist in the study area or have with potential habitat in the study area and
5. Provide recommendations to minimise the environmental impacts of the proposal.

2.2 Definitions

The following terms are used frequently throughout the report:

- ***The proposal*** is the development, activity or action proposed. In this case the proposal is the installation of a pipeline 50 kilometres in length from Liddell Power Station and ending 35 kilometres south of Liddell, within the Bulga Mine.

- ***Subject site*** is defined in *Threatened Biodiversity Survey and Assessment: Guidelines for Developments and Activities - Working Draft* (DEC 2004a) as the area directly affected by the proposal. In this case, the subject site is the 15m wide disturbance footprint of the proposal

- ***Study area*** is defined in DEC (2004a) as the subject site and any additional areas that are likely to be affected by the proposal, both directly and indirectly. In this case the study area is the area of direct impact (15m width) plus the areas of indirect impacts (5m buffer on each side of the area of direct impact).

- ***Subject species*** means those threatened species that are known or considered likely to occur in the study area.

- ***Affected subject species*** means species likely to be affected by the proposal.

- ***Affected community*** means subject endangered ecological community likely to be affected by the proposal.

- ***Abundance*** means a quantification of the population of the species or community.

- ***Regional*** means the area defined within the applicable IBRA Bioregion (Thackway and Cresswell 1995), that is the Sydney Basin Bioregion.

- ***Local population*** is defined in DEC (2004a) as the population of a species within the study area.

- ***Local occurrence*** is used in reference to endangered ecological communities and is defined in DEC (2004a) as the community that occurs within the study area.

- ***Locality*** is the area within a 10 kilometre radius of the study area.

- ***Threatened biota*** refers to threatened and migratory species, populations and ecological communities as listed on the TSC and EPBC Acts.

2.3 The Proposal

Macquarie Generations plans to construct a pipeline of approximately 65 kilometres with two main components: the southern and western component (Figure 2). The western component is approximately 7.5 kilometres in length and originates at the coal mine directly adjoining Macquarie Generation's main land holding.

Only the southern component (the proposal) has been assessed in this report. The proposal originates 35 kilometres south of Liddell Power Station (Figure 2) and is approximately 50 kilometres in length. The majority of the pipeline is to be

sub-surface and where possible located along existing tracks and easements. Subsurface construction will include a combination of open trenching and boring techniques. Most of the line will be laid in open trenches, while roadway and the Hunter River crossings will be bored.

Trenching along the majority of the route will be undertaken by wheel trencher, except where hard rock terrain is encountered where a backhoe or rock saw will be used. Pipe lowering-in and backfilling operations are likely to use a combination loader and backhoe. Fauna egress points will be provided at regular intervals along the open trench.

Subsurface sections of the pipeline will, wherever possible, be confined to a high disturbance zone of 15 metres width for trenching, brush and spoil pile and vehicle movement. Root stock will be left in the ground where practicable to stabilise the area and reduce erosion. Large mature trees will be preserved where practicable by making small adjustments to the trench line. Adjacent areas along the route, chosen for low impact, will be used for laying out pipe lengths and equipment prior to placement in the trench.

A number of watercourse crossings will be traversed by the proposal and the methods may vary depending on the situation. In the case of ephemeral streams, an open trench will be dug with a backhoe and may be anchored by concrete collars and/or course crushed rock. This is likely to be undertaken during dry periods to avoid increased sedimentation and erosion of the creek line. The major Hunter River crossing will be by crossed directional under boring, passing several metres below the river bed, to avoid disturbing the banks or riparian vegetation. The two crossings of the Wollombi Brook on mine properties are expected to be by overhead steel pipes attached to an existing conveyor gantry in one case and a high level haul road bridge in the other.

The proposed works would include clean up and rehabilitation, hence removal of construction material, surface contouring and reseeding. As part of the restoration process, vegetation removed will be stockpiled and spread back over the disturbed area. Where the proposal is within existing low usage access track alignments, the original track function will be restored.

2.3.1 Potential Impacts of the Proposal

The disturbance footprint of the proposal is approximately 25 metres wide, including 15 metres direct impact area with a 5 metres buffer zone. Light vehicle parking and siting of ancillaries will be placed on existing tracks adjacent to the proposed works or within existing clearings. Direct impacts that may apply to this proposal and will be considered in this assessment include:

- vegetation clearance

- the removal of potential habitat
- the fragmentation of potential habitat
- soil compaction
- disturbance to soil seed bank

Indirect impacts that may apply to this proposal include:

- edge effects
- the potential for erosion
- the provision of a suitable seed bed for exotic weed invasion and introduction and transfer of weed propagules
- increased human activity within or adjacent to sensitive habitat areas.

Section 5.0 discusses the specific impacts associated with the proposal and the proposed amelioration measures. Direct impacts are usually unavoidable while indirect impacts can be mitigated through amelioration measures.

2.4 The study area

The study area is located in the Upper Hunter Valley across two local government boundaries Muswellbrook (northern section) and Singleton (southern section). The proposal will almost exclusively transverse coal mining and/or Macquarie Generation properties.

In recent years, the study area has been subject to ongoing agricultural activities and impacts from mining. A large portion of the study area is cleared or highly disturbed and contains isolated and fragmented patches of native vegetation. Several of these patches contain the Endangered Ecological Community Warkworth Sands Woodland, as listed on the TSC Act.

2.4.1 Soils and Landform

Kovac and Lawrie have mapped a number of soil landscapes within the study area, as follows:

- Alluvial landscapes along the main rivers, creeks and their tributaries occurring in the study area, including -
    - Hunter, which occurs on the floodplains of the Hunter River and its tributaries. The Parent material is alluvium; and,

- Wollombi, which occurs on the valley flats and undulating rises of the Wollombi Brook and its tributaries. The parent rock is sandstone and conglomerate.

- Soloths landscapes on the floodplains of the study area , including –

  - Bulga, which occurs on the colluvial slopes of the area bounding the steep Lees Pinch and Watagan soil landscapes. Parent rock includes sandstone, conglomerate, claystone, shale, mudstone and coal;

  - Liddell, which occurs on undulating low hills and undulating hills in the Liddell Power Station area. Parent rock includes Lithic sandstone, shale, mudstone, conglomerate, siltstone and coal; and,

  - Jerrys Plains, which occurs on the undulating low hills to the south and west of Jerrys Plains. Parent rock includes lithic sandstone, mudstone, siltstone and conglomerate.

- Yellow podzolic landscapes on the floodplains adjoining the Hunter River in the southern section of the study area, including –

  - Branxton, which occurs on the undulating hills and rises with many small creek flats, extending over a large area between Singleton and Cessnock. Parent rock includes sandstone, shale, mudstone, siltstone, tuff, limestone and coal.

- Siliceous sands landscapes in two small pockets adjoining Wollombi Brook in the centre of the study area, including –

  - Warkworth, which occurs on the linear sand dunes found on old terraces of the Hunter River downstream from Warkworth. Parent material is quaternary aeolian sand.

- Red clays landscapes at the northern end of the study area, including –

  - Brays Hill, which occurs on undulating low hills to the west of Muswellbrook. The parent material includes calcareous shale, sandstone and some basalt.

2.4.2 Climate

The study area generally has a high summer rainfall between 50-60 millimetres per month, with 118 rainfall days per year. The average maximum summer temperature is 30.2^0C with an average summer minimum of 17.3^0C. The average

maximum winter temperature is 18^0C and the average winter minimum is 6.2^0C in winter (BOM 2007).

2.5 Local Landscapes

The locality lies within the Hunter catchment, occupying an area of relatively gentle, undulating hills, river valleys and floodplains. The Hunter River catchment is a broad, deep incision into the typically rugged escarpment and tablelands including floodplain and terraces associated with of the major streams such as the Hunter River (Peake 2005). The rugged escarpments of Yengo and Wollemi national parks are located to the south of the locality with the river valley and floodplains extending to the north and east throughout the valley. The study area is located within the floodplains and river valley.

Settlement in the Upper Hunter Valley occurred mostly between 1810 and 1830. Settlement, followed by extensive vegetation clearing, and associated livestock, crop and weed introduction and infrastructure development, brought with them massive changes to the ecology of the region. It is estimated that up to 99% of the pre-European vegetation types of the Central Hunter Valley Floor (CHVF) had been removed or altered at that time (Peake 2005). That area covers the floor of the Hunter Valley from Branxton to Muswellbrook, bounded by escarpments to the south and west and foothills to the north and north-east (Peake 2005).

Land usage in the Hunter Valley covers a broad range of types. Agricultural activities include, but are not limited to, beef-cattle grazing, dairying, cropping, farm forestry, viticulture and horticulture and mining including both open cut and underground mining (Peake 2005;). Much of the area has been urbanized. Vegetation within the river valley and floodplains is currently restricted to isolated to isolated patches, riparian vegetation and/or areas unsuitable for farming. The escarpment of the Wollemi and Yengo National Parks to the south and south-east, comprise much of the catchment's remaining forested land.

The vegetation and fauna habitats within the study area are similar to the surrounding landscape (locality), described in detail Section 4.0 they are largely fragmented and have been previously disturbed by agriculture, mining activities and associated infrastructure.

3.0 METHODS

3.1 Taxonomy

The plant taxonomy (method of classification) used in this report follows Harden (1992, 1993, 2000, 2002), Fairley and Moore (2000), Robinson (2003) and subsequent advice from the National Herbarium of NSW. In the body of this report plants are referred to by their scientific names only.

Names of vertebrates follow the Census of Australian Vertebrates (CAVs) maintained by Department of Environment and Water Resources (DEW). In the body of this report vertebrates are referred to by both their common and scientific names when first mentioned. Subsequent references to these species cite the common name only. Common and scientific names are included in the Appendices.

3.2 Legislation

Federal and State Acts that are considered with regard to terrestrial flora and fauna are listed below.

- Commonwealth *Environment Protection and Biodiversity Conservation Act* 1999 (EPBC Act)
- NSW *Threatened Species Conservation Act* 1995 (TSC Act)
- NSW *Environmental Planning and Assessment Act* 1979 (EP&A Act)

3.3 Literature and Database Review

A list of documents used to prepare this report is located in *References*. Records of threatened species, populations and communities were obtained from the Atlas of NSW Wildlife within a 10 kilometres radius of the study area.

Potential occurrences of threatened species, populations and communities listed on the EPBC Act were obtained from the DEW EPBC Online Database within a 10 kilometres radius of the study area. Database searches were conducted in July 2007.

3.4 Field Survey

The study area was inspected between the 25th and 29th of July 2007. The general condition of the site was assessed and observations of plant communities, habitat, flora and fauna were made (as detailed below). During the site visit the weather was overcast with showers and moderate to strong winds.

3.4.1 Flora

Plants growing in the study area were surveyed by undertaking a habitat assessment as well as targeted searches for threatened species. The plant communities were surveyed using the random meander technique described by Cropper (1993).

Portions of the study area supporting flora and fauna habitats were traversed on foot, with the exception of areas with access restrictions. Disturbed sections of the study area that are unlikely to provide habitat for threatened flora and fauna were not surveyed on foot.

Due to access and time restrictions not all portions the study area were surveyed in detail.

3.4.2 Vegetation Condition Assessment

Vegetation condition was assessed according to the degree to which it resembles relatively natural, undisturbed vegetation. Vegetation was assessed as being in Good, Moderate or Poor condition or an unnatural landscape according to the following criteria:

- **species composition** (species richness, degree of weed invasion);
- **vegetation structure** (representation of each of the original layers of vegetation); and,
- **resilience** (This is the capacity of a site for natural regeneration. This is primarily linked to the degree to which the natural soil profile of the area has been disturbed).

The categories of vegetation conditions are as follows:

Good: containing a high number of indigenous species; no weeds present or weed invasion restricted to edges and track margins; vegetation community contains original layers of vegetation; vegetation layers (ground, shrub, canopy etc.) are intact, or if modified, natural soil profile remains intact;

Moderate: containing a moderate number of indigenous species; moderate level of weed invasion; weeds occurring in isolated patches or scattered throughout; one or more of original layers of vegetation are modified; natural soil profile remains intact; able to be regenerated to Good condition with minimal level of management;

Poor: containing a low number of indigenous species; high level of weed invasion; weeds occurring in dense patches or scattered throughout; one or more

original vegetation layers (ground, shrub, canopy etc.) are modified or missing, but natural soil profile intact; able to be regenerated to Moderate or Good condition with substantial management; and,

Unnatural landscape: highly modified landscape containing few or no indigenous species; exotic species dominant; original native vegetation layers removed; natural soil profile disturbed; unable to be regenerated to natural condition; requires a high input of resources to achieve restoration goals.

3.4.3 Fauna

The fauna survey was undertaken as a habitat based assessment. Species encountered through observations were recorded and active searching and listening was carried out for birds and reptiles. In addition targeted surveys including spotlighting, call playback and bat call detection were used to record threatened species likely to utilise the study area. It should be noted that these surveys were limited due to site access restrictions.

3.4.4 Fauna Habitat Assessment

The three categories used to evaluate habitat value were Good, Moderate and Poor, as detailed below:

Good: ground flora containing a high number of indigenous species; vegetation community structure, ground, log and litter layer intact and undisturbed; a high level of breeding, nesting, feeding and roosting resources available; a high richness and diversity of native fauna.

Moderate: ground flora containing a moderate number of indigenous species; vegetation community structure, ground log and litter layer moderately intact and undisturbed; a moderate level of breeding, nesting, feeding and roosting resources available; a moderate richness and diversity of native fauna species.

Poor: ground flora containing a low number of indigenous species, vegetation community structure, ground log and litter layer disturbed and modified; a low level of breeding, nesting, feeding and roosting resources available; a low richness and diversity of native fauna.

Other habitat features, such the value of the study area as a habitat corridor, the presence of remnant communities or unusual plant community structure, were also used to assess habitat quality.

Survey effort: 5 days

3.4.5 Targeted Surveys

In addition to the habitat assessment other surveys methods were used to determine the presence of threatened and common animal species such as owls, gliders, possums and bats and these are discussed in detail below. Given the study area is highly disturbed and fragmented surveys were restricted to largely intact areas of potential habitat.

Spotlighting

Targeted species: Squirrel Glider, Koala, Grey-headed Flying Fox, Powerful Owl, Masked Owl, Barking Owl

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 (Figure 3).

Survey effort: 3 hours

Bat call detection (Echolocation analysis)

Targeted species: Large-footed Myotis, Greater Broad-nosed Bat, Large-eared Pied Bat, Eastern False Pipistrelle, Eastern Cave Bat, Eastern Bent-wing Bat Large Bentwing Bat, Eastern Freetail Bat and Yellow-bellied Sheathtail Bat.

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 (Figure 3).

Survey effort: 6 nights

Call playback

Targeted species: Powerful Owl, Masked Owl, Barking Owl, Yellow-bellied Glider, Squirrel Glider

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 and 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 (Figure 3).

Survey effort: 2hours 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 (eg. birds, frogs and some nocturnal mammals).

Indirect evidence of fauna species includes remains (eg. bones, skin, fur), scats (droppings), diggings or burrows, and hair or body remains identified from predator scats.

Survey effort: 5 days

3.5 Limitations

This study was a habitat-based assessment. As such, no trapping, or vegetation quadrat sampling techniques were used.

One of the main limitations in the surveys was the short time period over which surveys were carried out and the lack of seasonal surveys. This is likely to have resulted in non-detection for some target species, such as:

- Annual plant species which are only visible above ground during specific seasons, such as the threatened species *Goodenia macbarronii*, which dies back in Autumn and persists only as seeds in the soil seed bank through winter (Benson and McDougall 1997).

- Cryptic plant species that may not be detected unless in flower such as the threatened orchid *Diuris tricolor*, which is deciduous and only visible above ground when in flower in spring (Benson and McDougall 2005). Another species *Eucalyptus glaucina* is difficult to distinguish from the locally common *Eucalyptus blakelyi* without live flower buds, which are only present on trees for limited periods of time during late winter to spring (Benson and McDougall 1998)

- Some fauna species also likely to be inactive during the winter period such as migratory birds, reptiles and some frog species, hence the survey period may have reduced the probability of detecting these species.

Due to the recent flooding in the Upper Hunter and security issues access to the study area was restricted by land-owners. In some cases access to sites was limited to two days, reducing survey periods and possibly resulting in low numbers or non–detection of some targeted species.

The final route for the proposed gas pipeline was determined after the surveys were completed hence some areas of the final route were not surveyed.

Given these limitations, a conservative approach was taken in the impact assessments. Where there is suitable habitat existed for a species but that species was not detected in the current surveys, it was assumed that the species was present in the area and mitigation measures to reduce impacts on the species are recommended.

4.0 RESULTS

4.1 Plant Communities

4.1.1 Plant Communities Mapped

The plant communities of the locality have been mapped by Peake (2005) (Figure 4). This vegetation mapping was ground-truthed as part of the flora surveys. This section of the report describes the plant communities mapped as occurring in the study area by Peake (2005).

Seven plant communities are mapped by Peake (2005) as occurring in the study area:

- Central Hunter Box - Ironbark Woodland
- Central Hunter Bulloak Forest Regeneration
- Central Hunter Ironbark - Spotted Gum - Grey Box Forest
- Central Hunter Swamp Oak Forest
- Hunter Valley River Oak Forest
- Planted areas
- Warkworth Sands Woodland

Additional communities are mapped as occurring within the locality (as listed in Section 5.1) but are not considered further here, as they were neither mapped by Peake (2005) as occurring within the study area, nor observed during the field surveys.

The majority of the study area supported three plant communities: Warkworth Sands Woodland, Central Hunter Box - Ironbark Woodland and planted areas. The other four communities are mapped as very small, isolated and degraded remnants within the study area.

Warkworth Sands Woodland is listed as an Endangered Ecological Community under the TSC Act.

Descriptions of the plant communities below are modified from Peake (2005).

Central Hunter Box-Ironbark Woodland

Peake (2005) describes Central Hunter Box-Ironbark Woodland as consisting of:

- A low-to mid-high woodland dominated by *Eucalyptus crebra*, *Brachychiton populneus* and *Eucalyptus moluccana*, with *Allocasuarina luehmannii* dominant in the small tree layer.

- A shrubby understorey, varying from dense to sparse, or absent and commonly including shrubs *Notelaea microcarpa, Bursaria spinosa* and *Breynia oblongifolia*.

- A sparse to dense groundcover, composed of a variety of forbs, grasses, sedges, ferns and twiners, including *Cymbopogon refractus, Aristida ramosa, Dichondra repens* and *Cheilanthes sieberi*.

Central Hunter Bulloak Forest Regeneration

Central Hunter Bulloak Forest Regeneration was mapped as occurring within the study area. Peake (2005) describes this community as being highly variable, and often consisting of:

- A low-to mid-high open to closed forest dominated by *Allocasuarina luehmannii* with other tree species, such as *Angophora floribunda, Casuarina glauca* and *Eucalyptus crebra,* being uncommon to locally abundant,.

- The groundcover is typically sparse and includes tufts of grasses such as *Aristida vagans, Cynodon dactylon* and *Eragrostis leptostachya,* as well as ferns, sedges and forbs such as *Fimbristylis dichotoma, Commelina cyanea, Lomandra multiflora* and *Chrysocephalum apiculatum.*

Central Hunter Ironbark - Spotted Gum - Grey Box Forest

Peake (2005) describes Central Hunter Ironbark - Spotted Gum - Grey Box Forest as being:

- An open forest to woodland dominated by *Eucalyptus crebra, Corymbia maculata,* and *Eucalyptus moluccana*, with a sparse small tree layer of *Allocasuarina luehmannii* and *Acacia parvipinnula.*

- A sparse shrub layer dominated by *Daviesia ulicifolia, Pultenaea spinosa, Bursaria spinosa* and *Acacia falcata.*

- A variable groundcover, with dominant species including *Cheilanthes sieberi, Cymbopogon refractus, Pratia purpurascens* and *Dianella revoluta*.

Central Hunter Swamp Oak Forest

Central Hunter Swamp Oak Forest is mapped as occurring within the study area in one small, remnant. Peake (2005) describes this plant community as being:

- A low to mid-high gallery forest with a closed canopy usually dominated by *Casuarina glauca*, with *Eucalyptus tereticornis* or *Angophora floribunda* also occurring occasionally.
- A midstorey and shrub layer is usually absent.
- Groundcover is variable and usually consists of *Dichondra repens, Microlaena stipoides, Austrostipa verticillata, Pratia purpurascens* and *Cheilanthes sieberi.*

Hunter Valley River Oak Forest

Hunter Valley River Oak Forest was observed in the study area as sparse *Casuarina cunninghamiana* trees along the banks of the Hunter River.

Peake (2005) describes Hunter Valley River Oak Forest as consisting of:

- A mid-high to tall forest with a mid-dense canopy dominated by *C. cunninghamiana* with other trees, including *Angophora floribunda, Eucalyptus tereticornis,* and *C. glauca,* only occurring very sparingly.
- A midstorey is rarely present, but may consist of rainforest species such as *Trema tomentosa, Backhousia myrtifolia* and *Rapanea variabilis*. Weed species *Lantana camara* and *Olea europaea* var. *cuspidata* are also common in the midstorey.
- The understorey is usually absent or dominated by weeds.
- Vines are common including *Pandorea pandorana* and the weed species *Cardiospermum grandiflorum*.

Warkworth Sands Woodland

Peake (Peake 2005) describes Warkworth Sands Woodland as consisting of:

- A low to mid-high woodland (or forest) dominated by trees, shrubs and groundcovers that occur on sandy soils.
- A sparse tree canopy dominated by *Angophora floribunda*, with other tree species, including *Eucalyptus tereticornis* and *E. glaucina*, or intergrades of the two, being abundant to absent.

- A sparse small tree stratum consisting of *Banksia integrifolia* and *Acacia filicifolia.*

- A sparse to dense shrub layer dominated by *Breynia oblongifolia* and *Hibbertia linearis*.

- A groundcover usually dominated by *Pteridium esculentum* and *Imperata cylindrica.*

The mapped distribution of Warkworth Sands Woodland in Peake (2005) differs significantly from the distribution of this community as mapped by Flora Search (2004) in Coal and Allied (2005), in the region to the west of Wallaby Scrub Road.

Coal and Allied (2005) describe the vegetation west of Wallaby Scrub Road as containing a large core area of Central Hunter Box-Ironbark Woodland. The vegetation to the west, south-west and north of this core is mapped as a mosaic of smaller patches of the box-ironbark community and smaller patches of Warkworth Sands Woodland. In contrast, the mapping of the vegetation of this area by Peake (2005) shows the vegetation as consisting of a large core area of Warkworth Sands Woodland, with the vegetation to the north consisting of a mosaic of Warkworth Sands Woodland and Central Hunter Box-Ironbark Woodland.

The level of detail of this survey was insufficient to enable clarification of this discrepancy in the mapping of Warkworth Sands due to time and access restrictions. Therefore it should be noted that the assessments of the Warkworth Sands Woodland within this report are based on the vegetation mapping undertaken by Peake (2205). Peake's mapping was used primarily due to the fact that it is recognised by the Hunter Central Rivers Catchment Management Authority, and was published more recently than that of FloraSearch (2004) in Coal and Allied (2005). In addition, given that Peake (2005) maps the vegetation over the entire locality, as opposed to the limited coverage of FloraSearch (2004), the use of the mapping by Peake (2005) enables this study to follow one consistent mapping coverage across the locality.

While the adoption of one mapping treatment over another has the potential to result in different outcomes of the impact assessments, this is not likely in this case. Irrespective of which mapping was used, the impact assessment would have shown a likely significant impact based on:

- the amount of Warkworth Sands Woodland to be impacted by the proposal

- the proportion of Warkworth Sands Woodland to be impacted by the proposal compared to the area of this EEC that remains, and

- the level of fragmentation likely to be caused by the proposal.

4.1.2 Plant Communities Observed

Six plant communities were recorded within the study area;

- Planted areas
- Exotic pasture
- Warkworth Sands Woodland - observed to the west of Wallaby Scrub Road, in the Lemington / Long Point area, and on the eastern side of Charlton Road, near the Bulga Mine;, all in the southern portion go the study area
- Central Hunter Box-Ironbark Woodland - the dominant plant community observed in the study area
- Central Hunter Ironbark - Spotted Gum - Grey Box Forest - occurred in as one small, isolated remnant west of the Bayswater Power Station
- Hunter Valley River Oak Forest - observed as sparse *Casuarina cunninghamiana* trees along the banks of the Hunter River

Only one remnant of Warkworth Sands Woodland in the study area was observed to be in Good condition. This remnant was located between Wallaby Scrub Road and Wollombi Brook (sections 11, 12 and 15 in Figure 2) and is referred to by (Peake 2005) as the only remnant within the full extent of this plant community that remains in reasonable condition.

There were a number of discrepancies between the vegetation observed in the study area during the surveys and the regional vegetation mapping of the study area by Peake (2005) (described above). One such discrepancy was the occurrence of Central Hunter Bulloak Forest Regeneration in the regional vegetation mapping by Peake (2005). Due to the similarity of this plant community to depauperate remnants of other plant communities common in the locality, especially Central Hunter Box-Ironbark Woodland, Central Hunter Bulloak Forest Regeneration was not identified during this survey. A second discrepancy related to Central Hunter Swamp Oak Forest, which was mapped by Peake (2005) as occurring in very small, isolated and degraded remnants within the study area. This community was not observed during the survey.

It should be noted that not all of the study area was surveyed and some of the surveyed areas were not surveyed in detail. It is therefore likely that additional plant communities occur within the study area. Where areas were not surveyed the vegetation mapping by (Peake 2005) was assumed to be correct.

The condition and location of the plant communities recorded within the study area during the surveys are described below.

Section 1 (southern end of pipeline, western side of Bulga Mine, and along Charlton Rd - 3.7 km)

The proposal passes through no remnant vegetation along this section of the route. The area was highly disturbed, and is dominated by weeds, or contains no vegetation.

Section 2 (Bulga Mine / Charlton Rd - 0.5 km) (Plate 1)

Section 2 predominantly supported Warkworth Sands Woodland, interspersed with Central Hunter Box-Ironbark Woodland (as mapped by Peake, 2005). Due to previous disturbances such as clearing and partial usage as tracks, this vegetation was in Poor to Moderate condition.

The vegetation supported species representative of Warkworth Sands Woodland; however these were distributed sparsely, most likely due to previous clearing of this area. The presence of many regenerating juvenile trees and shrubs up to several metres in height indicated the vegetation has considerable capacity to regenerate.

The canopy was dominated by a sparse layer of *Angophora floribunda*, with few occurrences of *Eucalyptus blakelyi* and with stands of *Allocasuarina luehmannii* and *Acacia parvipinnula / A. filicifolia* occurring in the small tree layer. *Eucalyptus crebra* was present within this area suggesting intergrades between the two plant communities. The shrub and ground cover layers were disturbed, with native species occurring sparsely. Exotic species such as *Chloris gayana* and *Eragrostis curvula* were recorded.

This section of the route contained several tracks where the vegetation was in Poor condition. In some cases the soil had been physically disturbed along these tracks and consequently supported no vegetation or was dominated by exotic grasses.

Section 3 (Charlton Rd – 0.6 km) (Plate 2)

This area was highly disturbed due to the construction of a dam wall (in the southern part of this section) and vehicular tracks (in the northern part of this section). The area consisted mostly of bare soil, with scattered remnant *Eucalyptus crebra* and *E. blakelyi* trees and exotic grasses.

Section 4 (Along Charlton Rd – 0.9 km) (Plate 3)

The proposal follows an unsealed road and power line easement in Section 4. The road contained no vegetation, however, the powerline easement and the road verge both contained low vegetation maintained by slashing. This vegetation was in poor condition due to the highly modified structure and dominant exotic grasses. The native woodland was regenerating despite these disturbances, supporting

Eucalyptus crebra and *Allocasuarina luehmannii*, as well as indigenous shrubs, herbs and grasses.

The native vegetation on both sides of the powerline easement approximated Central Hunter Box-Ironbark Woodland, as described by Peake (2005) being dominated by *Eucalyptus crebra* and *Allocasuarina luehmannii*. This area was considered to be in Good condition.

Section 5 (Charlton Rd to Putty Rd – 0.4 km) (Plate 4)

This section contained Central Hunter Box-Ironbark Woodland in Moderate condition due to degradation through previous clearing and grazing. A mature canopy of *Eucalyptus crebra* occurred in most of this area, with large numbers of trees regenerating in the understorey. The midstorey was mostly absent and the ground layer contained a mixture of indigenous herbs and grasses, exotic grasses and pasture weeds.

Section 6 (Putty Rd west to first gate - 0.5 km) (Plate 5)

This section consisted of an unsealed road with a cleared road verge passing through grazing paddocks. The road verge and paddocks were dominated by exotic grasses, with regenerating elements of Central Hunter Box Ironbark Woodland, especially *Eucalyptus crebra* and *Allocasuarina luehmannii.* This regenerating vegetation was in Poor condition due to the effects of grazing.

Section 7 (Putty Rd west: first gate to western end of airstrip – 0.5 km) (Plate 6)

This section consisted of an unsealed road flanked by strongly-regenerating Central Hunter Box – Ironbark Woodland. This vegetation was in Moderate condition due to its altered structure and reduced species diversity, especially in the ground and mid-storey layers. Few weeds were observed in this section. Extensive and dense soil crusts of lichen were also recorded.

Section 8 (airstrip – 2.5 km) (Plate 7)

This section followed a disused airstrip, supporting minimal vegetation growing through cracks in the bitumen airstrip surface. Species consisted of exotic and native grasses below a sparse layer of regenerating trees such as *Eucalyptus crebra, E. blakelyi* and *Allocasuarina luehmannii*. Vegetation condition was Poor as the area had been cleared and surfaced with bitumen.

Vegetation beyond the north-western end of the airstrip was similar to that growing along the airstrip, with a denser grass layer, and stands of *Melaleuca decora* occurring along drainage lines.

Section 9 (north-west of airstrip – 0.3 km)

Further to the north-west, the vegetation condition improved, with a greater density of regenerating trees (*Eucalyptus crebra, E. blakelyi, Allocasuarina luehmannii*), and an increased density of native grasses. Exotic grasses were present, mature trees were sparse and few shrubs were observed here. Vegetation condition was Poor – Moderate as the area had previously been cleared, and the diversity of the regenerating vegetation was low.

Section 10 (drainage line – 0.2 km)

Between the north-eastern end of the airstrip and the Warkworth Sands area, the proposal passes through a low area, crossed by a network of drainage lines. In this section the vegetation was dominated by *Eucalyptus blakelyi* with a minor occurrence of *E. crebra.* The small tree layer was composed of *Allocasuarina leuhmannii,* with *M. decora* occurring along drainage lines.

The vegetation in this area does not approximate any of the plant communities mapped for the locality by Peake (2005). The presence of *Eucalyptus crebra, Allocasuarina luehmannii* and *Olea microcarpa* on a clay substrate suggests the plant community may be similar to the Central Hunter Box-Ironbark Woodland, which is abundant locally. However, Central Hunter Box-Ironbark Woodland as defined by Peake (2005) does not contain *Eucalyptus blakelyi*, which was a common species in this section of the study area.

This area was mapped by Peake (2005) as Warkworth Sands Woodland, which is consistent with the dominance of *Eucalyptus blakelyi*. However the presence of a clay-gravel substrate rather than sand, the resulting presence of species preferring clay substrate and the lack of other species typical of the Warkworth Sands Woodland suggests that the plant community present is not Warkworth Sands Woodland.

This vegetation in Section 10 was in Good to Moderate condition, with only the ground layer showing signs of significant disturbance or weed invasion. Weeds observed were predominantly exotic grasses occurring mostly in isolated patches or along tracks and edges.

Section 11 (Warkworth Sands – along track – 2.2 km)

This section of the proposal passed through Warkworth Sands Woodland, an Endangered Ecological Community listed under the TSC Act (DEC 2004b).

This vegetation was dominated by mature trees of *Angophora floribunda* with occasional occurrences of other *Eucalyptus blakelyi* and *E. crebra*. The mid-storey varied in density between sparse to moderately dense, with *Banksia integrifolia* commonly occurring, as well as *Acacia filicifolia* and *A. fimbriata*. The understorey

contained *Imperata cylindrica,* as well as other native grasses, *Pteridium esculentum* and various ground cover species or low shrubs, such as *Grevillea montana* and *Lomandra leucocephala*.

This occurrence as mapped and described by Peake (2005). While this section was mapped by Peake (2005) as only supporting Warkworth Sands Woodland, this vegetation was observed to be interspersed with small areas of Central Hunter Box-Ironbark Woodland, where the substrate consisted of clay rather than sand, predominantly along drainage lines and other areas of impeded drainage that crossed the proposal.

The proposal follows a broad clearing through the Warkworth Sands Woodland for most of the length of this section. This clearing generally consisted of two vehicular tracks (roughly 2-3 metres wide), separated by a vegetated fence line (1-2 metres wide), and flanked by partially cleared verges (3-5 metres wide, although not present for the full length). This clearing was lined with woodland in Good condition.

The vehicular tracks were predominantly bare soil, but, for the most part, contained remnant ground cover species and small shrub species typical of Warkworth Sands Woodland such as *Lomandra leucocephala* and the rare *Grevillea montana,* as well as exotic grasses, such as *Eragrostis curvula.* The fenceline was vegetated with Woodland in various states of condition, from Poor where the trees and shrubs were absent and the ground cover contained infestations of exotic grasses, to Good where all layers of indigenous vegetation remained intact and few weeds were present. The cleared verges of the road were largely in Moderate to Good condition, with the only evident impacts being recent partial removal of sections of the shrub and tree layer. Areas recently cleared were regenerating strongly with a healthy mix of indigenous species.

Impacts evident in this area included:

- Historical clearing to create tracks;
- Slashing of tracks and verges for access maintenance;
- Historical clearing along fenceline to enable construction of fence (vegetation now largely regenerated);
- Compaction of soil along wheel ruts of tracks;
- Soil erosion in clay areas on slopes along wheel ruts of tracks and associated localised sediment build up;
- Recent partial clearing of vegetation on verges of tracks;

- Mild weed invasion through cleared area, predominantly along tracks; and,
- Impacts of mild grazing on western side of fenceline.

Section 12 (Warkworth Sands – no track - 0.6 km)

The vegetation in the Section 12 passes through Warkworth Sands Woodland in varying condition, having been disturbed by varying levels of grazing and historical clearing. Unlike Section 11, this section of the proposal did not follow a vehicular track, but passed directly through the extant vegetation.

Areas in Poor condition supported a sparse canopy of large, mature *Angophora floribunda* and/or *Eucalyptus blakelyi* trees and a layer of regenerating immature *A. floribunda* and *Banksia serrata* trees in varying densities. The ground layer varied from a dense cover of *Pteridium esculentum* with minor occurrences of other species typical of Warkworth Sands Woodland (eg. *Hibbertia linearis*), to a dense cover of exotic pasture grasses, weeds and native grasses.

Section 13 (0.2 km)

Section 13 consisted of Central Hunter Box-Ironbark Woodland in Poor condition, with reduced native species diversity and altered structure as a result of grazing. While the canopy layer, dominated by *Eucalyptus crebra*, was largely intact, the midstorey was largely absent and the ground layer was heavily infested with exotic grasses and pasture weeds.

Section 14 (0.4 km)

Section 14 consisted of a low-lying paddock that was inundated by flood waters at the time of the survey. The margins of this depression contained no native vegetation and no native vegetation was observed emerging from the water.

Section 15 (Warkworth Sands area, east to Wallaby Scrub Road – 1.1 km) (Plate 9)

Section 15 of the proposal has an east-west orientation and meets Wallaby Scrub Rd at its eastern end. This section followed a vehicular track along a fenceline, with Good condition Warkworth Sands Woodland to the south and cleared paddocks on the north. The track was mostly 2-3 metres wide and contained bare sandy soil with regenerating plants typical of Warkworth Sands Woodland such as *Hibbertia linearis, Pteridium esculentum, Breynia oblongifolia* and *Banksia integrifolia*. Along small sections of this track, several metres-width of vegetation had been cleared adjacent to the track.

At its eastern end, the woodland was interspersed with disused quarries, which contained little native vegetation.

Section 16 (Wallaby Scrub Rd to Jerry's Plains Rd / Golden Highway – 1.7 km)

This section of the proposal follows a vehicle track through Central Hunter Box-Ironbark Woodland mostly in Good condition. The track was approximately 4-6m metres wide and consisted mostly of bare soil. For half of the length of this section, the proposal follows the track through woodland in Good condition. The remaining half follows the top of an embankment along the southern side of a railway line, with bare soil on the northern side of the route. The southern side of the route consists of mostly vegetation in Good condition, with some areas considered to be in Poor condition due to impacts from vegetation clearing, sedimentation and erosion.

The Central Hunter Box Ironbark Woodland in this section is dominated by *Eucalyptus crebra* and *E. moluccana*, with a small tree layer of *Allocasuarina luehmannii*, and a shrub layer dominated by *Acacia* spp. and *Notelaea microcarpa*. The ground layer varied in condition, with intact areas dominated by indigenous grasses, and areas disturbed by road construction, sedimentation and erosion supporting bare soil.

Section 17 (Side branch – Golden Hwy – Wallaby Scrub Rd – Wollombi Brook – 6.1 km)

This section was not surveyed in detail due to access restrictions. Two habitat assessments were undertaken from the roadside where the proposal crosses Wallaby Scrub Road and where the proposal crosses Wollombi Brook.

From the Golden Highway to Wollombi Brook the proposal followed a powerline easement and/or access easement which contained Central Hunter Box-Ironbark Woodland in Poor condition. However, the vegetation was largely removed in this section and maintained as cleared.

At the crossing of Wollombi Brook, the vegetation was mostly restricted to the banks of the brook and consisted of narrow remnants of Hunter Valley River Oak Forest, which will be avoided by the proposal.

Two large, mature specimens of *Eucalyptus camaldulensis* were recorded on the northern side of the Wollombi Brook bridge crossing. *Eucalyptus camaldulensis* in this locality form part of the Hunter Valley Endangered Population of *Eucalyptus camaldulensis* as listed on the TSC Act.

Hunter Valley Weeping Myall Woodland was not mapped by Peake (2005) as occurring within the study area. However, Peake (2005) maps the community as occurring within 200m of the proposal within this section of the route. Hunter Valley Weeping Myall Woodland is listed as an EEC under the TSC Act and as a

Critically Endangered Ecological Community under the EPBC Act. Given the limited surveying undertaken of this section of the study area, it could not be determined whether the proposal coincides with any occurrences of this EEC.

The study area was not surveyed beyond the crossing of Wollombi Brook, due to site access restrictions.

Section 18 (Golden Highway/Long Point Rd to Hunter River – 5.7 km)

This section of the proposal predominantly passes through wide road verges and power-line easements beside the Golden Hwy and Long Point Rd, which were largely cleared of vegetation.

Where vegetation did occur it consisted of regenerating elements of Central Hunter Box Ironbark Woodland, with *Eucalyptus crebra* and *Allocasuarina luehmannii* being the dominant species. This vegetation may be re-classified as Central Hunter Ironbark Forest Regeneration. *Melaleuca decora* was observed growing along drainage lines crossing the path of the proposal.

Warkworth Sands Woodland was not observed in this section, contrary to the vegetation mapping by Peake (2005). The survey however, only covered the roadside vegetation, given that the proposal follows the road in this section. It is possible that Warkworth Sands Woodland occurs here behind the visual barrier formed by the dense stands of *Allocasuarina luehmannii* observed growing along road easement.

Section 19 (Hunter River to Lemington, along Comleroi Road – 2.1 km)

From the Hunter River north to Lemington, the proposal passes through a cleared paddock and then follows Comleroi Road. The proposal is expected to be contained within the road and associated cleared verges in this section.

Section 20 (Comleroi Road to Patrick Plains / Hunter River, along Lemington Road – 7.5 km)

Since the time of the surveys, the proposal has been relocated through this section. The amended route has not been surveyed.

The area surveyed in this section contained significant areas of Warkworth Sands Woodland. This area was considered to be in Poor condition due to the effects of clearing and cattle grazing.

The amended route appears to avoid the surveyed remnants of Warkworth Sands Woodland, passing through cleared grazing paddocks with isolated trees.

Section 21 (Hunter River crossing – Lemington – 0.2 km) (Plate 10)

Where the proposal crosses the Hunter River, north of the Lemington open cut mine, vegetation mapping by Peake (2005) suggest that the proposal may pass through Hunter Valley River Oak Forest.

At the time of survey access restrictions prevented this section of the subject site from being surveyed. The riparian vegetation was surveyed however, approximately half a kilometre downstream of the subject site. The vegetation at this downstream location was Hunter Valley River Oak Forest in Poor condition, consisting of a thin strip of *Casuarina cunninghamiana* trees, or potential intergrades with *C. glauca* (Peake 2005), growing on the eroded river banks with occasional occurrences of *Salix babylonica*. No other vegetation layers were observed, as the banks were mostly eroded and contained no vegetation. The top of the banks were vegetated with a ground layer of exotic pasture weeds and very occasional *Angophora floribunda* trees.

Section 22 (Hunter River north to New England Highway – 9.8 km)

Section 22 was not surveyed in its entirety due to access restrictions. This section consisted of reclaimed mining land, with no remnant vegetation. The site was dominated by exotic pasture weeds, with occasional patches of revegetated trees and shrubs.

Section 23 (New England Highway – 15.8 km)

This section of proposal extended from alongside the New England Highway to Liddell Power Station and to the coal conveyer on the western side of the Bayswater Power Station. It followed road easements, coal conveyer easements, associated access roads and passes through highly-degraded, reclaimed mining land.

Due to time constraints, the lack of substantial vegetation remnants and the absence of any mapped EEC's, this section of the study area was not surveyed in detail.

This section was mapped by Peake (2005) as supporting thin strips of Central Hunter Swamp Oak Forest and small, scattered patches of Planted areas, Central Hunter Box-Ironbark Woodland and Central Hunter – Ironbark – Spotted Gum – Grey Box Forest. All vegetation observed along this section of the study area was either highly degraded, small remnants or areas of revegetation.

Section 24 (West of Bayswater Power Station) (1.9 km)

This section of the proposal followed the easement and access roads associated with a coal conveyer. The proposal, in this section, passed through the edge of an

area of Central Hunter Ironbark - Spotted Gum – Grey Box Forest, in Good – Moderate condition.

Section 25 (2.7 km)

Section 25 of the proposal was outside the study area and was therefore not surveyed.

4.2 Flora

A list of plant species recorded in the study area is provided in Appendix 1. A total of 108 plant species were recorded in the current survey, including 74 native species and 34 exotic species.

4.2.1 Threatened Flora

Database searches revealed that 16 threatened flora species listed on the TSC and/or the EPBC Acts have been either previously recorded or have potential habitat within the locality. The distribution of threatened plants derived from DECC is illustrated in Figure 5.

Eucalyptus camaldulensis was recorded within the study area during the survey. Occurrences of this species within the locality are part of the endangered population, River Red Gum (*Eucalyptus camaldulensis*) population in the Hunter Catchment, as listed under the TSC Act.

No other threatened plant species were recorded in the study area during this survey. However, potential habitat exists within the study area for the following threatened species and populations:

- Weeping Myall Population in the Hunter Catchment (i.e. endangered population of *Acacia pendula* in the Hunter Catchment)
- Hunter Valley endangered population of *Cymbidium canaliculatum*
- *Diuris tricolor* and the Pine Donkey Orchid population in the Muswellbrook local government area (i.e. endangered population of *Diuris tricolor*)
- *Eucalyptus glaucina*
- *Goodenia macbarronii*
- *Pterostylis gibbosa*

Table 1: Threatened flora listed on the TSC Act or EPBC Act that may occur in the locality

Latin Name	Common Name	EPBC Act [2]	TSC Act [1]	Habitat	Potential habitat
Acacia pendula	Weeping Myall	-	E2	Weeping Myall is an erect or spreading tree 5-13 metres high. A disjunct population of this species occurs in the Hunter Valley at the eastern distributional limit of the species' range. Within the Hunter catchment, the species typically occurs on heavy soils, sometimes on the margins of small floodplains. All known sites within the Hunter population occur on private or non-conservation land and are potentially vulnerable to clearing. The species occurs on the western slopes, western plains and far western plains of NSW, and south into Victoria and north into Queensland. The Hunter population is known to occur naturally as far east as Warkworth, and extends northwest to Muswellbrook and to the west of Muswellbrook at Wybong. The population has only been recorded to date at six locations: Jerrys Plains, Edderton, Wybong, Appletree Creek, Warkworth and Appletree Flat. These locations occur within the Muswellbrook and Singleton Local Government areas, with the population potentially also occurring within the Mid-Western Regional and Upper Hunter LGA's.	Yes. Within Central Hunter Box – Ironbark Woodland
Cymbidium canaliculatum	Tiger Orchid		E2	Epiphytic orchid found in dry sclerophyll forest or woodland where it grows in tree hollows, in clumps of fern or sometimes on rocks (Harden 1993). Endangered population in the Hunter Valley, where it is at its southern and eastern-most limit of distribution Most commonly found in *Eucalyptus albens* dominated woodland, typically between 2 and 6 m above the ground. Also, but less-commonly found on *E. moluccana, Angophora floribunda, Acacia salicina* and other species. (NSW Scientific Committee 2006) Current population estimate is 90 plants, however this could be as high as 300-500. (NSW Scientific Committee 2006) Recorded in Wollemi and Goulburn River National Parks, although 90% of known population occurs on non-conservation land. (NSW Scientific Committee 2006)	Yes, within Central Hunter Box-Ironbark Woodland, Central Hunter Spotted Gum – Ironbark - Grey Box Woodland, Central Hunter Bulloak Forest Regeneration
Cynanchum elegans	White-flowered Wax Plant	E	E1	Rainforest gullies scrub and scree slopes in Gloucester and Wollongong districts (Harden 1992). Occurs mainly at the ecotone between dry subtropical rainforest and sclerophyll forest/woodland communities (NPWS 2002a). Has been recorded in dry subtropical rainforest, littoral rainforest, *Leptospermum laevigatum-Banksia integrifolia* Coastal scrub, *Eucalyptus tereticornis* forest and woodland, *Corymbia maculata* forest and woodland and *Melaleuca armillaris* scrub to open scrub (NPWS 2002a).	No.
Darwinia biflora	-	V	V	Grows in heath or sedgeland on sandstone or in the understorey of woodland on shale-capped ridges (Harden 1991, Robinson 1994, Fairley and Moore 2000) particularly where it intergrades with Hawkesbury sandstone. Canopy often includes *Eucalyptus haemastoma* and *Corymbia gummifera* (NPWS 2000a). Prefers moist shallow depressions (Robinson 1994).	No. Site does not contain shale-capped ridges, or Hawkesbury sandstone.
Dillwynia tenuifolia	-	V	V	The core distribution is the Cumberland Plain from Windsor to Penrith east to Deans Park. Other populations in western Sydney are recorded from Voyager Point and Kemps Creek in the Liverpool LGA, Luddenham in the Penrith LGA and South Maroota in the Baulkham Hills Shire. Disjunct localities include: the Bulga Mountains at Yengo in the north, Kurrajong Heights and Woodford in the Lower Blue Mountains. Locally abundant particularly within dry areas within Castlereagh Ironbark Forest and Shale Gravel Transition Forest on tertiary alluvium or laterised clays. Flowering occurs sporadically from August to March depending on environmental conditions (DEC 2005a).	No. Site does not contain shale-gravel transitional soils or vegetation.

Latin Name	Common Name	EPBC Act [2]	TSC Act [1]	Habitat	Potential habitat
Diuris tricolor	(=*D. Sheaffiana*) Pine Donkey Orchid	V	V, E2	*Diuris tricolor* grows in grassy sclerophyll forest or woodland usually with *Callitris* spp. (Harden 1993, Bishop 1996). This species usually grows among grass in sclerophyll forest (Bishop 1996), however, it has also recorded from a red earth soil in a Bimble Box community in western NSW (DEC 2005b).The Pine Donkey Orchid is distributed sporadically but may be locally common (Jones 2006). It occurs predominantly on the western slopes from Narrandera, north to Toowoomba (Jones 2006). Within the Hunter Valley, it is known to occur at Muswellbrook and Wybong, but likely to occur more widely west of Singleton, and potentially on the Merriwa Plateau (Peake 2005). It can be difficult to detect because of its specific flowering season (Peake 2005) of Sept – Nov (Jones 2006). Disturbance regimes are not known, although the species is usually recorded from disturbed habitats (DEC 2005b). The population of *Diuris tricolor* in the Muswellbrook local government area (LGA) comprises a number of occurrences, ranging from a few scattered individuals to a few thousand individuals (B Holzinger, pers. comm.). The area of occupancy of the population is less than 50 km2 in the Muswellbrook LGA. Therefore, the geographic distribution of the population is estimated to be highly restricted (NSW Scientific Committee 2007).	Yes. Within Central Hunter Box – Ironbark Woodland, Central Hunter Bulloak Regeneration, and Central Hunter Spotted Gum – Ironbark – Grey Box Forest.
Eucalyptus camaldulensis	River Red Gum	-	E2	Tree to 30 metres high (occasionally taller); bark smooth, white, grey to red-brown, shedding in short ribbons or flakes. The population of River Red Gum in the Hunter is unique in NSW, as it is the only one to occur in a coastal catchment. It is disjunct and at the limit of the range of the species. It may be genetically distinct, and is of conservation significance. Most occurrences are on private land and there are no known occurrences in conservation reserves. Regeneration of trees is not occurring in most remnants because of changes in hydrology, cropping and grazing of the understorey or weed infestation.	Yes. Within Hunter Floodplain Red Gum Woodland Complex
Eucalyptus glaucina	Slaty Red Gum	V	V	Occurs near Casino and from Taree to Broke where it is locally common but very sporadic. Found in grassy woodland on deep, moderately fertile and well watered soil (Harden 2002). Previously recorded within Central Hunter Riparian Forest (mu13) (NPWS 2000b).	Yes. Within Central Hunter Box – Ironbark Woodland, Central Hunter Bulloak Regeneration, Central Hunter Spotted Gum – Ironbark – Grey Box Forest, Central Hunter Swamp Oak Forest, Hunter Valley River Oak Forest and Warkworth Sands Woodland.
Eucalyptus nicholii	Narrow-leaved Black Peppermint	V	V	This species is widely planted as an urban street tree and in gardens but is quite rare in the wild. It is confined to the New England Tablelands of NSW, where it occurs from Nundle to north of Tenterfield, largely on private property. Grows in dry grassy woodland, on shallow and infertile soils, mainly on granite (DEC 2005e).	No. Site is outside natural range of this species.

Latin Name	Common Name	EPBC Act [2]	TSC Act [1]	Habitat	Potential habitat
Goodenia macbarronii	Narrow Goodenia/ McBarron's Goodenia	-	V	McBarron's Goodenia grows on the western slopes of the Great Dividing Range in NSW, south from the Guyra and Inverell districts. It is widely distributed throughout the tablelands, western slopes and western plains. The species also occurs in north-eastern Victoria and the Darling Downs in Queensland. In NSW it has been recorded at Tingha, Guyra, the Warrumbungle Ranges, east of Rylstone, the Pilliga and Denobollie State Forests, the Narrabri, Coonabarabran, Torrington and Tocumwal districts, Grenfell, Weddin Mountain, Gungal, the Milthorpe district, and Holbrook (the Type locality). McBarron's Goodenia grows in damp sandy soils in seepages. The species is usually found in shaded, seasonally damp sites in clay-loam, sandy-loam and sandy soils. Habitats in NSW include a recently graded roadside drain adjacent to *Eucalyptus crebra* and *Callitris glaucophylla* woodland, dry eucalypt forest with low shrubby undergrowth in sandy soil, damp sandy patches in bushland areas, along roadsides, near water in a shallow excavation which has exposed the clay subsoil, on the banks of a sandy creek and in *Eucalyptus blakelyi* and *Angophora floribunda* woodland. Sites often have some form of recent disturbance, such as depressions made by grading and excavation along roadsides. Other sites include grazed paddocks and clearings with a large proportion of weed and exotic species, and cleared open grazing land which was formerly eucalypt woodland (DEC 2005f).	Yes. Within Central Hunter Box – Ironbark Woodland and Central Hunter Bulloak Regeneration.
Melaleuca groveana	Grove's Paperbark	-	V	Found in coastal region north of Yengo National Park and west to Werikmbe National Park where it grows in higher altitude heath, often in exposed areas (Harden 2002). Scattered populations occur in coastal districts north of Port Stephens to southeast Queensland. Grove's Paperbark grows in heath and shrubland, often in exposed sites, at high elevations, on rocky outcrops and cliffs. It also occurs in dry woodlands (DEC 2005g).	No. Site does not contain heath, cliffs or rocky outcrops and is not at a high altitude.
Olearia cordata	-	V	V	A NSW endemic with a scattered distribution generally restricted to the south-western Hunter Plateau, eastern Colo Plateau, and the far north-west of the Hornsby Plateau near Wiseman's Ferry east of Maroota. Populations are typically small and scattered. Grows in dry open sclerophyll forest and open shrubland, on sandstone ridges. Flowers November to May (DEC 2005i).	No. Site does not contain sandstone ridges.
Pomaderris brunnea	Rufous Pomaderris	V	V	Open forest confined to the Colo River & upper Nepean River (Harden 1990), on clay & alluvial soils (Fairley and Moore 1995). In the Hawkesbury/Nepean region, the species is known to be associated with Dry sclerophyll forests (Cumberland, Upper Riverina, Sydney Coastal, Sydney Hinterland, Sydney Sand Flats), Coastal Floodplain Wetlands and Coastal Valley Grassy Woodlands (DEC 2005k).	No. Site is outside known range of species,
Pterostylis gibbosa	Illawarra Greenhood	E	E1	Known from a small number of populations in the Hunter region (Milbrodale), the Illawarra region (Albion Park and Yallah) and the Shoalhaven region (near Nowra). It is apparently extinct in western Sydney which is the area where it was first collected (1803). All known populations grow in open forest or woodland, on flat or gently sloping land with poor drainage. In the Illawarra region, the species grows in woodland dominated by *Eucalyptus tereticornis*, *E. longifolia* and *Melaleuca decora*. Near Nowra, the species grows in an open forest of *Corymbia maculata*, *E. tereticornis*, and *E. paniculata*. In the Hunter region, the species grows in open woodland dominated by *E. crebra*, *E. tereticornis* and *Callitris endlicheri*. The Illawarra Greenhood is a deciduous orchid that is only visible above the ground between late summer and spring and only when soil moisture levels can sustain its growth (DEC 2005l).	Yes. Within Central Hunter Box - Ironbark Woodland, Central Hunter Ironbark - Spotted Gum - Grey Box Forest and Warkworth Sands Woodland.
Thesium australe	Austral Toad-flax	V	V	Clay soils in grassy woodlands or coastal headlands (James *et al.* 1999). Found in very small populations scattered across eastern NSW, along the coast, and from the Northern to Southern Tablelands. Often found in damp sites in association with *Themeda australis*. A root parasite that takes water and some nutrient from other plants, especially Kangaroo Grass (DEC 2005p).	No

Latin Name	Common Name	EPBC Act [2]	TSC Act [1]	Habitat	Potential habitat
Wollemia nobilis	Wollemi Pine	E	E1	Plants emergent above warm-temperate coachwood-sassafras rainforest, in a deep sheltered gorge in a remote part of the Wollemi National Park (Harden 2000).	No. Site contains no deep sheltered gorges and is outside natural range of this species.

Key: 1) Listed on the TSC Act as Endangered (E1), Extinct (E4), Endangered Population (E2) or Vulnerable (V); 2) Listed on the EPBC Act as Endangered (E) or Vulnerable (V)

4.3 Fauna Habitats

The study area has been highly disturbed due to agricultural and mining practices. The fauna habitat within the study area is largely restricted to isolated patches of woodlands, waterbodies and cleared paddocks and broadly corresponds to the plant communities outlined in Section 4.1. Finer scale habitat features include fallen timber, tree hollows, leaf litter and permanent and ephemeral waterbodies. Animal species may utilise some of these features wholly or partly, in conjunction with one another, or may depend entirely on one specific habitat type. These habitats features and species associations are discussed in further detail below.

Woodland

The Woodland habitat occurs through out the study area in isolated patches and broadly corresponds to the Central Hunter Ironbark Woodland and Warkworth Sands Woodland plant communities observed in section 5, 7, 11, 12, 15, 16 and 20 of the study area (Section 4.1) (Plate 1 and 9).

Woodlands provide a wide range of foraging and sheltering habitat for vertebrate fauna. Myrtaceaeous trees dominate the upper canopy in these areas and supply direct (foliage, nectar, exudates) and indirect (arthropods) food for a range of vertebrates. In particular, native trees such as *Eucalyptus crebra, E. moluccana, Angophora floribunda* and allocasuarinas are considered feed trees for threatened species including Regent Honeyeater *Xanthomyza phrygia*, Swift Parrot *Lathamus discolor* and Glossy Black-cockatoo *Calyptorhynchus lathami*.

A few small tree hollows (formed in stags, mature and/or senescent trees) were recorded in the study area, providing nesting and roosting habitat for a range of common birds and arboreal mammal species. Most of the hollows were observed within the Warkworth, Central Hunter Ironbark Woodland (Section 11,12,15,16 and 20). These hollows are likely to provide habitat for small bird and insectivorous bats. A few medium sized hollows were recorded along the Hunter River, providing shelter for mammals (eg Brushtail Possums), birds (eg parrots) and insectivorous bats. Locally recorded threatened species requiring tree-hollows for mating and/or nesting include the Squirrel Glider *Petaurus*

norfolcensis, Brown Treecreeper *Climacteris picumnus victoriae,* Glossy Black-cockatoo and micro-bats.

Understorey and shrub vegetation was relatively open and dominated by native species. The ground cover had a good layer of leaf litter and fallen branches and bark (scattered throughout woodland areas), providing refuge and nesting habitat for a range of terrestrial animals. Many invertebrates and amphibians rely on these 'moisture-retaining' microhabitats to over-winter or as refuge during periods of drought. Similarly, many reptiles rely on ground litter and debris for shelter and foraging. Larger hollow logs provide potential denning and nesting habitat for small to medium sized mammals including Common Wombat, *Vombatus ursinus*.

Given the Woodland habitat has been previously disturbed by agriculture, fire roads and infrastructure such as powerlines the condition of the habitat varies from poor to moderate. In areas that have been highly disturbed and/ or contain only small isolated patches of remanet woodland (e.g. section 5, 7 and 20), fauna habitat are considered to be in poor condition. However with the larger section of Woodland west of Wallaby Scrub Road (e.g. Section 11, 12, 15and 16) habitats are considered to be in Moderate condition, with the ground flora containing a number of indigenous species; ground, log and litter layer largely intact and undisturbed; and a large variety of habitat and resources for a range of native fauna available. Examples of threatened fauna that may utilise these habitats include Swift parrot, Regent Honeyeater, Squirrel Glider and Micro-bats.

Waterbodies (River/creek/drainage lines)

A number of watercourses will be traversed by the proposal, including the Hunter River (Plate 10), Wollombi Brook, Foy Brook, Bayswater Creek and Saltwater Creek, dams and a number of unnamed drainage lines (e.g. section 8,10, 12 17 and 19). All these waterbodies differ in structure and habitats vary with changing fluvial geomorphology, from isolated pools and small areas of riffle habitat to areas of open water. At the time of the survey, the Upper Hunter had recently experienced extreme wet weather; hence the habitat within the waterbodies was altered due to flood waters and the condition of the river/ creek/drainage lines could not be determined.

In general, open water habitat is generally restricted to areas along the Hunter River and farm dams. These areas may provide habitat for waterbird species and foraging habitat for birds and bat species. Riparian vegetation along the Hunter River was restricted to a small strip of mature eucalypts with little or no shrub layer and a ground cover of mainly exotic grasses and scattered timber.

Creeklines contained a mixture of rock and sandy soil with debris such as bark, leaf litter and fallen timber scattered along the creek, providing habitat for a

range of amphibians and reptiles. In some cases, such as Bayswater creek, the creeklines were choked with rushes, providing habitat for frog species including the Green and Golden Bell Frog, *Litoria aurea*. Riparian habitat varied from a sparse and shrubby understorey, thus providing shelter and basking habitat for reptiles including the Eastern Water Dragon *Physignathus lesueurii* spp. *lesueurii*, to woodland habitats dominated by eucalypts, thus providing shelter and foraging resources for a range of fauna.

Drainage lines within the study area were highly degraded with little or no riparian vegetation. The drainage lines were generally covered with exotic grasses and scattered timber. Despite the disturbance, these drainage lines may provide limited potential habitat for the Green and Golden Bell Frog.

Cleared areas

The study area had largely been cleared and was subjected to ongoing disturbances from agricultural and mining. Isolated patches of native vegetation remained, but these were often surrounded by cleared areas used for either mining, agricultural or infrastructure such as an airstrip, fire roads and utilities easements (eg. powerline easement) (Plate 11). This habitat broadly corresponds to the plant communities recorded in section 3, 4, 6, 8, 9, 15, 16, 18, 19 and 22 of the study area (Section 4.1 of this report).

Despite these disturbances, some native animal species may occur within disturbed vegetation and microhabitat components of these areas. Generally these areas would provide few habitat opportunities for native fauna. Species likely to inhabit these areas include introduced and domestic animals and natives tolerant of disturbance or favouring edge/ecotone habitats.

A portion of this cleared area habitat occurs within the floodplains of the Hunter River (e.g. section 14 and 20). Due to the relatively high soil fertility of floodplains, most of the native vegetation occurring on the floodplains within the study area have been previously cleared for agricultural practices and are subject to ongoing grazing disturbances. Vegetation on the floodplains is restricted to exotic pasture and grasses with scattered stand of mature eucalypts, providing foraging and nesting for a range of birds and common mammal species.

Given the flooding in the locality prior to the surveys, many of the floodplains were inundated with water, providing habitat for waterbird species.

Cleared areas are considered to be in Poor condition, with the ground flora containing a low number of indigenous species; fragmented plant communities; ground, log and litter layer highly disturbed; and few resources available for native fauna.

4.4 Fauna

One threatened bird species listed on the TSC Act, Grey-crowned Babbler, and one migratory species listed on the EPBC, Brown Falcon, were recorded during the current survey. Anabat analysis identified four possible bat species, Southern Cave Bat, Little Forest Bat, Eastern Horseshoe Bat, Eastern Bent-wing Bat and Eastern Cave Bat (the latter two species are listed as Vulnerable on the TSC Act). However, the Anabat results are not conclusive, as Eastern Horseshoe Bat calls are very short and the other two calls were of species that overlap in frequency and can be hard to tell apart (Narawan Williams, *pers com* . 2007)

In addition to these species, four amphibians, 36 bird species and four mammal species (two introduced) were recorded during the current surveys a detailed list of animal species utilising the study area are listed in Appendix 2.

4.4.1 Significant Fauna

A total of 56 threatened or migratory animal species or their habitats have been previously recorded within the local area Atlas of NSW Wildlife (Figure 6) and EPBC Act Online Database - Environmental Reporting Tool (DEW 2007). Of these, 48 animal species are listed under the TSC Act and 26 animal species listed under the EPBC Act.

The study area contains potential habitat for 31 threatened species listed on the TSC Act and 11 threatened and/or migratory species listed on the EPBC Act (Table 2). These have been considered further in Section 5 (Impact Assessment).

Table 2: Threatened fauna listed on the TSC Act or EPBC Act *t*hat may occur in the locality

Latin Name	Common Name	EPBC Act[1]	TSC Act[2]	Habitat	Potential habitat
Amphibians					
Litoria aurea	Green and Golden Bell Frog	V	E1	Found in marshes, dams and stream sides, particularly those containing bullrushes or spikerushes (NPWS 1999c). Preferred habitat contains water bodies that are unshaded, are free of predatory fish, have a grassy area nearby and have diurnal sheltering sites nearby such as vegetation or rocks (White and Pyke 1996, NPWS 1999c).	Yes
Litoria littlejohni	Littlejohn's Tree Frog	V	V	Occurs in wet and dry sclerophyll forests associated with sandstone outcrops between 280 and 1000 metres on the eastern slopes of the Great Dividing Range (Barker *et al.* 1995). Prefers rock flowing streams, but individuals have also been collected from semi-permanent dams with some emergent vegetation (Barker *et al.* 1995). Forages both in the tree canopy and on the ground, and has been observed sheltering under rocks on high exposed ridges during summer. It is not known from coastal habitats.	No
Heleioporus australiacus	Giant Burrowing Frog	V	V	Prefers hanging swamps on sandstone shelves adjacent to perennial non-flooding creeks (Daly 1996). Can also occur within shale outcrops within sandstone formations. In the southern part of its range can occur in wet and dry forests, montane sclerophyll woodland and montane riparian woodland (Daly 1996). Individuals	No

Latin Name	Common Name	EPBC Act[1]	TSC Act[2]	Habitat	Potential habitat
				can be found around sandy creek banks or foraging along ridge-tops during or directly after heavy rain. Males often call from burrows located in sandy banks next to water (Barker *et al.* 1995).	
Mixophyes iteratus	Giant Barred Frog	E	E1	Usually found in coastal riverine rainforest and upland areas such as the Border Ranges (Barker *et al.* 1995).	No
Pseudophryne australis	Red-crowned Toadlet	-	V	Occurs on wetter ridge tops and upper slopes of sandstone formations on which the predominant vegetation is dry open forests and heaths. This species typically breeds within small ephemeral creeks that feed into larger semi-perennial streams. After rain these creeks are characterised by a series of shallow pools lined by dense grasses, ferns and low shrubs (Thumm and Mahony 1996, Thumm and Mahoney 1997).	No
Birds					
Erythrotriorchis radiatus	Red Goshawk	V	E1	Occur in forest and woodland habitat near permanent water. In NSW prefer Melaleuca swamp forest and open eucalypt woodland (Marchant & Higgins 1993). Require greater than 20 metres tall for nesting (Marchant and Higgins 1993).	No
Haliaeetus leucogaster	White-bellied Sea-eagle	M	-	A migratory species that is resident to Australia. Found in terrestrial and coastal wetlands; favouring deep freshwater swamps, lakes and reservoirs; shallow coastal lagoons and saltmarshes (English and Predavec 2001).	No
Oxyura australis	Blue-billed Duck	-	V	Almost wholly aquatic, preferring deep water in large, permanent wetlands with an abundant aquatic flora (Marchant and Higgins 1990).	No
Stictonetta naevosa	Freckled Duck	-	V	The freckled duck breeds in permanent fresh swamps that are heavily vegetated. Found in fresh or salty permanent open lakes, especially during drought. Often seen in groups on fallen trees and sand spits (Simpson and Day 1996).	No
Apus pacificus	Fork-tailed Swift	M	-	Almost exclusively aerial (Higgins 1999).	No
Hirundapus caudacutus	White-throated Needletail	M	-	An aerial species found in feeding concentrations over cities, hilltops and timbered ranges (Pizzey 1983).	Yes
Ardea alba	Great Egret	M	-	Terrestrial wetlands, estuarine and littoral habitats and moist grasslands. Inland, prefer permanent waterbodies on floodplains; shallows of deep permanent lakes (either open or vegetated), semi-permanent swamps with tall emergent vegetation and herb dominated seasonal swamps with abundant aquatic flora. Also regularly use saline habitats including mangrove forests, estuarine mudflats, saltmarshes, bare saltpans, shallows of salt lakes, salt fields and offshore reefs. Breeding requires wetlands with fringing trees in which to build nests including mangrove forest, freshwater lakes or swamps and rivers (Marchant and Higgins 1990).	No
Ardea ibis	Cattle Egret	M	-	Occurs in tropical and temperate grasslands, wooded lands and terrestrial wetlands (Marchant and Higgins 1993).	Yes
Callocephalon fimbriatum	Gang-gang Cockatoo	-	V	In summer, occupies tall montane forests and woodlands, particularly in heavily timbered and mature wet sclerophyll forests (Higgins 1999). Also occur in subalpine Snow Gum woodland and occasionally in temperate or regenerating forest (Forshaw and Cooper 1981). In winter, occurs at lower altitudes in drier, more open eucalypt forests and woodlands, particularly in box-ironbark assemblages, or in dry forest in coastal areas (Shields and Crome 1992). It requires tree hollows in which to breed (Gibbons and Lindenmayer 1997).	Yes
Calyptorhynchus lathami	Glossy Black-cockatoo	-	V	Inhabits forest with low nutrients, characteristically with key Allocasuarina species. Tends to prefer drier forest types (NPWS 1999b) with a middle stratum of allocasuarina below eucalyptus or angophora. Often confined to remnant patches in hills and gullies (Higgins 1999). Breed in hollows stumps or limbs, either living or dead (Higgins 1999).	Yes
Ephippiorhynchus asiaticus	Black-necked Stork	-	E1	Found in swamps, mangroves and mudflats. Can also occur in dry floodplains and irrigated lands and occasionally forages in open grassy woodland. Nests in live or dead trees usually near water (Pizzey 1983).	No

Latin Name	Common Name	EPBC Act[1]	TSC Act[2]	Habitat	Potential habitat
Climacteris picumnus victoriae	Brown Treecreeper (eastern subspecies)	-	V	Live in eucalypt woodlands, especially areas of relatively flat open woodland typically lacking a dense shrub layer, with short grass or bare ground and with fallen logs or dead trees present (Traill and Duncan 2000).	Yes
Monarcha melanopsis	Black-faced Monarch	M	-	A migratory species found during the breeding season in damp gullies in temperate rainforests. Disperses after breeding into more open woodland (Pizzey 1983).	No
Myiagra cyanoleuca	Satin Flycatcher	M	-	Migratory species that occurs in coastal forests, woodlands and scrubs during migration. Breeds in heavily vegetated gullies (Pizzey 1983).	No
Rhipidura rufifrons	Rufous Fantail	M	-	Migratory species that prefers dense, moist undergrowth of tropical rainforests and scrubs. During migration it can stray into gardens and more open areas (Pizzey 1983).	No
Falco berigora	Brown Falcon	M	-	Occur in woodland and forest areas with open country nearby for hunting. Prefer pen habitats such as grassland and low shrublands (Marchant and Higgins 1993)	Yes
Grantiella picta	Painted Honeyeater	-	V	Found mainly in dry open woodlands and forests, where it is strongly associated with mistletoe (Higgins *et al.* 2001). Often found on plains with scattered eucalypts and remnant trees on farmlands.	Yes
Melithreptus gularis gularis	Black-chinned Honeyeater	-	V	Found mostly in open forests and woodlands dominated by box and ironbark eucalypts (Higgins *et al.* 2001). It is rarely recorded east of the Great Dividing Range (Higgins *et al.* 2001).	Yes
Xanthomyza phrygia	Regent Honeyeater	E	E1	A semi-nomadic species occurring in temperate eucalypt woodlands and open forests. Most records are from box-ironbark eucalypt forest associations and wet lowland coastal forests (Pizzey 1983, NPWS 1999d).	Yes
Merops ornatus	Rainbow Bee-eater	M		Usually occurs in open or lightly timbered areas, often near water (Higgins 1999).	Yes
Pyrrholaemus sagittata	Speckled Warbler	-	V	This species occurs in eucalypt and cypress woodlands on the hills and tablelands of the Great Dividing Range. They prefer woodlands with a grassy understorey, often on ridges or gullies (Blakers *et al.* 1984, NSW Scientific Committee 2001). The species is sedentary, living in pairs or trios, and nests on the ground in grass tussocks, dense litter and fallen branches. They forage on the ground and in the understorey for arthropods and seeds (Blakers *et al.* 1984, NSW Scientific Committee 2001). Home ranges vary from 6-12 hectares (NSW Scientific Committee 2001).	Yes
Stagonopleura guttata	Diamond Firetail	-	V	Found in a range of habitat types including open eucalypt forest, mallee and acacia scrubs (Pizzey and Knight 1997).	Yes
Melanodryas cucullata	Hooded Robin	-	V	This species lives in a wide range of temperate woodland habitats, and a range of woodlands and shrublands in semi-arid areas (Traill and Duncan 2000).	Yes
Pomatostomus temporalis temporalis	Grey-crowned Babbler	-	V	Occurs in drier, more open forests, scrubby woodlands, trees bordering roads, farmland with isolated trees (Simpson and Day 1996).	Yes
Lathamus discolor	Swift Parrot	E	E1	The Swift Parrot occurs in woodlands and forests of NSW from May to August, where it feeds on eucalypt nectar, pollen and associated insects (Forshaw and Cooper 1981). The Swift Parrot is dependent on flowering resources across a wide range of habitats in its wintering grounds in NSW (Shields and Crome 1992). This species is migratory, breeding in Tasmania and also nomadic, moving about in response to changing food availability (Pizzey 1983).	Yes
Neophema pulchella	Turquoise Parrot	-	V	Occurs in open woodlands and eucalypt forests with a ground cover of grasses and understorey of low shrubs (Morris 1980). Generally found in the foothills of the Great Divide, including steep rocky ridges and gullies (Higgins 1999). Nest in hollow-bearing trees, either dead or alive; also in hollows in tree stumps. Prefer to breed in open grassy forests and woodlands, and gullies that are moist (Higgins 1999).	No
Rostratula australis	Australian Painted Snipe	VM	E1	Usually found in shallow inland wetlands including farm dams, lakes, rice crops, swamps and waterlogged grassland. They prefer freshwater wetlands, ephemeral or permanent, although they have been recorded in brackish waters (Marchant & Higgins 1993).	Yes

Latin Name	Common Name	EPBC Act[1]	TSC Act[2]	Habitat	Potential habitat
Rostratula benghalensis	Painted Snipe	-	E1	Found in the fringes of swamps, dams, sewage farms and marshy areas, generally with a cover of grasses, lignum or open timber (Pizzey and Knight 1997).	Yes
Gallinago hardwickii	Latham's Snipe	M	-	Typically found on wet soft ground or shallow water with good cover of tussocks. Often found in wet paddocks and seepage areas below dams (Pizzey and Knight 1997).	Yes
Ninox connivens	Barking Owl	-	V	Generally found in open forests, woodlands, swamp woodlands and dense scrub. Can also be found in the foothills and timber along watercourses in otherwise open country (Pizzey 1983).	Yes
Ninox strenua	Powerful Owl	-	V	Occupies wet and dry eucalypt forests and rainforests. Can occupy both un-logged and lightly logged forests as well as undisturbed forests where it usually roosts on the limbs of dense trees in gully areas. It is most commonly recorded within Red Turpentine in tall open forests and Black She-oak within open forests (Debus and Chafer 1994). Large mature trees with hollows at least 0.5 metres deep are required for nesting (Garnett 1992). Tree hollows are particularly important for the Powerful Owl because a large proportion of the diet is made up of hollow-dependent arboreal marsupials (Gibbons and Lindenmayer 1997). Nest trees for this species are usually emergent with a diameter at breast height of at least 100 centimetres (Gibbons and Lindenmayer 1997).	Yes
Tyto novaehollandiae	Masked Owl	-	V	Inhabits a diverse range of wooded habitat that provide tall or dense mature trees with hollows suitable for nesting and roosting (Higgins 1999). Mostly recorded in open forest and woodlands adjacent to cleared lands. Nest in hollows, in trunks and in near vertical spouts or large trees, usually living but sometimes dead (Higgins 1999). Nest hollows are usually located within dense forests or woodlands (Gibbons and Lindenmayer 1997). Masked owls prey upon hollow-dependent arboreal marsupials, but terrestrial mammals make up the largest proportion of the diet (Gibbons and Lindenmayer 1997, Higgins 1999).	Yes
Tyto tenebricosa	Sooty Owl	-	V	Often found in tall old-growth forests, including temperate and subtropical rainforests. In NSW mostly found on escarpments with a mean altitude <500 m. Nests and roosts in hollows of tall emergent trees, mainly eucalypts (Higgins 1999) often located in gullies (Gibbons and Lindenmayer 1997). Nests have been located in trees 125 to 161 centimetres in diameter (Gibbons and Lindenmayer 1997).	No
Mammals					
Dasyurus maculatus	Spotted-tailed Quoll	E	V	Uses a range of habitats including sclerophyll forests and woodlands, coastal heathlands and rainforests (Dickman and Read 1992). Habitat requirements include suitable den sites, including hollow logs, rock crevices and caves, an abundance of food and an area of intact vegetation in which to forage (Edgar and Belcher 1995).	No
Phascogale tapoatafa	Brush-tailed Phascogale	-	V	Occurs in dry sclerophyll open forest with a sparse ground cover of herbs, grasses, shrubs or leaf litter (Soderquist 1995, NPWS 1999a). Individuals may also inhabit heathland, swamps, rainforest and wet sclerophyll forest (NPWS 1999a). Nests and shelters in tree hollows, using many different hollows over a short period of time. Suitable hollows are 25-40 millimetres wide (NPWS 1999a).	No
Saccolaimus flaviventris	Yellow-bellied Sheathtail Bat	-	V	Reported from a wide range of habitats throughout eastern and northern Australia, including wet and dry sclerophyll forest, open woodland, acacia shrubland, mallee, grasslands and desert (Churchill 1998). They roost in tree hollows and have also been observed roosting in animal burrows, abandoned Sugar Glider nests, cracks in dry clay, hanging from buildings and under slabs of rock (Churchill 1998). The species flies high and fast and forages above the canopy (Churchill 1998).	Yes
Petrogale penicillata	Brush-tailed Rock-wallaby	V	E1	Found in rocky areas in a wide variety of habitats including rainforest gullies, wet and dry sclerophyll forest, open woodland and rocky outcrops in semi-arid country. Commonly sites have a northerly aspect with numerous ledges, caves and crevices (Eldridge and Close 1995).	No

Latin Name	Common Name	EPBC Act[1]	TSC Act[2]	Habitat	Potential habitat
Mormopterus norfolkensis	Eastern Freetail Bat	-	V	Most records are from dry eucalypt forests and woodlands to the east of the Great Dividing Range. Appears to roost in trees, but little is known of this species' habits (Allison and Hoye 1995, Churchill 1998).	Yes
Pseudomys oralis	Hastings River Mouse	E	E1	Inhabits open forests and woodlands with a grass, sedge, rush or heath understorey, that is usually approximately 10 to 75cm above ground. The Hastings River Mouse also requires shelter sites, such as rock piles, hollow logs, yabby burrows or cavities in the butts of old, large trees to be in close proximity. Populations often inhabit areas of suitable habitat that have not been burnt for approximately 5 to 10 years (NPWS 1999e).	No
Petaurus australis	Yellow-bellied Glider	-	V	Restricted to tall native forests in regions of high rainfall. Preferred habitats are productive, tall open sclerophyll forests where mature trees provide shelter and nesting hollows. Critical elements of habitat include sap-site trees, winter flowering eucalypts, mature trees suitable for den sites and a mosaic of different forest types (NPWS 1999f).	No
Petaurus norfolcensis	Squirrel Glider	-	V	Generally occurs in dry sclerophyll forests and woodlands but is absent from dense coastal ranges in the southern part of its range (Suckling 1995). Requires abundant hollow bearing trees and a mix of eucalypts, banksias and acacias (Quin 1995). There is only limited information available on den tree use by Squirrel Gliders, but it has been observed using both living and dead trees as well as hollow stumps (Gibbons and Lindenmayer 1997). Within a suitable vegetation community at least one species should flower heavily in winter and one species of eucalypt should be smooth barked (Menkhorst *et al.* 1988).	Yes
Phascolarctos cinereus	Koala	-	V	Inhabits eucalypt forests and woodlands. The suitability of these forests for habitation depends on the size and species of trees present, soil nutrients, climate and rainfall (Reed and Lunney 1990, Reed *et al.* 1990).	Yes
Pteropus poliocephalus	Grey-headed Flying-fox	V	V	This species is a canopy-feeding frugivore and nectarivore of rainforests, open forests, woodlands, melaleuca swamps and banksia woodlands. Bats commute daily to foraging areas, usually within 15 kilometres of the day roost (Tidemann 1995) although some individuals may travel up to 70 kilometres (Augee and Ford 1999).	Yes
Chalinolobus dwyeri	Large-eared Pied Bat	V	V	Located in a variety of drier habitats, including the dry sclerophyll forests and woodlands to the east and west of the Great Dividing Range (Hoye and Dwyer 1995). Can also be found on the edges of rainforests and in wet sclerophyll forests (Churchill 1998). This species roosts in caves and mines in groups of between 3 and 37 individuals (Churchill 1998).	Yes
Falsistrellus tasmaniensis	Eastern False Pipistrelle	-	V	Inhabit sclerophyll forests, preferring wet habitats where trees are more than 20 metres high (Churchill 1998). Two observations have been made of roosts in stem holes of living eucalypts (Phillips 1995). There is debate about whether or not this species moves to lower altitudes during winter, or whether they remain sedentary but enter torpor (Menkhorst and Lumsden 1995). This species also appears to be highly mobile and records showing movements of up to 12 kilometres between roosting and foraging sites (Menkhorst and Lumsden 1995).	Yes
Miniopterus australis	Little Bent-wing Bat	-	V	Shows a preference for well timbered areas including rainforest, wet and dry sclerophyll forests, melaleuca swamps and coastal forests. Roost in caves, congregating into maternity colonies in summer months (Churchill 1998).	Yes
Miniopterus schreibersii oceanensis	Eastern Bent-wing Bat	-	V	Broad range of habitats including rainforest, wet and dry sclerophyll forest, paperbark forest and open grasslands. Roost in caves and man made habitats and under road culverts (Strahan 1995).	Yes
Myotis macropus	Large-footed Myotis	-	V	Occurs in most habitat types as long as they are near permanent water bodies, including streams, lakes and reservoirs. Commonly roost in caves, but can also roost in tree hollows, under bridges and in mines (Richards 1995, Churchill 1998).	Yes
Nyctophilus bifax	Eastern Long-eared Bat	V	V	Favours wetter habitats, ranging from rainforest and monsoon forest to riverine forests of paperbark, but are also found in open	No

Latin Name	Common Name	EPBC Act[1]	TSC Act[2]	Habitat	Potential habitat
				woodland, tall open forest and dry sclerophyll woodland. In northern NSW they are restricted to rainforest. The species have been recorded roosting under peeling bark, among epiphytes, in tree hollows, in the roots of strangler figs, amongst the dead fronds of a prickly tree fern and in foliage (Churchill 1998).	
Scoteanax rueppellii	Greater Broad-nosed Bat	-	V	Prefer moist gullies in mature coastal forests and rainforests, between the Great Dividing Range and the coast. They are only found at low altitudes below 500 metres (Churchill 1998). In dense environments they utilise natural and human-made opening in the forest for flight paths. Creeks and small rivers are favoured foraging habitat (Hoye and Richards 1995). This species roosts in hollow tree trunks and branches (Churchill 1998).	Yes
Vespadelus troughtoni	Eastern Cave Bat	-	V	A cave-roosting species that is usually found in dry open forest and woodland, near cliffs or rocky overhangs; has been recorded roosting in disused mine workings. It is occasionally found along cliff-lines in wet eucalypt forest and rainforest. The Eastern Cave Bat is found in a broad band on both sides of the Great Dividing Range from Cape York to Kempsey, with records from the New England Tablelands and the upper north coast of NSW. The western limit appears to be the Warrumbungle Range, and there is a single record from southern NSW, east of the ACT (NPWS 2005).	Yes
Reptiles					
Hoplocephalus bitorquatus	Pale-headed Snake	-	V	Found in a variety of habitats from wet sclerophyll forest to dry eucalypt forest on the western slopes of NSW (Swan 1990, Cogger 1992). Feeds largely on frogs and lizards (Cogger 1992).	Yes
Hoplocephalus bungaroides	Broad-headed Snake	V	E1	Mainly occurs in association with communities occurring on Triassic sandstone within the Sydney Basin. Typically found among exposed sandstone outcrops with vegetation types ranging from woodland to heath. Within these habitats they generally use rock crevices and exfoliating rock during the cooler months and tree hollows during summer .	No
Aprasia parapulchella	Pink-tailed Worm Lizard	V	V	Type specimens were found under weathered granite rocks on a grazed, grassy riverside slope (Cogger 1992)	No

Key: 1) Listed on the EPBC Act as Endangered (E) or Vulnerable (V) or covered under migratory provisions (M) on the EPBC Act
2) Listed on the TSC Act as Endangered (E), Vulnerable (V)

5.0 IMPACT ASSESSMENT

5.1 Potential Impacts on Plant Communities

The plant communities that will be impacted by the proposal are listed in Table 3. Potential impacts (direct and indirect) on the plant communities in the study area include the following:

- Clearing of vegetation
- Increased fragmentation within remnants of these communities
- Disturbance of soil seed bank through the physical disturbance of the natural soil profile and compaction of soil leading to reduced recruitment of native plant species
- Increased length of edges
- Increased potential for weed invasion.

Table 3: Plant communities impacted by the proposal

Plant community	Directly cleared (hectares)	Indirectly impacted (hectares)	Total (hectares)
Central Hunter Box-Ironbark Woodland	12.2	8.2	20.3
Central Hunter Bulloak Forest Regeneration	1.1	0.8	1.9
Central Hunter Ironbark - Spotted Gum - Grey Box Forest	3.0	2.0	5.0
Central Hunter Swamp Oak Forest	0.5	0.3	0.8
Hunter Valley River Oak Forest	0.4	0.2	0.6
Planted areas	2.1	1.5	3.7
Warkworth Sands Woodland	6.3	4.2	10.6

The following additional plant communities are mapped within the locality but are unlikely to be impacted by the proposal, as they do not occur within the study area:

- Hunter Floodplains Red Gum Forest
- Hunter Lowlands Red Gum Forest
- Hunter Valley Weeping Myall Woodland (= Hunter Valley Weeping Myall Woodland EEC)

- Mt Arthur Forest Complex
- Narrabeen Footslopes Slaty Box Woodland
- Southern Hunter Escarpment Spotted Gum Woodland
- Southern Hunter Footslopes Sheltered Forest
- Upper Hunter Coastal Myall Exposed Forest
- Upper Hunter Narrabeen Gully Ironwood Dry Rainforest
- Upper Hunter White Box – Ironbark Grassy Woodland

5.1.1 Potential Impacts on Endangered Ecological Communities

Two of the communities mapped as occurring in the study area are listed as Endangered Ecological Communities under the TSC Act:

- Hunter Valley Weeping Myall Woodland
- Warkworth Sands Woodland

Hunter Valley Weeping Myall Woodland is also listed as a Critically Endangered Ecological Community under the EPBC Act under the name of Weeping Myall - Coobah - Scrub Wilga Shrubland of the Hunter Valley.

Hunter Valley Weeping Myall Woodland is mapped by Peake (2005) as occurring within approximately 300m of the proposal, but not within the study area. Given that access restrictions prevented this section of the study area from being surveyed during this study, this area should be surveyed prior to commencement of works to ensure that the proposal does not affect this Critical EEC. If the proposal is likely to affect this Critical EEC either directly or indirectly, the potential impacts of the proposal will need to be assessed as stipulated by Part 3A of the EP&A Act and the EPBC Act.

Warkworth Sands Woodland will be impacted by the proposal; therefore an impact assessment has been undertaken following the Part 3A Guidelines for Threatened Species Assessment (impact assessment) (Appendix 3). This assessment found that the proposal is likely to have a high impact on the Warkworth Sands Woodland EEC. These impacts are as follows:

- Fragmentation of the largest and most-intact remnant of Warkworth Sands Woodland, through the division of the large remnant into two. This large remnant of Warkworth Sands Woodland is part of an offset area for the Warkworth Mine (ERM 2002).

- The likely removal of up to 6.34 hectares of this EEC
- The disturbance is likely to be difficult or impossible to regenerate given the level of disturbance, in the maintenance of the clearance as an easement, making the fragmentation permanent
- Clearing or modification of approximately 1.03 percent of the remaining extent of the community (including removal of 0.63 percent and modification of 0.42 percent).

These impacts are discussed further in Appendix 3 of this report.

5.2 Potential Impacts on Flora

Each of the species identified in Table 1 as having potential habitat within the study area is assessed in this section against the potential impacts of the proposal. Of the 15 threatened species considered in Table 1 three have known habitat within the study area: *Acacia pendula, Eucalyptus camaldulensis* and *E. glaucina;* and three have potential habitat within the study area: *Diuris tricolor, Goodenia macbarronnii* and *Pterostylis gibbosa.* These species are discussed further in Section 5.2.1of this report, below.

One regionally significant species was recorded in the study area, *Grevillea montana.* This species is not listed on the TSC Act or the EPBC Act and, as such, further impact assessments are not required. This species should, however, be avoided by the proposed works.

5.2.1 Potential Impacts on Threatened Plant Species

Potential impacts to the threatened flora recorded and/or having potential habitat in the study area is discussed in Table 3 below. Impact assessments are required for *Acacia pendula* (Hunter Valley endangered population)*, Cymbidium canaliculatum* (Hunter Valley endangered population), *Diuris tricolor* (threatened species and Muswellbrook local government area endangered population)*, Eucalyptus camaldulensis* (Hunter Valley endangered population)*, Eucalyptus glaucina, Goodenia macbarronnii* and *Pterostylis gibbosa* (Appendix 3). Assessments of Significance under the EPBC Act are required for *Diuris tricolor, Eucalyptus glaucina, Goodenia macbarronnii* and *Pterostylis gibbosa* (Appendix 4).

The proposal will have a moderate to low on the threatened plant species or endangered plant populations with known or potential habitat in the study area.

A Referral to the Environment Minister is not considered necessary for threatened

flora species as part of the proposed works.

Table 4: Potential Impacts on Threatened Plant Species

Species	Vegetation community/habitat	Area of habitat within Direct Impact zone (ha)	Recorded in study area during survey	Recorded in study area - previous records	Recorded in locality	Impact assessment (Guidelines on Threatened Species Assessment under Part 3A of the EP&A Act) required?	Assessment of Significance under the EPBC Act required?
Acacia pendula	Central Hunter Box – Ironbark Woodland	12.2	No	Yes	Yes	Yes	No
Cymbidium canaliculatum	Central Hunter Box – Ironbark Woodland Central Hunter Bulloak Regeneration Central Hunter Spotted Gum – Ironbark – Grey Box Forest	22.6	No	No	Yes	Yes	No
Diuris tricolor (= D. sheaffiana)	Central Hunter Box – Ironbark Woodland Central Hunter Bulloak Regeneration Central Hunter Spotted Gum – Ironbark – Grey Box Forest	16.3	No	No	Yes	Yes	Yes
Eucalyptus camaldulensis	Hunter Floodplain Red Gum Woodland Complex	0	Yes	Yes	Yes	Yes	No
Eucalyptus glaucina	Central Hunter Box – Ironbark Woodland Central Hunter Bulloak Regeneration Central Hunter Spotted Gum – Ironbark – Grey Box Forest Central Hunter Swamp Oak Forest Hunter Valley River Oak Forest Warkworth Sands Woodland	23.5	No	Yes	Yes	Yes	Yes
Goodenia macbarronii	Central Hunter Box – Ironbark Woodland Central Hunter Bulloak Regeneration	13.3	No	No	Yes	Yes	No
Pterostylis gibbosa	Central Hunter Box - Ironbark Woodland Central Hunter Ironbark - Spotted Gum - Grey Box Forest Warkworth Sands Woodland	20.2	No	No	Yes	Yes	Yes

5.3 Potential Impacts on Fauna Habitats

Fauna habitats within the study area have been previously disturbed by agriculture, mining and infrastructure and are subject to ongoing disturbances. The main impacts of the proposal on the fauna habitats within the study area are the removal, modification and/or fragmentation of potential habitat. The proposal will involve clearing approximately 31 hectares of Woodland habitat (Central Hunter Ironbark Woodland and Warkworth Sands Woodland). In addition there may also be an increase in sedimentation and erosion where the proposal is trenched across drainage lines or creeklines.

The proposal may result in the increase in habitat fragmentation; however, fauna habitats within the study area are currently fragmented due to existing fire roads, fence, optic cable installation and powerlines. Furthermore, impacts on the Woodland habitat are likely to be temporary as the site will be rehabilitated post works, with the exception of possible maintenance works.

It should also be noted that although there will be disturbance to Woodland habitat, the proposal will avoid trees with hollows where possible, thus the impact of the proposal on species reliant on these habitat features will be low. Also the amount of habitat to be removed has been based on vegetation mapping, hence is conservative and does not allow for disturbed areas such as existing tracks within the Woodland habitat.

5.4 Potential Impacts on Threatened Fauna

Where there is potential habitat (foraging or breeding resources) for threatened species in the study area, further consideration must be given to the potential impact of the proposal on these species.

The proposal may impact threatened species in the following ways:

- causing death or injury of individuals
- causing loss or disturbance of limiting foraging resources; and/or
- causing loss or disturbance of limiting breeding resources

Limiting resources are specialised habitat components that species are dependent on for their ongoing survival. Such limiting resources are predominantly associated with specialised breeding habitats (such as tree hollows or suitable nest/maternity roost sites) that occur at low densities, with high levels of competition from a range of species. However, for some species, limiting

resources include specialised foraging habitats that have a restricted distribution (such as Koalas feeding only on specific tree species).

Actual or potential habitat exists within the study area for a total of 35 threatened animals species listed on the TSC Act and/or EPBC Act as identified in Table 2. The potential impacts of the proposal on each of these threatened animal species are assessed in Appendices 3 and 4.

Amphibians

Potential habitat for one threatened frog species, the Green and Golden Bell Frog, occurs along creeklines and dams within the study area. The Green and Golden Bell Frog population in the Upper Hunter is known to occur in the Ravensworth / Liddell / Bayswater area and, despite its apparent transient nature and seemingly small population size, is considered highly significant due to its inland location. This population has been most recently detected around Liddell and Bayswater Power Stations (Department of Environment and Conservation 2005).

The Green and Golden Bell Frog was not recorded within the study area during the current surveys. The weather conditions during the survey period were not ideal for detecting this species. If this species does occur within the study area it is likely to be highly significant due to its inland location (Department of Environment and Conservation 2005)

Although the proposal is unlikely to traverse any of the dams in the study area, it will pass through a number of creeklines. In particular Bayswater Creek and the drainage lines west of Wallaby Scrub Road provide limited potential habitat for the Green and Golden Bell Frog. The proposed works are likely to remove or modify potential breeding and foraging resources for this species, as such, an impact assessment has been prepared for the Green and Golden Bell Frog (Appendices 3 and 4).

If this species is present it is likely that the proposal will have a significant impact on habitat for the Green and Golden Bell Frog. If trenching is likely to be undertaken in areas of potential habitat it is recommended that targeted surveys be undertaken to determine if the species is present.

The Green and Golden Bell Frog were not recorded within the study area during the current surveys. The weather conditions during the survey period were not ideal for detecting this species. If this species does occur within the study area it is likely to be highly significant due to its inland location (Department of Environment and Conservation 2005).

The proposal is likely to trench through the creek/ drainage lines resulting in the loss of potential foraging habitat for this species. If the Green and Golden Bell Frog occur within the study area, it may be substantially impacted by the proposal. Therefore it is recommended that targeted surveys be undertaken for this species during the appropriate season.

Birds

Two threatened or migratory birds, Grey-crowned Babbler and Brown Falcon were recorded during the current survey. Potential habitat for a further 19 threatened bird species (Table 2) occurs within the waterbodies (including water logged areas), cleared/disturbed and woodland habitat types in the study area. Of these 21 bird species, the proposal is likely to result in the loss or disturbance of limiting foraging or breeding resources of 12 woodland bird species (Table 5). As such impact assessments have been prepared for these species (Appendices 3 and 4).

Although the proposal is likely to traverse habitats for the remaining nine birds, it is unlikely to result in the death and/or loss of limiting resources for these species, given they are highly mobile and potential habitat is widely distributed within the study area. As such, impact assessments are not required for these species.

The results of the impact assessments and Significant Impact Criteria found that the proposal is unlikely to result in a substantial impact on these species given the small area to be impacted, extent of the potential habitat in the study area and the fact that the disturbed areas are to be regenerated post works. .A Referral is not required for those birds species (Swift parrot, Regent honeyeater and/or Rainbow Bee-eater) listed on the EPBC ACT.

It is likely that fauna habitat values for these species within the study area could be maintained assuming that the recommendations listed in Section 6.0 are adhered to and possibly improved during rehabilitation works (i.e. planting foraging trees

Table 5: Potential impact and impact assessment requirements for threatened bird species recorded within the local area and with potential habitat in the study area

Threatened Species	Potential impacts			Impact assessment required
	Individual death or injury	Loss or disturbance of limiting foraging resources	Loss or disturbance of limiting breeding resources	
Brown Falcon	No	No	No	No
Swift Parrot	No	Yes	No	Yes
Regent Honeyeater	No	Yes	Yes	Yes
Black-chinned Honeyeater	No	Yes	Yes	Yes
Brown Treecreeper	No	Yes	Yes	Yes
Speckled Warbler	No	Yes	Yes	Yes
Hooded Robin	No	Yes	Yes	Yes
Grey-crowned Babbler	No	Yes	Yes	Yes
Diamond Firetail	No	Yes	Yes	Yes
Rainbow Bee-eater	No	Yes	Yes	Yes
Painted Honeyeater	No	Yes	Yes	Yes
Powerful Owl	No	No	No	No
Barking Owl	No	No	No	No
Masked Owl	No	No	No	No
Gang-gang Cockatoo	No	Yes	No	Yes
Glossy Black-cockatoo	No	Yes	No	Yes
White-throated Needletail	No	No	No	No
Cattle Egret	No	No	No	No
Latham's Snipe	No	No	No	No
Painted Snipe	No	No	No	No
Australian Painted Snipe	No	No	No	No

Mammals

The study area is likely to provide potential habitat for 13 threatened mammals within the study area (Table 2). The proposed clearing of approximately 30.3 hectares this potential Woodland habitat may reduce the availability of nesting and foraging resources for species such as micro-bats and arboreal mammals. However it is unlikely that the proposal would have a substantial impact on the habitat of cave dwelling bats, as the proposal is unlikely to traverse or impact roosting or maternity sites. Given the high mobility of these species, it is also unlikely that the modification or removal of 0.4 percent (approximately 7,045

hectares of woodland habitat within the locality) of the available foraging habitat for these species will have a substantial impact.

The loss of tree hollows may result in the loss of breeding habitat and shelter for tree-hollow dependant bats and Squirrel Gliders. As such impact assessments have been prepared for these species (Appendices 3 and 4).

The results of the impact assessments found that the proposal is unlikely to result in a substantial impact on these species given the small area to be impacted, extent of the potential habitat in the study area and the fact that the disturbed areas are to be regenerated post works. A Referral is not required for Grey-headed Flying-fox listed as Vulnerable on the EPBC ACT.

It is likely that fauna habitat values for these species within the study area could be maintained assuming that the recommendations listed in Section 6.0 are adhered to and possibly improved during rehabilitation works (i.e. planting foraging trees).

Reptiles

Three reptile species were identified as likely to occur within the locality, the Broad-headed Snake, the Pink-tailed Worm Lizard and the Pale-headed Snake. The Broad-headed Snake and Pink-tailed Worm Lizard require finer scale habitat features such as rocky outcrops, exfoliating rock and rock crevices for shelter. These habitat features are not present within the study area, hence the study area is unlikely to provide potential habitat for these species. As such, impact assessments have not been prepared for these species. The Pale-headed Snake has been identified as having potential habitat within the study area, although this species has not been previously recorded within the locality. Habitat for this species is restricted to the Woodland habitat and in regrowth areas along creeks and near dams. The proposal is likely to clear or modify this potential habitat. Impact assessments have therefore been prepared for the Pale-headed Snake (Appendices 3 and 4).

Based on the impact assessment it is unlikely the proposal would have a significant impact on the Pale-headed Snake given the small impact area given the small area to be impacted, extent of the potential habitat in the study area and the fact that the disturbed areas are to be regenerated post works. Furthermore, with suitable mitigation measure such as such as retaining shelter features, constructing fauna egress points along the open trench and sedimentation controls near watercourses are likely to reduce the impacts on potential Pale-headed Snakes.

5.5 Key Thresholds

The Part 3A Guidelines of the EP&A Act (DEC & DPI 2005) set out a number of key thresholds which need to be addressed to justify the impacts of the proposal on threatened species, populations or ecological communities. The key thresholds are (DEC & DPI 2005):

- whether or not the proposal, including actions to avoid or mitigate impacts or compensate to prevent unavoidable impacts will maintain or improve biodiversity values.
- whether or not the proposal is likely to reduce the long-term viability of a local population of the species, population or ecological community.
- whether or not the proposal is likely to accelerate the extinction of the species, population or ecological community or place it at risk of extinction.
- whether or not the proposal will adversely affect critical habitat.

Based on the impact assessments following the Part 3A Guidelines of the EP&A Act for Threatened Species Assessment (Appendix 3), the proposal is unlikely to reduce the long-term viability of, accelerate the extinction of and/or adversely affect critical habitat for threatened species and/or populations within the study area (Table 6). It should be noted that targeted surveys are required for some threatened species and populations (as shown in Table 6) to further clarify impacts of the proposal and ensure any occurrences of significant species are avoided.

Given the impacts of the proposal on the EEC Warkworth Sands Woodland it is unlikely that the proposal would maintain or improve biodiversity values. Impacts of the proposal may reduce the long-term viability of the ecological community and potentially accelerate the extinction of the ecological community. The impacted area is not identified as critical habitat, but it likely to be vital to the long-term survival of the community across its range. The impacts of the proposal on the EEC Warkworth Sands Woodland are discussed in more detail in Section 5.1.1. The current proposal can not be justified based on the impacts to Warkworth Sands Woodland. It is therefore recommended that the proposed route be altered to avoid any impacts on this Endangered Ecological Community

Table 6: Assessment of Key Thresholds

Threatened Biota	Will the proposal reduce the long-term viability of a local population of the species, population or EEC's?	Will the proposal accelerate the extinction of the species, population or EEC's or place it at risk of extinction.	Will the proposal adversely affect critical habitat.
Acacia pendula[2]	Unlikely*	Unlikely*	No
Cymbidium canaliculatum[2]	Unlikely*	Unlikely*	No
Diuris tricolor[1]	Unlikely*	Unlikely*	No
Eucalyptus camaldulensis[2]	Unlikely*	Unlikely*	No
Eucalyptus glaucina[2]	Unlikely*	Unlikely*	No
Goodenia macbarronii[1]	Unlikely*	Unlikely*	No
Pterostylis gibbosa[1]	Unlikely*	Unlikely*	No
Warkworth Sands Woodland	Yes	Yes	No
Woodland Birds	No	No	No
Hollow -dependant Bats	No	No	No
Green and Golden Bell Frog [1]	Unlikely*	Unlikely*	No
Swift Parrot	No	No	No
Regent Honeyeater	No	No	No
Painted Honeyeater	No	No	No
Black-chinned Honeyeater	No	No	No
Glossy Black-cockatoo	No	No	No
Gang-Gang Cockatoo	No	No	No
Grey-headed Flying-fox	No	No	No
Pale-headed Snake	No	No	No
Rainbow Bee-eater	No	No	No

[1] Additional targeted surveys are required for these species in an appropriate season

[2] Additional targeted surveys are required for these species as some areas of potential habitat were not surveyed due to access restrictions

* Further targeted surveys are required to determine whether any individuals are directly impacted by the proposal before a definitive assessment can be completed.

6.0 PROPOSED MITIGATION MEASURES

Erosion and Sedimentation Controls

Best practice sediment and erosion controls for the construction industry (Landcom 2004) should be implemented during the installation of the proposal and until disturbed areas have regenerated. Appropriate sediment and erosion control practices include the following;

- Suitably maintained erosion and sedimentation controls such as siltation fencing should be installed during construction and rehabilitation as part of an erosion and sedimentation control plan. Particular emphasis should be given to the areas around Warkworth Sands Woodland
- Minimising unnecessary disturbance to native vegetation and the soil profile
- Revegetating bare areas as soon as possible to stabilise areas
- Implementing appropriate site management practices – including scheduling of construction, sequencing of erosion control measures and restriction of access to non-essential areas
- Constructing diversion banks and channels to intercept and divert run-on water away from disturbed ground
- Implementing appropriate physical stabilisation techniques including terracing, silt fencing and geotextiles
- Regular inspection of drainage and sediment controls following construction and after heavy rainfall events, and repairing or up-grading where necessary

A best practice (Landcom 2004) self-auditing program for site stabilisation and erosion controls should be implemented for the site. The timing of site inspections should be conducted on a weekly basis during construction and at opportunistic times such as during and immediately following rainfall events that cause run-off. The self audit program will record the following;

- Condition of any stockpiles and trenched areas (including records of any slumping)
- Condition of sediment and erosion control structures
- Whether sediment or other pollutants are leaving the site or have the potential to do so

- Maintenance requirements, and
- Locations of sediment deposition.

Following completion of each audit, records should be provided to the site manager for further planning and implementation of appropriate sediment and erosion controls.

Threatened Biota

In order to eliminate or minimise potential impacts upon threatened species, populations and ecological communities, the following general measures are recommended for implementation during the installation and ongoing maintenance of the proposal:

- Utilise pre-existing tracks, and access points wherever possible to avoid disturbance to existing native vegetation
- Where clearing of native vegetation is required the top 100 millimetres of topsoil containing the soil stored seed bank should be stripped and stockpiled separately (not mixed with the subsoil layers during trenching). This topsoil should then be replaced over the surface upon completion of the works
- Where possible, all hollow bearing trees should be avoided. In those areas where vegetation clearing is necessary, a two staged process should be undertaken. Hollow bearing trees should be marked in stage 1 as the surrounding trees are cleared. These hollow bearing trees should then be left for 24 – 48 hours before clearing to allow fauna to escape these areas
- Where hollow limbs are removed they should be retained and relocated within the vicinity to provide fauna habitat
- The length of installation trench open at any one time should be minimised and fauna egress points should be provided every 50 metres of open trench to allow any animals which fall into the trench to escape. Any trapped animals should be removed prior to back filling of the trench
- Any native shrubs, logs, scattered timber or bush-rock that are removed should be stockpiled on the side of the proposal and access routes and raked back over the site following completion of the survey works
- Within riparian areas, care should be taken to avoid disturbance to the creekline (eg. by directional boring)

- Trenching through creek and drainage lines should be undertaken during dry periods to avoid increase in erosion and sedimentation

- Machinery footprint, turning circle access work should be kept to a minimum. Where possible large vehicles should reverse off each work site, to avoid the requirement of additional vehicular access clearing

- The final proposed route for the pipeline is yet to be accurately mapped. Threatened plant species that are likely to occur along the finalised route should be flagged by a suitably qualified botanist and, where possible avoided during construction

- Machinery and equipment that is brought in from another site, or from outside of the immediate area, is to be cleaned before entering bushland areas. This is in order to prevent the spread of weed seed and soil pathogens between sites. Following best practise procedures for the minimisation of transfer of fungal pathogens and plant propagules

- Weed control and bush regeneration strategies should be implemented within the study area

- Management strategies to prevent the spread of Chytrid fungus *Batrachochytrium dendrobatidis*, as well as *Phytophthora cinnamomi* should be implemented this should be in accordance with the DECC hygiene protocol for the control of disease in frogs

- Vegetation that is cleared or trimmed should be either a) mulched and spread on-site, if it is native and no significant weeds are present or b) if the vegetation is weedy, removed off-site

- Limit damage to the tree canopy, to minimise any potential increase in size of gaps in the tree canopy

- Following excavation of trenches and laying of pipes, the surface profile of the soil should be restored to pre-construction levels, to ensure the natural surface hydrology is not disturbed. This is especially the case within areas of habitat for *Eucalyptus camaldulensis,* that is, within Wambo Colliery land (section 17 in Figure 2)

- The alignment of the proposal should be altered to avoid the Warkworth Sands Woodland remnant located between Wallaby Scrub Road and Wollombi Brook (sections 11, 12, and 15 in Figure 2)

- Maintain a no impact zone around *Eucalyptus camaldulensis* trees of a size of two times the radius of the tree canopy

- Qualified ecologist should survey the vegetated sections of the route for the threatened plant species or endangered populations listed below, once the exact placement of the route has been finalised. Specific attention should be give to areas not surveyed preciously due to access restrictions and surveys should be undertaken for cryptic species during their flowering seasons:
    - *Acacia pendula*
    - *Cymbidium canaliculatum*
    - *Diuris tricolor*
    - *Eucalyptus camaldulensis*
    - *Eucalyptus glaucina*
    - *Goodenia macbarronnii*
    - *Pterostylis gibbosa*
- Qualified ecologist should survey creek and drainage lines that are likely to be traversed by the proposal for Green and Golden Bell Frog (*Litoria aurea*)

Implementation of the above measures should reduce the potential impact of the proposal on threatened species, populations, ecological communities and their habitats.

7.0 CONCLUSION

Much of the study area passes through grazing and reclaimed mining land containing no native vegetation and areas revegetated following mining. However, parts of the study area also pass through remnant native vegetation in Good to Moderate condition, having been relatively undisturbed or recovering well following historical clearing and grazing. Many of the vegetation remnants are partially fragmented by tracks, roads or easements of various types.

The proposal is likely to involve the clearing of approximately 25.6 hectares of native vegetation, including 6.3 hectares of Warkworth Sands Woodland, which is listed as an Endangered Ecological Community under the TSC Act. The proposal is likely to impact upon the largest and most intact remaining remnant of this EEC. As such, it is considered that the proposal is likely to have a high impact on this EEC, and it is recommended that the proposal is altered to avoid impacting upon this remnant of Warkworth Sands Woodland.

Eucalyptus camaldulensis belonging to the endangered River Red Gum population in the Hunter Catchment were recorded in the study area. No threatened plant species were recorded during the current surveys. Previous records of the Weeping Myall endangered population in the Hunter Catchment and the threatened species, *Eucalyptus glaucina*, occur in the study area. Further potential habitat occurs in the study area for three threatened plant species (*Diuris tricolor, Goodenia macbarronnii* and *Pterostylis gibbosa*) and the Pine Donkey Orchid (*Diuris tricolor*) endangered population in the Muswellbrook local government area.

Impact assessments following the Guidelines for Threatened Species Assessment under Part 3A of the EP&A Act and/or the Significant Impact Criteria Guidelines under the EPBC Act were undertaken for these threatened plant species and populations. It was found that the proposal will have a moderate to low impact on threatened plant species and populations provided the recommendations in Section 6.0 are adhered to. Further, it was found that the proposal is not likely to result in a significant impact on threatened plant species listed on the EPBC Act provided the recommendations in Section 6.0 are adhered to.

The study area provides potential habitat for 33 threatened and/or migratory species listed on the TSC and/or EPBC Act. The proposal is likely to modify and/or remove approximately 31 hectares of potential habitat for 21 of these species. Based on the impact assessments, given the extent of potential habitat for those species within the locality it is unlikely that the proposal would have a substantial impact on these species. It is likely that fauna habitat values for these species within the study area could be maintained assuming that the recommendations listed in Section 6.0 are adhered too and possibly improved during rehabilitation works (i.e. planting foraging trees).

In addition, it is likely that creeklines that provide potential habitat for the Green and Golden Bell Frog may be impacted by the proposal. This species was not detected during the current surveys. If this species does occur within the study area, it is likely that the proposal would have a significant impact on the Green and Golden Bell Frog habitat. It is therefore recommended that targeted surveys for the Green and Golden Bell Frog should be undertaken prior to the proposed works.

A number of amelioration measures are recommended in Section 6.0 to reduce the potential impacts of the proposal on flora and fauna of the local area.

With the implementation of these mitigation measures the proposal is unlikely to have a long-term impact on threatened species and/or populations within the study area. However, the proposal is likely to have a long-term impact on the EEC Warkworth Sands Woodland. It is recommended that the proposed route be altered to avoid impacting upon the Warkworth Sands Woodland remnant located between Wallaby Scrub Road and Wollombi Brook.