

Austar Coal Mine Pty Ltd

Austar Stage 2 Subsidence Management Plan – Environmental Attributes, Impacts and Controls

February 2007



Austar Stage 2 Subsidence Management Plan – Environmental Attributes, Impacts and Controls

Prepared by

Umwelt (Australia) Pty Limited

on behalf of

Austar Coal Mine Pty Ltd

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1	Ecological Assessment
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1.0 Introduction and Background

Austar Coal Mine is an aggregate of the former Ellalong, Pelton, Cessnock No.1 (Kalingo) and Bellbird South Collieries near Cessnock (see **Figure 1**). The mine is to be developed in three stages with Stage 1 comprising two longwall panels (A1 and A2), Stage 2 comprising three longwall panels (A3, A4 and A5) and Stage 3 for which mine planning is still being undertaken.

This report provides an assessment of environmental aspects of longwall mining in Stage 2 and forms part of the Subsidence Management Plan prepared by Austar Coal Mine. The report has been prepared in accordance with the requirements for the preparation of Subsidence Management Plans (SMP) (Department of Mineral Resources, December 2003).

This document addresses the environmental issues that are to be addressed in accordance with the Department of Primary Industries (Minerals) guidelines for the preparation of SMPs. Other SMP requirements are addressed by Austar Coal Mine and other specialists.

This document includes:

- a description of natural features;
- a description of environmentally sensitive areas;
- a description of the known and potential cultural heritage sites; and
- a description of the likely impact of subsidence on the natural features, environmentally sensitive areas and cultural heritage.

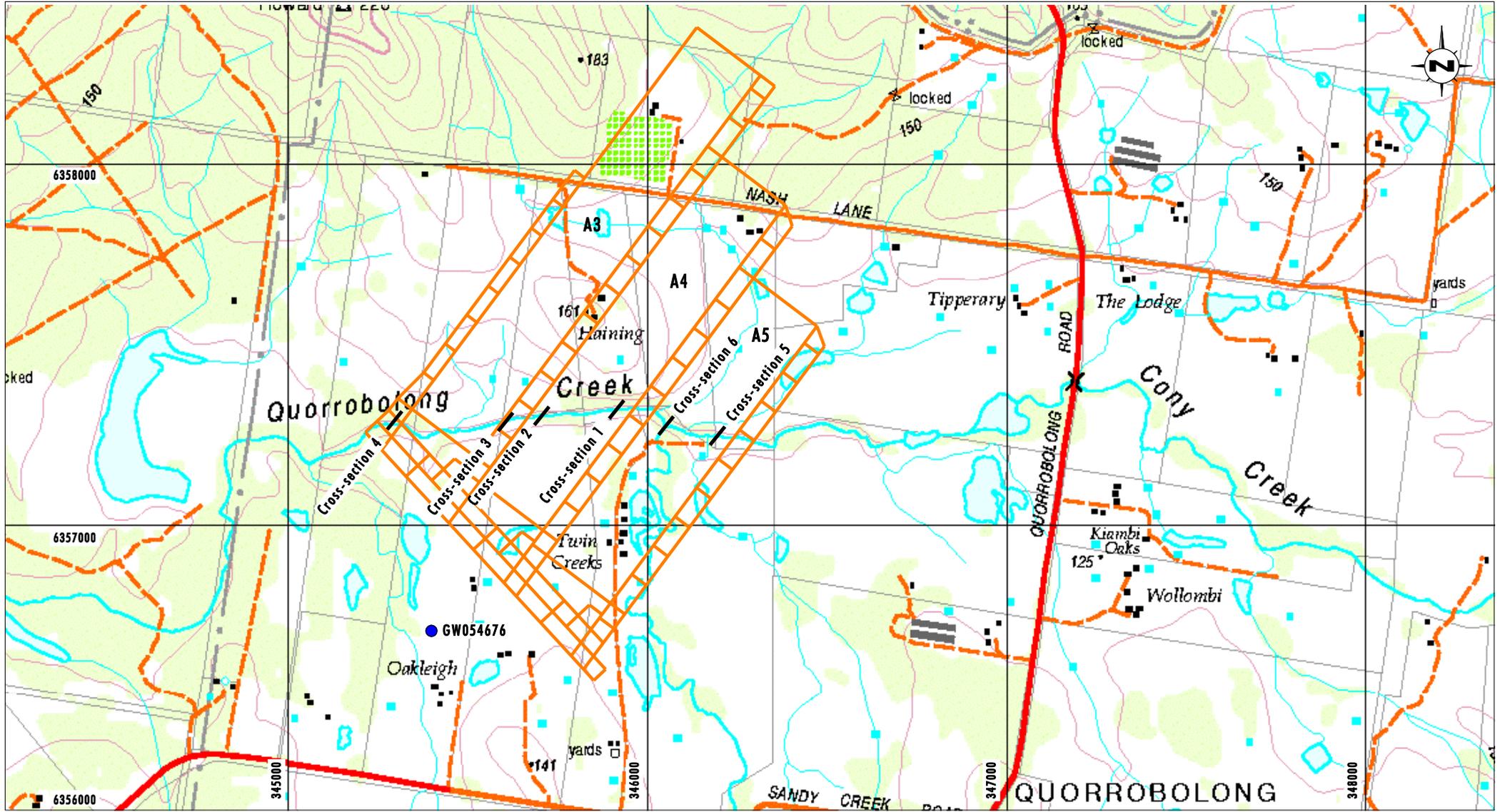
2.0 Characterisation of Surface and Sub-surface Features

2.1 Natural Features

2.1.1 Surface Water Resources and the Catchment Area

The Stage 2 study area is located immediately to the south of Broken Back Range (see **Figure 1**). The area encompasses the gentle south facing lower slopes of the Broken Back Range and the extensive creek flat of the Quorrobolong Creek system. The highest elevation in the study area is 161 metres above sea level and forms part of a northwest-southeast oriented spur that extends from the crest of Broken Back Range to a knoll that is located adjacent to the northern bank of Quorrobolong Creek. The creek flat that encircles this knoll typically has an elevation of approximately 125 mAHD. Slopes in the area of the floodplain range between 1% and 5% with the southern face of the knoll exhibiting near vertical sections.

The major drainage line through the area is Quorrobolong Creek which is a fourth order stream. Quorrobolong Creek enters the study area in the south western corner of Longwall A5. At this location the creek has a bed elevation of approximately 125 mAHD. From this point the creek flows in a northerly direction for approximately 550 metres to its confluence with Cony Creek which is approximately at the western edge of Longwall A5. At this location the creek system has a bed elevation of approximately 120 mAHD. Quorrobolong Creek



Base Source: LPI NSW 1:25 000 Topographic Maps
Source: Austar Coal Mine

0 250 500 750m
1:15 000

- Legend**
- Stage 2 Longwall Panels
 - Cross Section Location
 - Groundwater Bore

FIGURE 1

**Quorrobolong Creek, Cony Creek
and Other Natural Features**

above Longwall A5 is characterised by an incised channel that is typically 2 to 5 metres wide at the base and 8 to 10 metres wide at top of bank. The creek banks have steep sides which are typically 2 to 3 metres high and stable. The creek above Longwall A5 is bounded on either side by a thin strip of riparian vegetation. A series of off-stream farm dams are located on the western side of the creek.

Upstream of the confluence Cony Creek exhibits a broad channel that has a base width of approximately 6 to 10 metres and a top of bank width of approximately 30 to 40 metres and bank heights of 2 to 3 metres. At the eastern edge of Longwall A5, Cony Creek has a bed elevation of approximately 120.5 mAHD. Upstream of the confluence Cony Creek is lined by riparian vegetation that varies in width from one row of trees to approximately 50 metres.

Immediately downstream of the confluence, the channel narrows to be approximately 20 metres wide at top of bank. The northern bank of the creek is confined by a steep rock outcrop that is located on the southern face of a knoll. The top of the knoll has an elevation of approximately 160 mAHD which is 40 metres above the bed of the creek. This section of the creek is a natural constriction that acts as a control to flows in the Quorrobolong and Cony Creek systems upstream of the knoll. Quorrobolong Creek from the confluence flows due west and maintains a similar channel profile to the western edge of Longwall A3 which is approximately 900 metres downstream of the confluence. This section of the creek exhibits a sandy substrate and scattered and discontinuous riparian vegetation. At the western edge of Longwall A3 Cony Creek has a bed elevation of approximately 118.5 mAHD.

Quorrobolong Creek flows into Ellalong Lagoon approximately 5 to 6 kilometres to the west of the study area. The catchment area upstream of Ellalong Lagoon (including Quorrobolong and Cony Creeks) is approximately 87 km² and mainly comprises state forest and cleared agricultural land (HLA 1995:4.10).

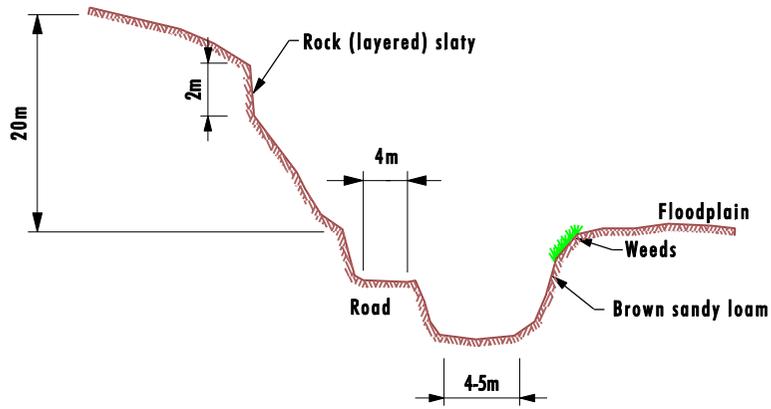
The headwaters of Cony Creek are located in the steep upper slopes of the Broken Back Range to the north east of the study area. Cony Creek at its downstream end is a fourth order stream. Quorrobolong and Cony Creek are joined from the north and the south by a number of smaller order drainage lines that originate from the southern slopes of Broken Back Range and the northern slopes of the Myall Range. Many sections of these creeks have been dammed both within the study area and higher in the catchment.

Cross-sections of the creek system from east to west are shown on **Figures 2 and 3** and in **Plates 1 to 6**. The creek has an extensive floodplain associated with it except where it is constricted by the steep southern face of the knoll. The banks of the creek are characterised by brown loamy sand underlain by brown sandy clay. The channel material consists of sand. Numerous pools occur along the length of the creek and no bedrock was noted in the banks or channel.

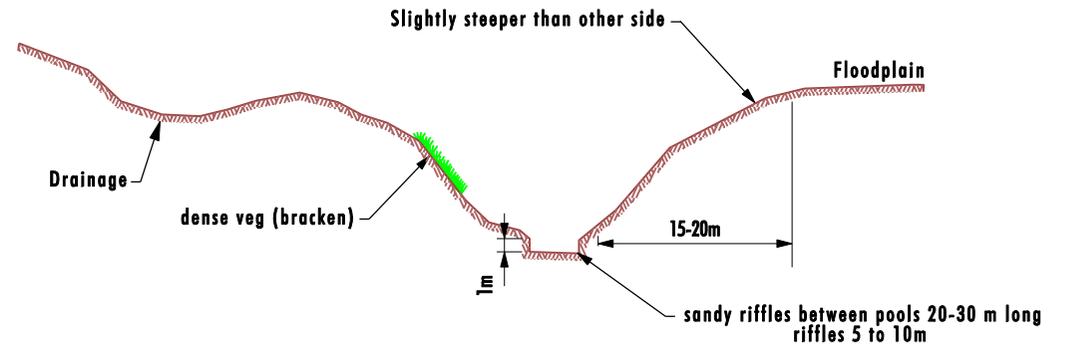
The banks of Quorrobolong Creek appear stable above all of the proposed longwalls. They are well vegetated and did not display any signs of undercutting or erosion. The riparian zone has also been substantially affected by wombat holes and rabbit warrens. This has resulted in tunnelling, large holes and a hummocky appearance along much of the area.

Cony Creek is characterised by a relatively straight channel located within an extensive floodplain. Small pools occur along the length of the channel to the east of Longwall A5. Small islands in the centre of the channel are also common. Mature casuarinas (approximately 50 years old) stabilise both the banks and the islands within the channel. The composition of the bed and banks is similar to that of Quorrobolong Creek.

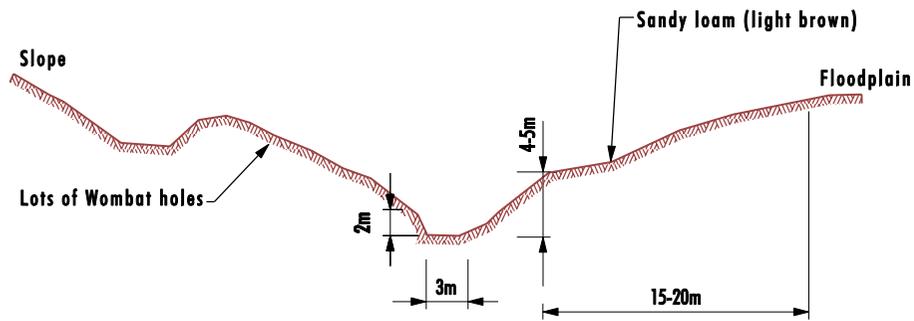
A number of small tributaries join both Quorrobolong and Cony Creek within the Stage 2 study area. An unnamed creek which flows around the spur to join Quorrobolong Creek from



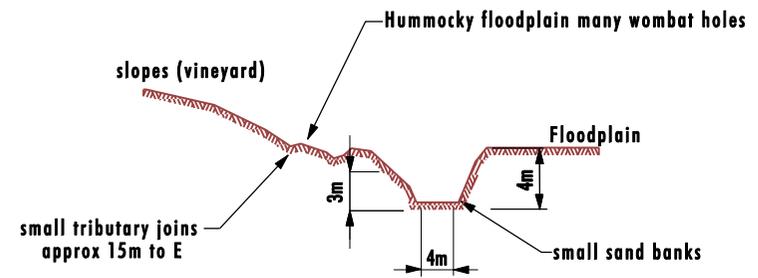
CROSS-SECTION 1



CROSS-SECTION 2



CROSS-SECTION 3



CROSS-SECTION 4

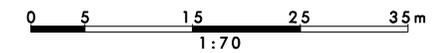
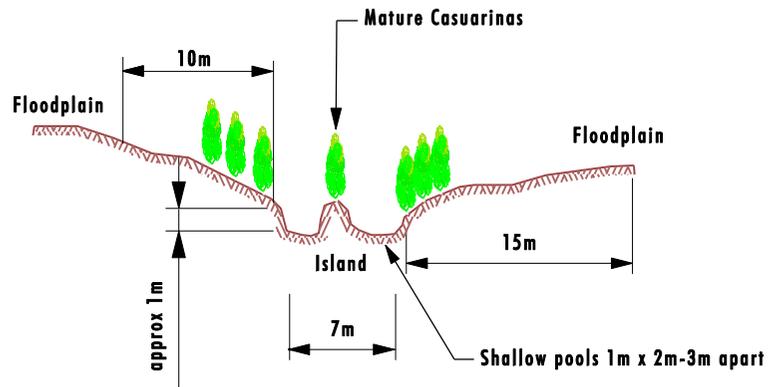
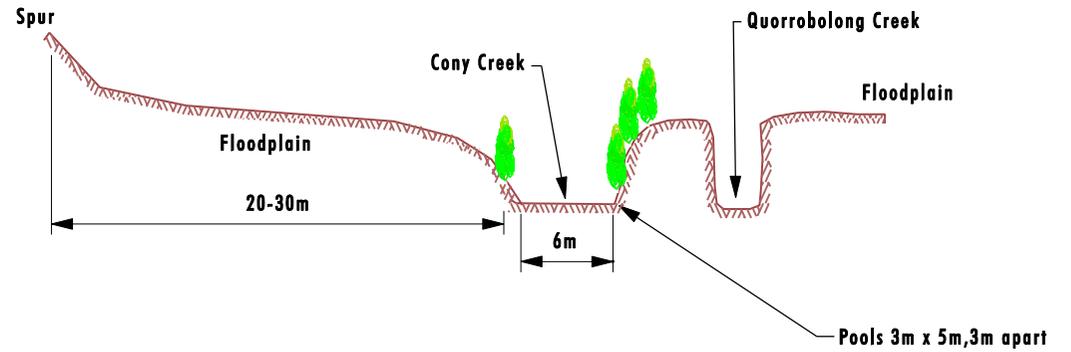


FIGURE 2
Quorrobolong Creek Cross Sections



CROSS-SECTION 5



CROSS-SECTION 6

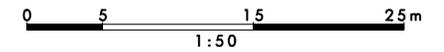


FIGURE 3
Cony Creek Cross Sections



PLATE 1
Quorrobolong Creek (Cross - Section 1)



PLATE 2
Quorrobolong Creek (Cross - Section 2)



PLATE 3
Quorrobolong Creek (Cross - Section 3)



PLATE 4
Quorrobolong Creek (Cross - Section 4)



PLATE 5
Cony Creek (Cross - Section 5)



PLATE 6
Cony Creek (Cross - Section 6)

the north does not have a defined channel, nor does the creek which flows into Quorrobolong Creek at the western boundary of Stage 2 (except at its lower end). The small tributary that joins Quorrobolong Creek from the north has vertical banks and is less than one metre deep and less than one metre wide. The composition of its banks and bed is similar to that of the main channel.

The southern and eastern portions of the study area are characterised by alluvial flats approximately 500 metres wide. These have been cleared for cattle grazing and vineyards and contain a number of dams. A few small tributaries cross the floodplain and join both Quorrobolong and Cony Creeks. No major floodplain features were noted, although a number of small chutes and billabongs are associated with Quorrobolong Creek near the western boundary of Stage 2.

The north westerly portion of the study area is characterised by the gentle to moderate slopes of a spur which extends from the Broken Back Range. This area has also been cleared for grazing and vineyards. Minor sheet erosion was noted on the lower slopes of the spur in the central section of Stage 2 (see **Plate 7**). Additionally, sections of the lower slope have collapsed and eroded as a result of extensive rabbit warrens.

Cessnock City Council (2004) concluded that the Congewai Creek catchment (of which Quorrobolong Creek and Cony Creek are a part) was relatively healthy when compared to other more developed catchments. The Department of Infrastructure, Planning and Natural Resources (DIPNR) groundwater vulnerability map (cited in Cessnock City Council 2004) ranked the Congewai Creek catchment as having a moderate to moderately high vulnerability rating. This was based on the fact that the majority of dwellings within the catchment rely on on-site waste disposal.

Cessnock City Council (2004) also noted that Quorrobolong Creek is affected by runoff with high nutrient and sediment concentrations as a result intensive agricultural land uses and stock watering along the creek bank. It has also been classified as being moderately saline (ANZECC 1992 in Cessnock City Council 2004) and unsuitable for potable supply.

It is understood that there are two licensed surface water extraction points on Cony Creek upstream of Longwall A5. It is understood that these licences are for the extraction of water for domestic and stock purposes during periods of high flow in Cony Creek.

2.1.2 Groundwater Resources

Potential groundwater resources in the area are the shallow alluvial aquifers associated with Cony and Quorrobolong Creek and the deeper fractured rock aquifer that is associated predominantly with the underlying coal measures.

There are four registered groundwater extraction bores in the general area (see **Figure 1**) but none located within the Stage 2 area. There are three low yielding (<1 L/sec), high salinity bores that are into the underlying coal measures and one shallow alluvial bore (GW054676) which is located to the west of Longwall A3 (GeoTerra 2006:7). The alluvial bore is approximately 13 metres deep, is low yielding (~1 L/s) and has high electrical conductivity (14,000 µS/cm to 16,000 µS/cm). It is understood that this bore is only used to provide baseline monitoring information for DNR.

The coal measures aquifers contain saline water which is unsuitable for domestic or agricultural purposes.



PLATE 7
Rabbit warrens on lower slopes of spur within Stage 2



PLATE 8
Bedrock escarpment within Stage 2

2.1.3 Swamps, Wetlands and Water Related Ecosystems

No swamps or wetlands occur within the study area, however several man-made farm dams are scattered throughout. These dams typically support little vegetation, and their habitat values would be consequently limited. Riparian habitats are present within both Cony and Quorrobolong Creeks which traverse the study area.

2.1.4 Escarpments and Rock Formations

A bedrock escarpment forms the southern edge of the bedrock spur within Stage 2 (see **Plate 8**). This escarpment also borders a section of Quorrobolong Creek. It is approximately 20-25 metres high and is characterised by thinly bedded mudstone and siltstone outcrop along its upper section. Differential weathering results in small overhangs which eventually fall onto the steep slope below the outcrop. Dense vegetation including blackberry and maidenhair fern covers the steep mid and lower sections of the slope.

2.1.5 Soils

The majority of Stage 2 is located within the Quorrobolong Soil Landscape, while the northern slopes are located within the Aberdare Soil Landscape.

The yellow podzolic soils of the Quorrobolong soil landscape occur adjacent to Quorrobolong and Cony Creeks. The A horizon consists of dark brown loamy sand, overlying a bleached yellow/orange A₂ horizon. The B horizon is characterised by brown sandy clay (HLA 1995:4.6 and Kovac & Lawrie 1991:316).

These soils display a number of features that indicate that they are dispersible:

- soil morphological properties that include:
 - an abrupt A/B texture boundary;
 - a bleached A₂ horizon;
- very high strength when dry; and
- very low permeability, leading to a 'porridge' appearance of the B horizon on vertical exposed cuttings (Charman & Murphy 1991).

The coarse sandy nature of the upper soil horizons can result in accelerated erosion if disturbed (EPPS and Associates 1988). The texture contrast between the A and B horizons and the low permeability of the B horizon clay, mean that the soil is highly susceptible to sheet and gully erosion. This susceptibility is illustrated on the lower slopes of the spur within the Stage 2 area where the surface has collapsed and eroded as a result of an extensive network of rabbit warrens. Additionally, many dams that have been built in the area have failed as a result of the dispersible subsoil clays (Trevor Duckworth, local landholder, pers. comm. September 2006).

The low spur and slopes in the northern part of Stage 2 fall within the Aberdare soil landscape (Kovac & Lawrie 1991:58-59). This brown podzolic soil is characterised by poorly structured dark brown loamy sand to clayey sand A horizons overlying a dark brown light clay B horizon (HLA 1995:4.6). The topsoil and subsoil of brown podzolic soils is highly erodible.

2.1.6 Flora

The vegetation within Stage 2 mainly comprises cleared land supporting Derived Grassland vegetation. The riparian and floodplain areas support Riparian Swamp Oak – Rough Barked Apple Open Forest, while small remnants of Spotted Gum – Ironbark Forest occur on ridgelines in the far north of the study area.

Regional vegetation mapping identifies the vegetation of Cony and Quorrobolong Creeks as *Central Hunter Riparian Forest*. The *Riparian Swamp Oak – Rough Barked Apple Open Forest* recorded within Stage 2 conforms to this community. Similarly, the *Spotted Gum – Ironbark Forest* recorded within Stage 2 conforms to the *Lower Hunter Spotted Gum – Ironbark Forest* as described for the Lower Hunter and Central Coast Regional Environmental Management Strategy (LHCCREMS) project.

On consideration of the structural and floristic composition of the *Riparian Swamp Oak – Rough-barked Apple Open Forest* and the geomorphology of the subject site, this community has the potential to conform to the Ecologically Endangered Community (EEC) *River-flat Eucalypt Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner Bioregions* (NSW Scientific Committee 2005). The *Spotted Gum – Ironbark Forest* was found to be consistent with the *Lower Hunter Spotted Gum – Ironbark Forest* EEC.

2.1.7 Fauna

A list of the 61 fauna species recorded opportunistically during the survey of Stage 2 is contained in **Appendix 1**. The list consists of 52 bird species, one reptile species, two amphibians, and six mammals. The area provides a range of foraging, roosting and nesting habitat for a variety of native fauna. The two broad habitat types were found to be Riparian habitats and Open Forest habitats. These are described in detail in **Appendix 1**.

2.1.8 Threatened Species

2.1.8.1 Flora

No threatened flora species were recorded in Stage 2, however two species have the potential to occur within the small area of Spotted Gum – Ironbark Forest in the north of the area. These are heath wrinklewort (*Rutidosis heterogama*) and small-flower grevillea (*Grevillea parviflora* subsp. *parviflora*). Each of these species is discussed in detail in **Appendix 1**.

No endangered flora populations were identified within Stage 2 and there is no potential for such populations to occur.

Seven regionally significant flora species were recorded within Stage 2 (*Parsonsia straminea*, *Maytenus silvestris*, *Acacia parvipinnula*, *Corymbia maculate*, *Eucalyptus amplifolia* subsp. *amplifolia*, *Melaleuca styphelioides*, and *Imperata cylindrica* var. *major*), however, each of these species are relatively widespread throughout the region, and therefore do not pose a significant constraint to the proposed development.

2.1.8.2 Fauna

Two threatened fauna species, the speckled warbler (*Pyrrholaemus sagittata*) and the grey-crowned babbler (*Pomatostomus temporalis temporalis*), were recorded within Stage 2. These species are described in detail in **Appendix 1**. Additionally, there is potential habitat for a further 18 species. It is considered that underground mining could have a significant

impact on three of these species – the green and golden bell frog (*Litoria aurea*), green-thighed frog (*Litoria brevipalmata*) and the large-footed myotis (*Myotis adversus*). A seven part test of significance under the *Environmental Planning and Assessment Act 1979* (EP&A Act) was consequently completed for each of these species (refer to **Appendix 1**). An assessment of significance under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) was undertaken for the green and golden bell frog which is also listed under the Act.

A number of EPBC listed migratory species have also been recorded within Stage 2 or are considered to have moderate to high potential to occur within the area (refer to **Appendix 1**). An assessment of significance has been undertaken for each of these.

There are no endangered fauna populations within Stage 2, nor is there any critical habitat.

2.2 Areas of Environmental Sensitivity

2.2.1 Areas as per 6.6.3 list SMP Guidelines

Area of Environmental Sensitivity	Relevance to Stage 2
Wetlands listed under the Ramsar Wetlands Convention	There are no Ramsar wetlands within Stage 2.
Land declared as critical habitat under the <i>Threatened Species Conservation Act 1995</i>	There is no critical habitat in the Stage 2 area.
Significant surface water courses and groundwater resources identified through consultation with relevant government agencies	See Section 2.2.2 .
Lake foreshores and flood prone areas	Quorrobolong and Cony Creek floodplains are within the Stage 2 area and have been investigated (see Section 2.2.3).
Cliffs, escarpments and other significant natural features	There is a small interbedded siltstone/claystone escarpment along the upper slope of the spur landform within Stage 2 (see Section 2.1.4).
Areas containing significant ecological values	The riparian environment within Stage 2 potentially contains the Ecologically Endangered Community <i>River- Flat Eucalypt Forest</i> (see Ecology Report).
Surface features of community significance	Quorrobolong and Cony Creeks drain to Ellalong Lagoon, a feature which is highly significant to the local community.
Any other land identified by the Dept to the title holder	None.

2.2.2 Significant Surface Watercourses and Groundwater Resources

Quorrobolong and Cony Creeks which flow through the Stage 2 area originate from the slopes of Broken Back Mountain to the north of the study area, and the Myall Range to the south of the study area. The creeks drain to Ellalong Lagoon approximately 5 kilometres west of Stage 2 area. Ellalong lagoon is a freshwater habitat which has been identified as an Area of Environmental Significance by Cessnock City Council (Cessnock City Council 2004). The lagoon was also identified by the local community as a significant cultural landscape. In recognition of this natural and cultural significance, a new conservation area that includes

Ellalong Lagoon has been incorporated into the NSW Government's Lower Hunter Regional Conservation Plan.

There are no significant groundwater resources within the study area. The alluvium associated with Cony Creek and Quorrobolong Creek systems provides a limited groundwater resource that supports the adjoining riparian vegetation.

2.2.3 Flood Prone Areas

A detailed flood assessment for the Quorrobolong Creek system has been prepared using a two dimensional hydrodynamic flood model RMA-2. The model was calibrated using the February 1990 storm event which was approximately a 1 in 200 year event. The methodology used, flood analysis undertaken and results are detailed in the Flooding Assessment Longwalls A3, A4 and A5 report (the flood study) (Umwelt 2007).

Using this calibrated model, the extent and nature of 1 in 1 year and 1 in 100 year Average Recurrence Interval (ARI) floods in the valley was assessed. As detailed in the flood study, extensive areas of the Quorrobolong Creek and Cony Creek floodplains are inundated during a 1 in 1 ARI flood event. Modelling indicates that all access tracks and houses in proximity to the Stage 2 area are above the predicted 1 in 100 year ARI flood level.

2.2.4 Areas Containing Significant Ecological Values

As discussed in **Section 2.1.6**, two EECs have potentially been recorded within the Stage 2 area - the *Lower Hunter Spotted Gum – Ironbark Forest* EEC and the *River-flat Eucalypt Forest on Coastal Floodplains* EEC. Two threatened fauna species occur within the area and there is also potential habitat for a number of other threatened flora and fauna species. A detailed description of the ecological values of the Stage 2 area and the expected impacts on these values is contained in **Appendix 1**.

2.2.5 Surface Features of Community Significance

The landscape within the Stage 2 study area is generally agricultural. Retaining this farming atmosphere across the flat expanse of floodplain has been identified as a 'community vision' for the area (Cessnock City Council 2004). The conservation of riparian zones was also identified as important to the local community. This priority is illustrated within Stage 2 by the fencing of the riparian zone by local landholders in an attempt to protect this landform.

2.2.6 Areas of Agricultural Productivity

Agricultural suitability of the study area was mapped by Department of Agriculture (now Department of Primary Industries) in the 1980s. Agricultural suitability is an assessment of the potential agricultural productivity of an area of land. It is based on consideration of land capability together with limitations such as climatic factors, soil physical characteristics, soil chemical characteristics, erosion potential, drainage, stoniness, soil depth and topography. The entire area of Stage 2 has been mapped as Class 3 land. The definition of Class 3 land is as follows:

Suitable for grazing or well suited to pasture improvement. It may be cultivated or cropped in rotation with pasture. The overall production level is moderate because of edaphic (soil factors) or environmental constraints. Erosion hazard, soil structural breakdown and other factors including climate may limit the capacity for cultivation, and soil conservation or drainage works may be required.

The Stage 2 area is therefore considered moderately productive land suited to improved pasture and to cropping with pasture rotation. In recent times vineyards have also been planted in the area.

The majority of Stage 2 is used for cattle grazing, as well as minor crops. Numerous dams, fences, gates and yards are located within the area.

3.0 Aboriginal Heritage

An archaeological survey was undertaken as part of the EIS for Ellalong Colliery – Extension into Bellbird South (HLA 1995a and HLA 1995b). The results of Brayshaw's (1987) investigations undertaken for the Bellbird South Coal Project were incorporated into this report (HLA 1995:6.10).

A small artefact scatter (Quorrobolong 1, NPWS No. 37-6-0422) was recorded by Brayshaw on the knoll adjacent to the northern side bank of Quorrobolong Creek. This site is within the current Stage 2 study area and is located over Longwall A4 (see **Figure 4**). The site is located approximately 300 metres to the north of Quorrobolong Creek and 45 metres above it. Brayshaw described the site as follows:

Small boulders of conglomerate sandstone were exposed on the hilltop, and artefacts were found in bare areas close to trees or in exposed scours.

A total of 7 artefacts were found in an 80 x 25 metre area at a maximum density of 4/m².

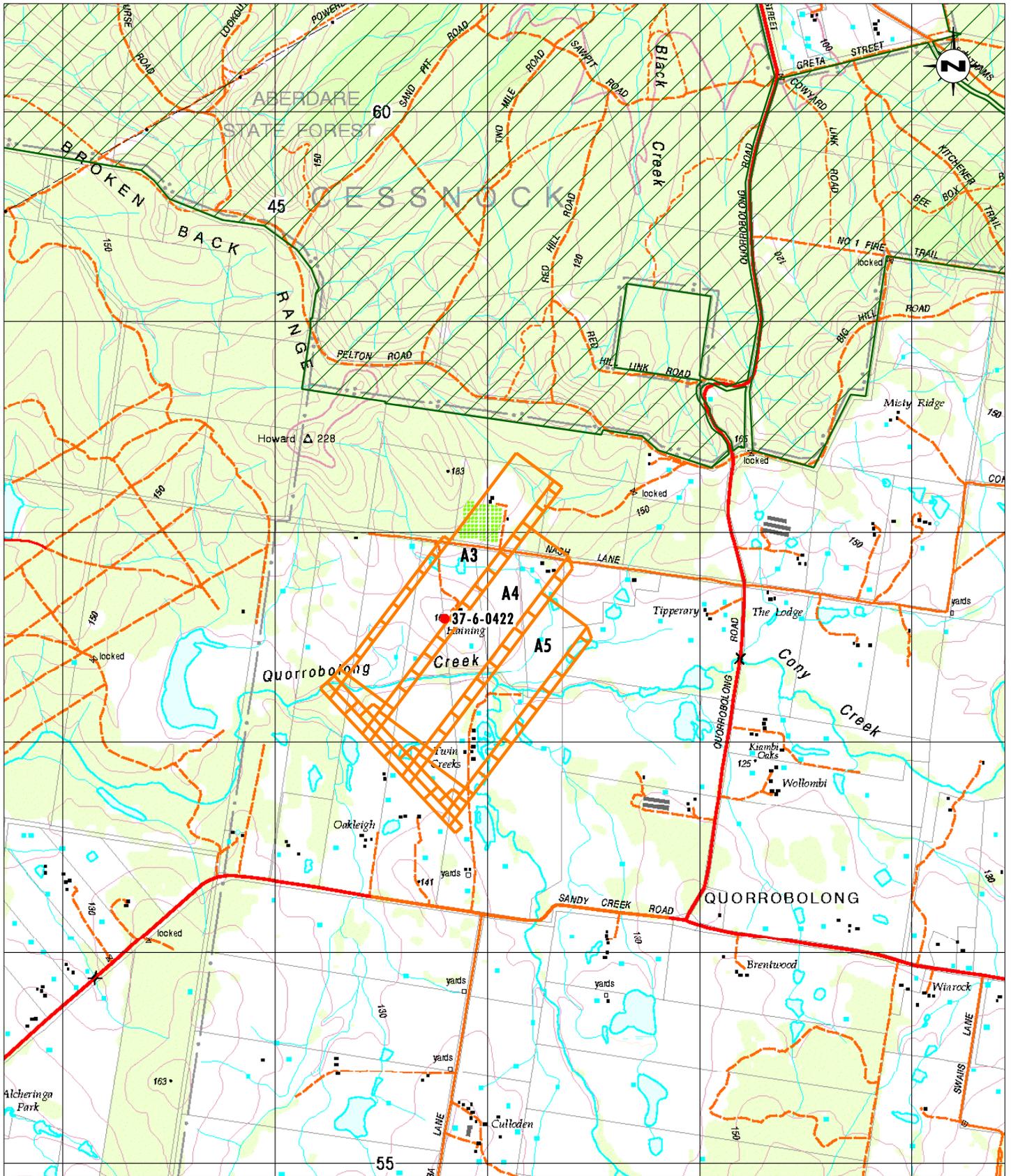
The artefacts included 3 indurated mudstone flakes, 1 silcrete flake, 1 silcrete core, 1 quartzite flake, and 1 quartzite flaked piece.

An isolated find (IF-1) was also located by Brayshaw on Broken Back Ridge to the northwest of the current study area (within Stage 1 of Austar Coal Mine). This site has not been assigned a NPWS number within the AHIMS database, probably because the description of this site was included on the site card for Quorrobolong 1. The site was located on a ridge saddle on Pelton Road, 1.6 kilometres northwest of Quorrobolong 1. The site consisted of a single multi-platformed silcrete core.

The Stage 2 study area was not surveyed by HLA (1995b) because areas of proposed surface impact were focused upon. The potential impacts to this area caused by subsidence were addressed through the recommendation of a subsidence monitoring program. HLA (1995b:15-16) considered that potential increases in erosion, especially adjacent to creeklines and wetlands, were the major potential threats to any Aboriginal heritage sites if they existed in this area.

It was suggested that a monitoring grid line be established so that watercourses and archaeological sites could be monitored for any changes that could lead to erosion. If such changes occurred, they would be detected early and the surfaces graded to preserve drainage and prevent ponding (HLA 1995a:7.23). These measures would also enable erosion to be minimised.

Aboriginal heritage was also addressed in the Statement of Environmental Effects (SEE) undertaken for the Modification of Consent (Section 96(2) of the EP&A Act 1979) for Stage 1 of the Austar Mine. The SEE reviewed HLA (1995a and 1995b) and Brayshaw (1987). IF-1, the isolated find recorded by Brayshaw (1987) was found to be located above one of the Stage 1 longwalls, however, it was concluded that the associated subsidence would not have a significant impact on the site. Consequently, no mitigation measures were recommended.



Base Source: LPI NSW 1:25 000 Topographic Maps
Source: Austar Coal Mine

0 400 800 1200m
1:25 000

Legend

- Stage 2 Longwall Panels
- Artefact Scatter

FIGURE 4

**Previously Recorded Aboriginal
Heritage Site within Stage 2**

There is potential that both surface and subsurface Aboriginal heritage sites are located within the Stage 2 study area. Areas adjacent to creeklines (reliable fresh water), and slightly elevated areas such as gently sloping lower slopes, benches, and spur crests have high archaeological sensitivity in this region. Additionally, the local Aboriginal community may consider the area to be of particular cultural significance.

Subsidence impact assessment and flood modelling indicates that surface drainage remediation works are not likely to be required in the Stage 2 area even if upper bound subsidence occurs.

Consistent with HLA (1995) recommendations which formed part of the existing development consent for underground mining, if surface works are required, an Aboriginal heritage assessment of the areas where works are likely to be required should be undertaken in consultation with the aboriginal community prior to any surface disturbance.

4.0 European Heritage

HLA (1995a and 1995b) summarised the European history of the Ellalong/Cessnock area. The following information was extracted from HLA (1995b:5).

The small settlers who occupied the Cessnock region from the 1820s were involved in grazing sheep and cattle, growing wheat and maize and timber getting. Vineyards developed after the 1840s and formed an important part of the farming economy.

With the development of mines at East Greta in 1891, exploitation of the South Maitland Coalfields began and mines began to open as the Greta coal measures were followed south. Mines were established in the Cessnock area by 1906 and were linked to what later became the South Maitland Railway. Collieries to the south of Cessnock (in the vicinity of the current study area) were established in the 1920s.

The effect of coal mining was to increase the regional population and improve the transport links to Maitland and Newcastle. Maze (1933) notes two opposing effects of coal mining on the agriculture of the area. Firstly, people gave up farming and became miners. Secondly, the growing demand for fresh food increased the production of vegetable, fruit and dairy products. Maze (1933) paints a picture of changing land use patterns from small farms growing grain or grazing sheep and cattle to a mining landscape. This landscape consisted of mines, transport networks to take the coal out to Newcastle, and a network of residential towns (such as Ellalong and Paxton) for miners. The agricultural landscape changed to dairying and vegetable production on the richer soils with the marginal farms being abandoned (Maze 1933:37-38).

HLA (1995b:5) postulated that two types of European heritage sites would be found in the proposed Ellalong Colliery area (including the current Stage 2 study area) – agricultural related sites and mining related sites. The following sites were identified during the archaeological survey:

- a large ring-barked tree (EL-2) was located on the boundary of a proposed washery emplacement area which does not form part of the Stage 2 area. This site was associated with the early pattern of European land use and settlement but was found to be of low significance;

-
- a section of the Kalingo Junction to Millfield and Paxton branch line which is not part of the Stage 2 study area. This section of line was found to be significant for its association with the mining industry and as part of the well known South Maitland Railway System, one of the largest private railways in Australia). However, its significance was found to be compromised by the removal of all track signalling and other railway facilities, leaving only the track formation. The integrity of this section was also found to have been affected by the its cutting by the Ellalong to Pelton coal conveyor;
 - a section of the Kalingo Junction to Cessnock No.1 Colliery line. This section was also assessed as being significant for the above reasons. However, this significance was found to be diminished by the low integrity of the line; and
 - the Cessnock No.1 Colliery. This site has important historical associations with the development of the Cessnock coal fields. The site was assessed as being a rare example and retaining integrity. A Conservation Management Plan and Heritage Impact Statement were recommended for this site prior to its proposed re-opening.

No European heritage sites were identified in the current Stage 2 study area as a result of HLA's (1995a and 1995b) investigations.

5.0 Subsidence Impacts

5.1 Overview of Predicted Subsidence Impacts

Mine Subsidence Engineering Consultants Pty Ltd (MSEC) (2007) has assessed the likely impact of subsidence on the creeklines within the Stage 2 study area. The analysis explores the likely systematic subsidence and valley related movements (based on the maximum expected subsidence level of 1.4 metres) and the upperbound systematic subsidence and valley related movements (based on the worst case scenario of 2.9 metres). The conclusions are summarised below:

- The maximum predicted tensile and compressive strains along the alignments of Quorrobolong and Cony Creeks (during or after the extraction of longwalls) are 0.7 mm/m and 0.5 mm/m respectively. The maximum upperbound tensile and compressive strains are 1.3 mm/m and 1.2 mm/m respectively.
- These tensile and compressive strains have the potential to cause surface tensile cracking in the alluvial creek beds. If such cracking does occur, the maximum crack width is 25 mm. It is likely, however, that a number of smaller cracks would occur rather than a single larger crack.
- Surface tensile cracking tends to occur within the top few metres of the surface soils, and would be expected to be filled with alluvial materials during subsequent flow events.
- The surface tensile cracking could potentially occur within the tensile zones around the perimeters of the longwalls.
- Smaller surface cracks could also occur behind the extraction face as each longwall is mined. However, such cracks tend to be transient because the travelling tensile phase (which causes the cracks) is generally followed by a travelling compressive phase which tends to partially close the cracks.

-
- The predicted and upperbound compressive strains along the alignments of the creeks are unlikely to be large enough to result in the buckling and dilation of the underlying strata along the creeks.
 - Buckling and dilation of underlying strata due to valley closure movements. These are likely to result in minor shallow fracturing of the rock strata under sections of Quorrobolong Creek system. This fracturing has negligible potential to adversely impact on surface flows or groundwater.
 - Surface tensile cracking could also occur in the locations where the underlying strata buckles and the depth of the overlying alluvials are shallow. In these cases, however, the surface cracks are likely to be filled with the alluvials during subsequent flow events.
 - In periods of flow, the dilated strata beneath the creekbeds would become water charged, and the surface water would flow over any surface cracking. In times of low flow, however, some of the surface water could be diverted into the dilated strata beneath the creek beds and this could temporarily affect the quality and quantity of the water flowing along the creeks.
 - Similar to surface tensile cracking, the underlying dilated strata would tend to be naturally filled with alluvials during subsequent flow events, especially during times of heavy rainfall. If these cracks and fractures in the underlying strata were found to not heal naturally, remedial measures may be required such as grouting.
 - Vertical fracturing may occur within the constrained zone, however this is likely to be discontinuous within the Hawkesbury Sandstone that underlays the creeklines. Any net loss of water from the creeks due to dilation and fracturing of the underlying strata is therefore unlikely.

5.2 Landform and Surface Water Resources

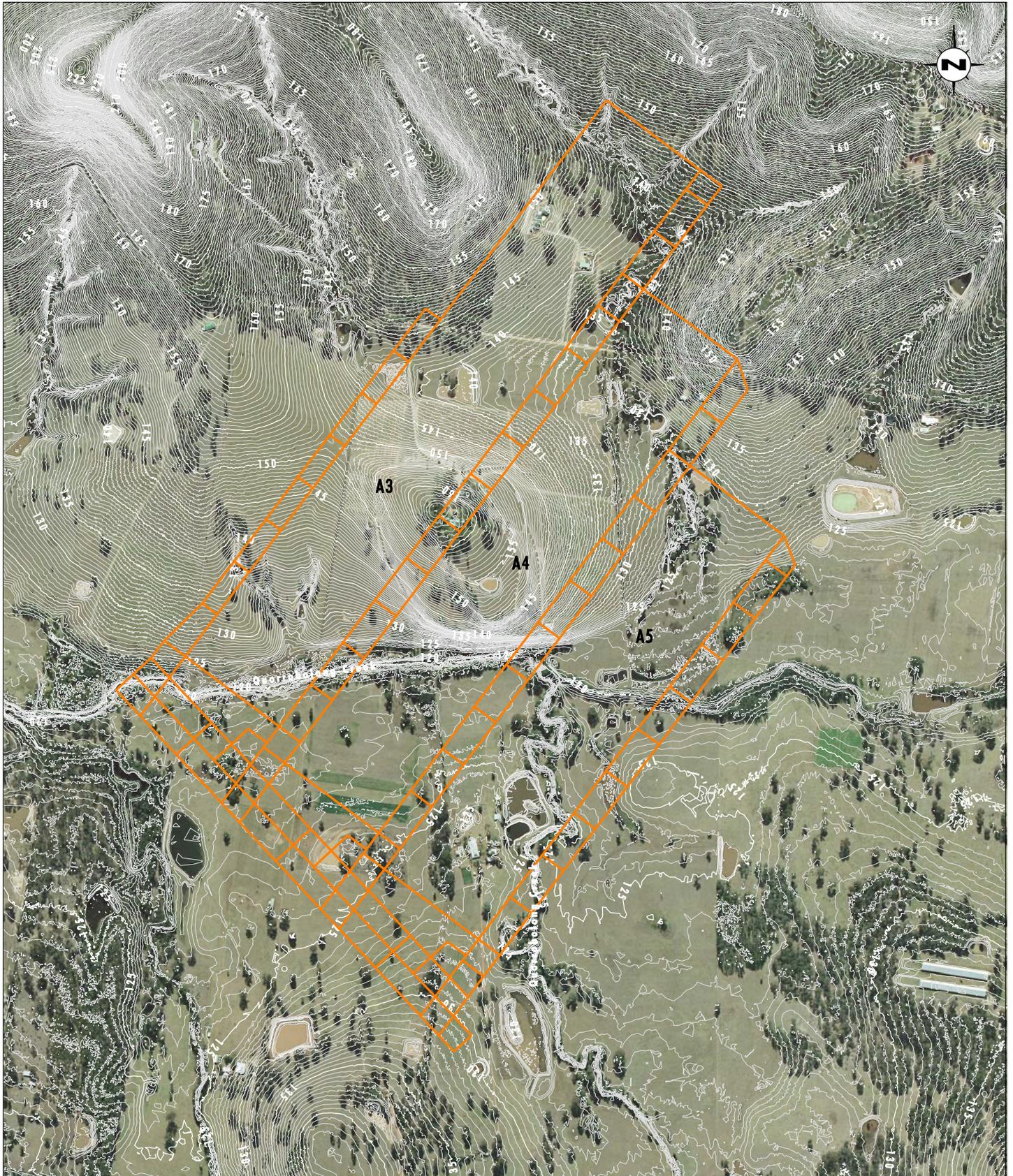
Based on both the maximum expected and upper bound subsidence predictions as set out in MSEC 2007, it is unlikely that the stability of the creek banks within Stage 2 will be affected. As shown on **Figures 5 to 8**, subsidence will not result in any significant increases in the localised steepness of channel beds or the subsided landform. Additionally, based on the flood modelling undertaken (see the flood study) no out of channel ponding or significant changes in ponding within the channel is expected to occur. It is therefore unlikely that any mitigation works will be required to maintain the flow or stability of the creeks that flow across Stage 2.

While minor cracking may occur along the Quorrobolong and Cony Creek alignments, this is unlikely to have an impact on channel stability or flows within the creek system. This minimal impact applies to both the predicted and maximum subsidence prediction scenarios.

The flooding assessment of Longwalls A3, A4 and A5 indicates that flood depths will be typically increased in the mining area. However, there will be minimal impact on flow velocities.

The flooding assessment also indicates that there will be no changes to flood inundation of access roads to dwellings or their associated flood hazards.

In addition, the flooding assessment indicates that the subsidence associated with mining will not result in the inundation of any dwellings during the 100 year ARI storm event that were



Base Source: AAM Hatch, 2006
Source: Austar Coal Mine

0 100 250 500m
1:10 000

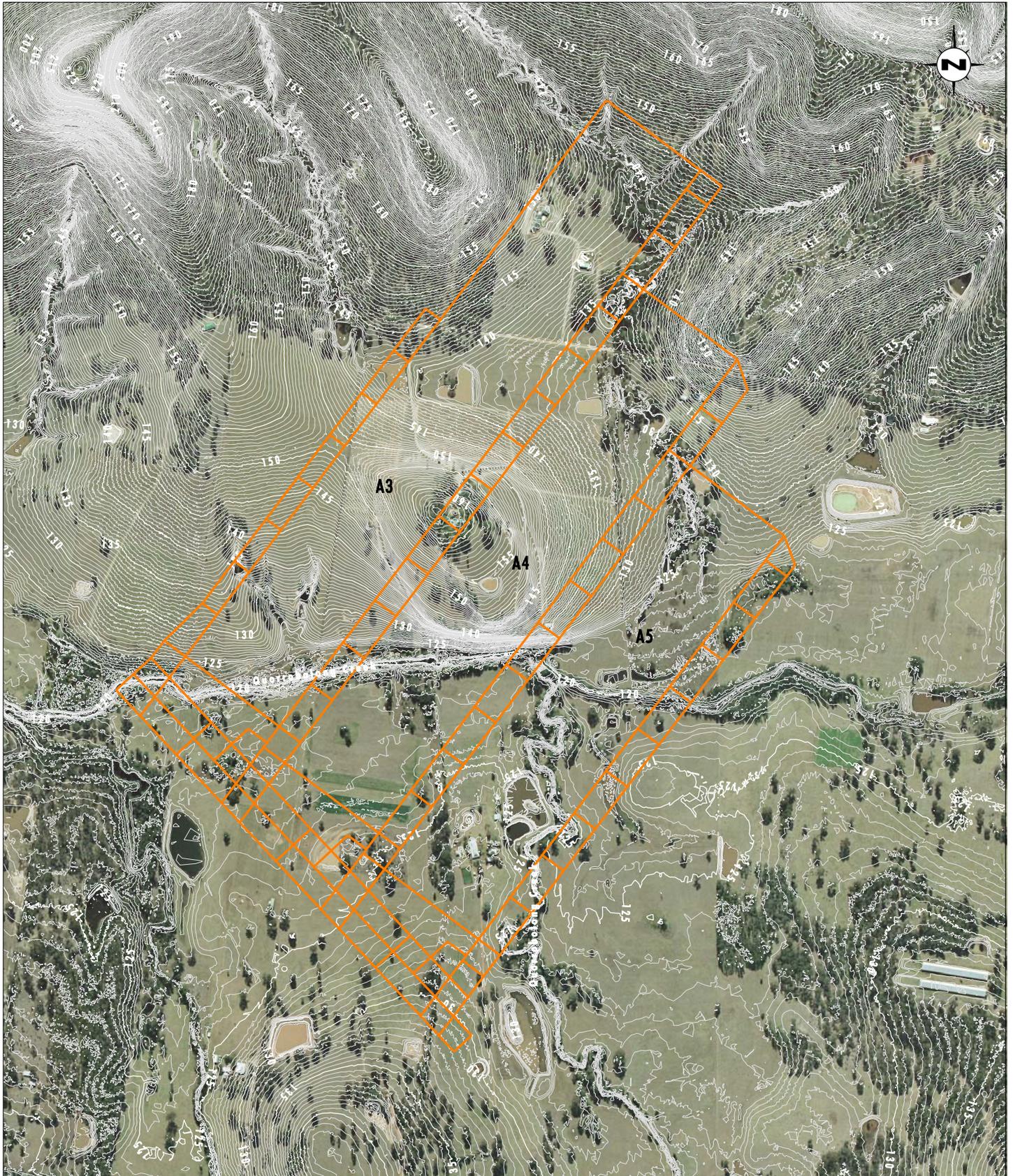
Legend

— Stage 2 Longwall Panels

FIGURE 5
Existing Landform

Note: Contour Interval is 0.5m

File Name (A4): R06_V1/2274_066.dgn



Base Source: AAM Hatch, 2006
Source: Austar Coal Mine

0 100 250 500m
1:10 000

Legend

— Stage 2 Longwall Panels

FIGURE 6

Predicted Landform following Mining of Longwall A3

Note: Contour Interval is 0.5m

File Name (A4): R06_V1/2274_067.dgn



Base Source: AAM Hatch, 2006
Source: Austar Coal Mine

0 100 250 500m
1:10 000

Legend

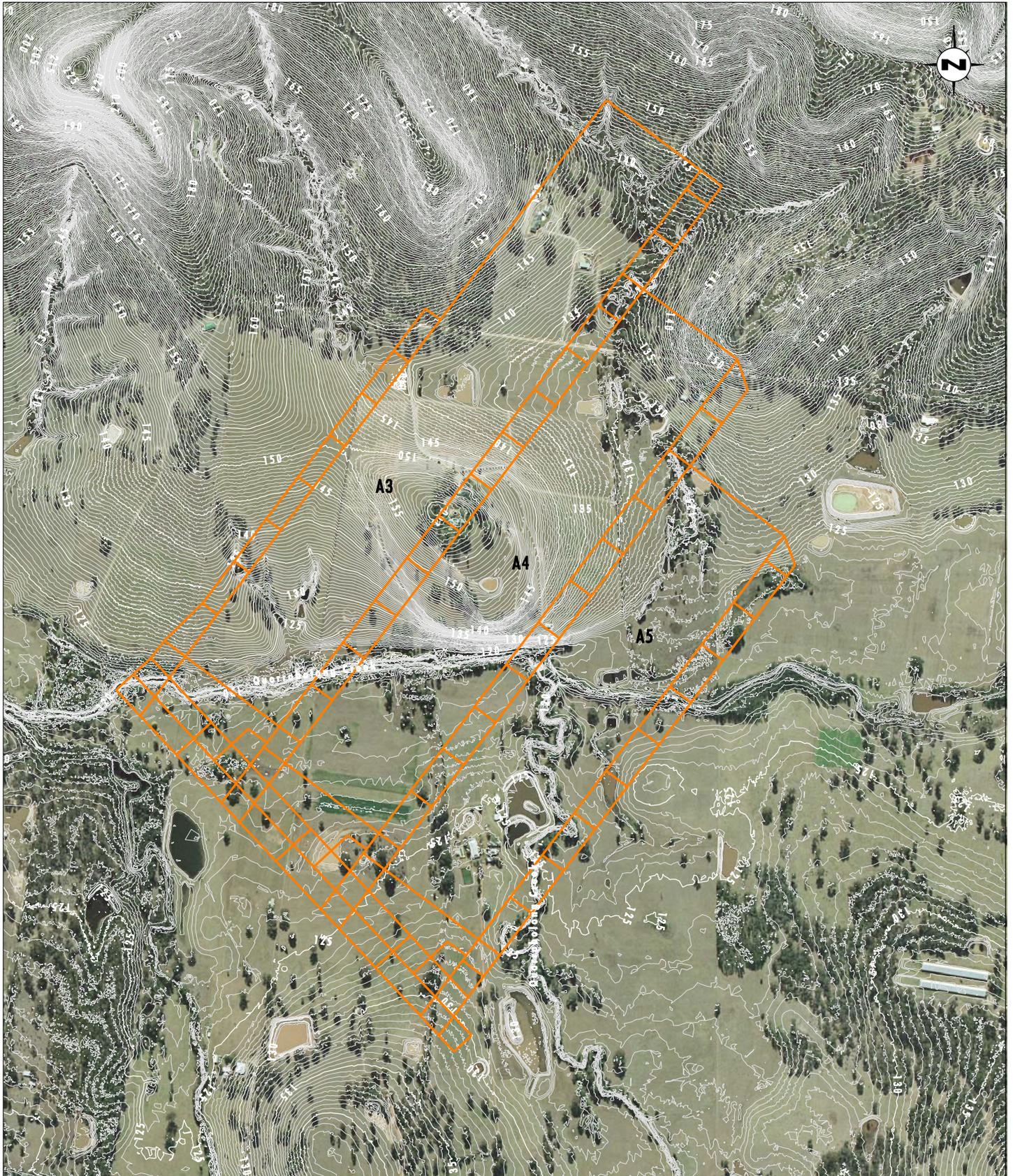
— Stage 2 Longwall Panels

FIGURE 7

**Predicted Landform following
Mining of Longwall A3 and A4**

Note: Contour Interval is 0.5m

File Name (A4): R06_V1/2274_068.dgn



Base Source: AAM Hatch, 2006
Source: Austar Coal Mine

0 100 250 500m
1:10 000

Legend

— Stage 2 Longwall Panels

FIGURE 8

Predicted Landform following Mining of Longwalls A3, A4 and A5

Note: Contour Interval is 0.5m

File Name (A4): R06_V1/2274_069.dgn

not previously inundated. However, it is predicted that freeboard above the 100 year ARI storm event of some dwellings upstream of the Stage 2 mining area will be increased with the predicted subsidence.

5.2.1 Ellalong Lagoon

Flood modelling and subsidence impact assessment indicates that longwall mining in Stage 2 will not impact on flow velocities downstream of the longwall mining area or long term net flows in Quorrobolong Creek and Cony Creek.

Analysis also indicates that channel stability and hence erosion potential of the creek banks is unlikely to be affected. As a result there are no predicted adverse changes to the volume of water, in channel velocities or water quality in Ellalong Lagoon as a result of longwall mining.

5.3 Aboriginal Heritage and Archaeological Sites

One Aboriginal heritage site has been recorded on the crest of a spur within the Stage 2 study area. Additionally, there is potential for previously unrecorded Aboriginal heritage material to occur within the area, particularly adjacent to creeklines and on slopes and elevated areas adjacent to creeklines.

Based on the expected and maximum subsidence and upper bound subsidence predictions, the surface impacts of longwall mining will be minimal. As a consequence surface mitigation works are likely to be necessary along the creek lines within the Stage 2 area. Consequently, there is low risk to Aboriginal heritage material either adjacent to creeklines, or within any other landform in Stage 2 as a result of longwall mining or associated mitigation works.

In the unlikely event that mitigation works become necessary, a full Aboriginal heritage assessment of that area(s) will be undertaken.

5.4 Groundwater Resources

As discussed in **Section 2.2.2**, groundwater resources in the study area are related to the coal measures which are at depth and highly saline and the shallow limited aquifer associated with Cony Creek and Quorrobolong Creek alluviums. Analysis of groundwater Bore GW 054676 which is located to the west of Longwall A3 (see **Figure 1**) shows that this bore has high conductivity (14,000 $\mu\text{S}/\text{cm}$ to 16,000 $\mu\text{S}/\text{cm}$) and low yield and is used for baseline monitoring purposes only. As a result groundwater resources in the area are of low yield and poor quality and are not suitable for use for agricultural or domestic purposes.

Further depressurisation of the regional groundwater table associated with the coal seam as a result of mining within Longwalls A3 to A5 is expected. Due to the depth of the coal seam (i.e. approximately 500 metres) and the long history of mining in the area, continued mining within Longwalls A3 to A5 is not expected to cause significant changes in the availability of groundwater resource in the area. In addition, groundwater associated with the coal measures is of low quality due to the high conductivity levels and is not suitable for agricultural or domestic purposes. In terms of depressurisation of groundwater in the coal measures, it is considered that longwall mining as proposed will have similar impacts to

those envisaged in 1995 EIS which formed the basis of development consent for the mining operation.

In regard to the shallow alluvial aquifer, subsidence modelling undertaken by MSEC (2007) indicates that hydraulically interconnected fracture networks above the longwall goaf is likely to extend to a height of approximately 225 metres. The depth of cover above the coal seam ranges from 485 metres in the south west corner of Longwall A3 to approximately 530 metres at the knoll in the middle of Longwall A4. As a result there is negligible potential for hydraulically interconnected cracking to extend from the shallow alluvial aquifer associated with Cony Creek and Quorrobolong Creek to the goaf. On this basis there is negligible potential for groundwater loss from the shallow aquifer as a result of cracking of the strata over the goaf.

Subsidence modelling (MSEC 2007) indicates that valley closure and surface tension cracking may occur as a result of subsidence. This could cause minor cracking and fractures in the upper 15 metres of the underlying stratum. This cracking is unlikely to result in drainage or loss of groundwater but may increase the capacity of the upper section of the underlying stratum to store groundwater through increased void space. This increased void space will be negligible and is unlikely to result in a significant decrease in groundwater levels. Any reduction in groundwater levels will be offset by minor flows in the creek system which will readily fill the additional void space. Sediment moving through the creek system will over a short period of time fill any cracks that may result from tension cracking. As a result, it is considered that subsidence has negligible potential to adversely impact on groundwater levels in the area. As previously discussed, available groundwater quality information indicates that groundwater in the shallow alluvial aquifer is low yielding and of poor quality and as a consequence is not suitable for agricultural or domestic purposes. In addition, minor temporary changes in groundwater levels that may result from subsidence are unlikely to significantly reduce groundwater availability to the riparian ecosystems that align Cony and Quorrobolong Creeks and draw water from the associated alluvial aquifer.

5.5 Flora and Fauna

There is potential that longwall mining and the resulting subsidence will have a significant impact on the potential *River-flat Eucalypt Forest* EEC. Consequently, a seven part test of significance under the EP&A Act has been undertaken (refer to **Appendix 1**). This test indicates that the proposed underground mining will not have a significant impact on the potential *River-flat Eucalypt Forest* EEC.

The development is considered unlikely to have a significant impact on the *Lower Hunter Spotted-gum – Ironbark Forest* EEC.

Analysis of the predicted levels of subsidence and associated changes to hydrology has identified that the impacts of the proposed development on the ecology of the study area are likely to be negligible. The proposed development is not expected to have a significant impact on any threatened species, populations or EECs recorded or with potential to occur within the study area.

In order to make certain that there will be no impacts due to unforeseen circumstances on the potential *River-flat Eucalypt Forest* EEC as a result of the proposed development, a monitoring program specifically focused on this EEC is recommended. If impacts resulting from the mining operation are recorded, means to remediate the impacts or prevent future impacts should be developed and implemented.

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APPENDIX 1

Ecological Assessment

Austar Coal Mine

Appendix 1
Austar Stage 2 Subsidence
Management Plan– Ecological
Assessment

February 2007

Austar Stage 2 Subsidence Management Plan – Ecological Assessment

Prepared by
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Report No. 2274/R06/A1/V2	Date: February 2007



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APPENDICES

1	Flora Species List
2	Test of Significance (EP&A Act)
3	Fauna Species List
4	Assessment of Significance (EPBC Act)

1.0 Ecological Assessment

Austar proposes to mine three longwalls (A3, A4 and A5) within an area referred to as Stage 2. The location of these longwalls is shown on **Figure 1.1**. This ecological assessment has been undertaken as part of preparation of a Subsidence Management Plan (SMP) for the proposed longwall mining.

The objectives of the ecological assessment were to:

- record the flora species, vegetation communities and fauna habitats occurring within the study area;
- identify any threatened species, populations or endangered ecological communities (EECs) listed under Schedules 1 and 2 of the *Threatened Species Conservation Act 1995* (TSC Act), the *Fisheries Management Act 1994* (FM Act) and also under the *Environmental Protection and Biodiversity Conservation Act 1999* (EPBC Act) that occur or have potential to occur within the study area;
- assess the potential impacts of the proposed development on threatened species, populations and EECs according to the *Environmental Planning and Assessment Act 1979* (EP&A Act) and the EPBC Act;
- address the requirement of State Environmental Planning Policy (SEPP) 44 - Koala Habitat; and
- to develop impact mitigation measures (where necessary) to reduce potential impacts on the ecological values of the study area.

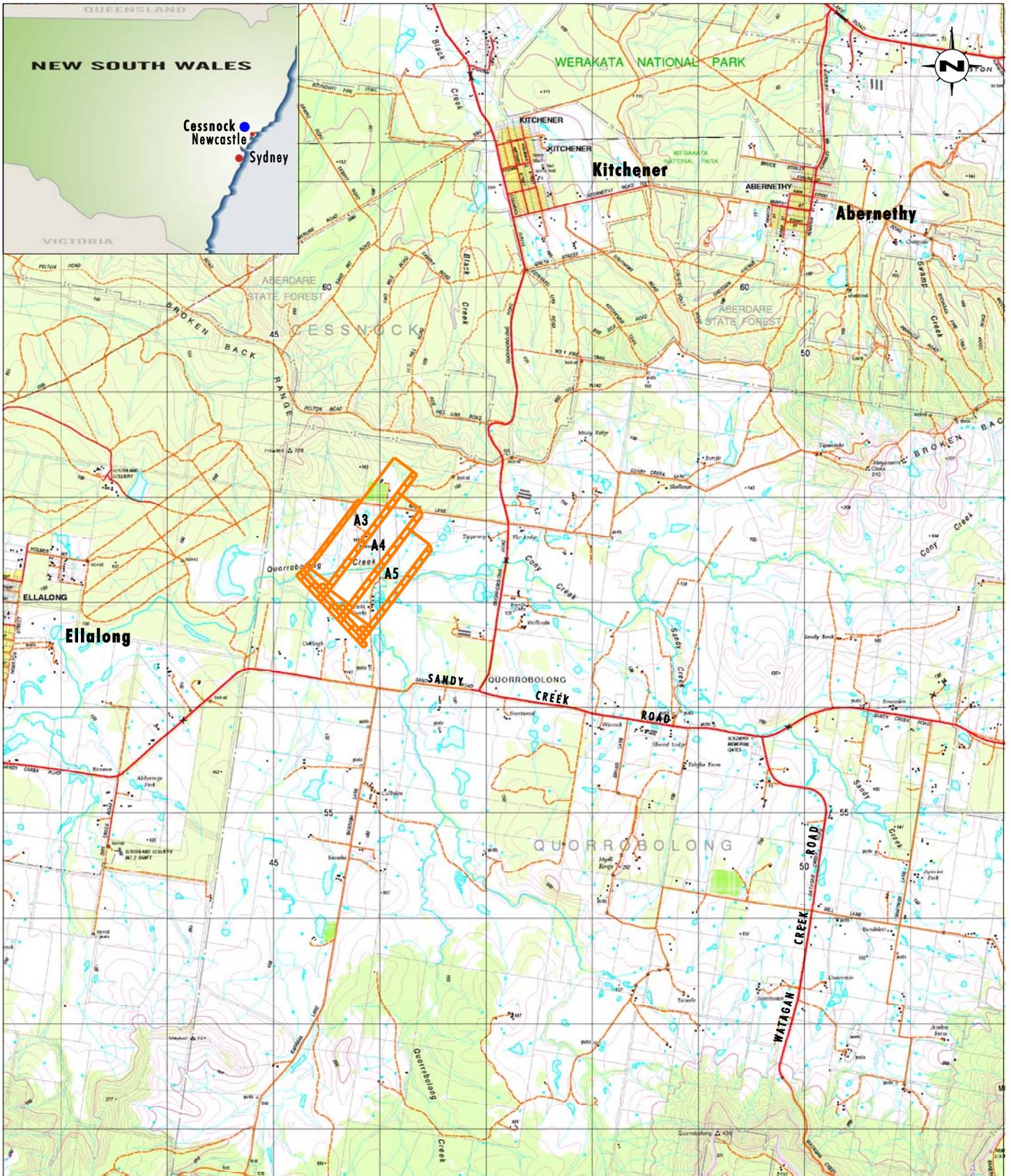
2.0 Methods

The following sections document the methods employed for the field work components of the project, which included flora surveys, fauna habitat assessments and opportunistic sightings of fauna species. Particular survey emphasis was placed on the riparian environments, as this is where the potential impacts from subsidence were predicted to be concentrated.

2.1 Flora Survey Methods

Flora surveys were undertaken across the study area on 24 and 25 August 2006 and 6 September 2006. The flora surveys consisted of walking transects aimed at identifying the vegetation communities occurring within the study area, recording the general species richness and also targeting the presence of threatened (TSC Act and EPBC Act) and significant flora species, endangered flora populations and EECs. In addition, information was gathered on the condition of the vegetation, including the general health of the vegetation, evidence of natural regeneration, occurrence and abundance of weeds and evidence of disturbance such as that caused by feral animals.

All vascular flora species encountered during the walking transects were recorded, and those that could not be identified in the field were collected, pressed and dried and either identified in the office or sent to the Royal Botanic Gardens Sydney for identification.



Base Source: LPI NSW 1:25 000 Topographic Maps
Source: Austar Coal Mine

0 0.5 1 2.5 km
1:50 000

Legend

— Stage 2 Longwall Panels and Study Area Boundary

FIGURE 1.1
Locality Plan

2.1.1 Plant Identification and Taxonomic Convention

All vascular plants recorded or collected were identified using keys and nomenclature in Harden (1992, 1993, 2000 & 2002) and Wheeler et al. (2002). Where known, changes to nomenclature and classification were incorporated into the results, as derived from *PlantNET* (Botanic Gardens Trust 2007), the on-line plant name database maintained by the National Herbarium of New South Wales.

Common names used follow Harden (1992, 1993, 2000 & 2002) where available, and draw on other sources such as local names where these references do not provide common names.

2.2 Fauna Survey Methods

A habitat assessment of the study area targeting the identification of potential habitat and resources for threatened fauna species, was undertaken on 24 and 25 August 2006. Observations of the following habitat features were made throughout the study area, with a focus on the riparian habitats:

- tree size class (trunk diameter);
- hollow-bearing trees and stags;
- fallen timber/logs;
- ground cover of rock outcrops;
- presence and condition of wet areas and water bodies;
- type and density of shrub and groundcover; and
- presence of faunal refugia.

In addition to these general habitat features, searches for specific requirements of threatened fauna species considered to potentially occur within the locality were also made including things such as the presence of winter flowering eucalypt species which are important foraging resources for migratory species such as the regent honeyeater (*Xanthomyza phrygia*) and the swift parrot (*Lathamus discolor*).

Habitat features such as tree hollows and fallen logs were observed for any evidence of fauna occupation such as scratches on the trunks of trees, chewed entrances to hollows, scratchings or diggings near logs and scats at the base of trees or in/near logs.

All habitat features observed were considered when assessing the likely presence or absence of any threatened fauna species within the study area. The known habitat requirements of each potentially occurring threatened species were compared with the habitat features recorded within the study area.

All fauna species observed opportunistically during field surveys were recorded.

2.2.1 Searches for Secondary Traces of Fauna

Many fauna species, while difficult to observe during surveys, leave behind evidence such as tracks, scats, hairs, scratches, burrows, bones and nests which indicate their presence. Such features were searched for during field surveys of the proposed disturbance area as part of the walking flora surveys. Features such as scats were identified in the field using the field guide *Tracks, Scratches and Other Traces* (Triggs 2004).

3.0 Flora Results

Included in the following sections are a description of the floristic diversity recorded, vegetation communities of the study area, and significant findings such as threatened flora species and EECs.

3.1 Flora Species

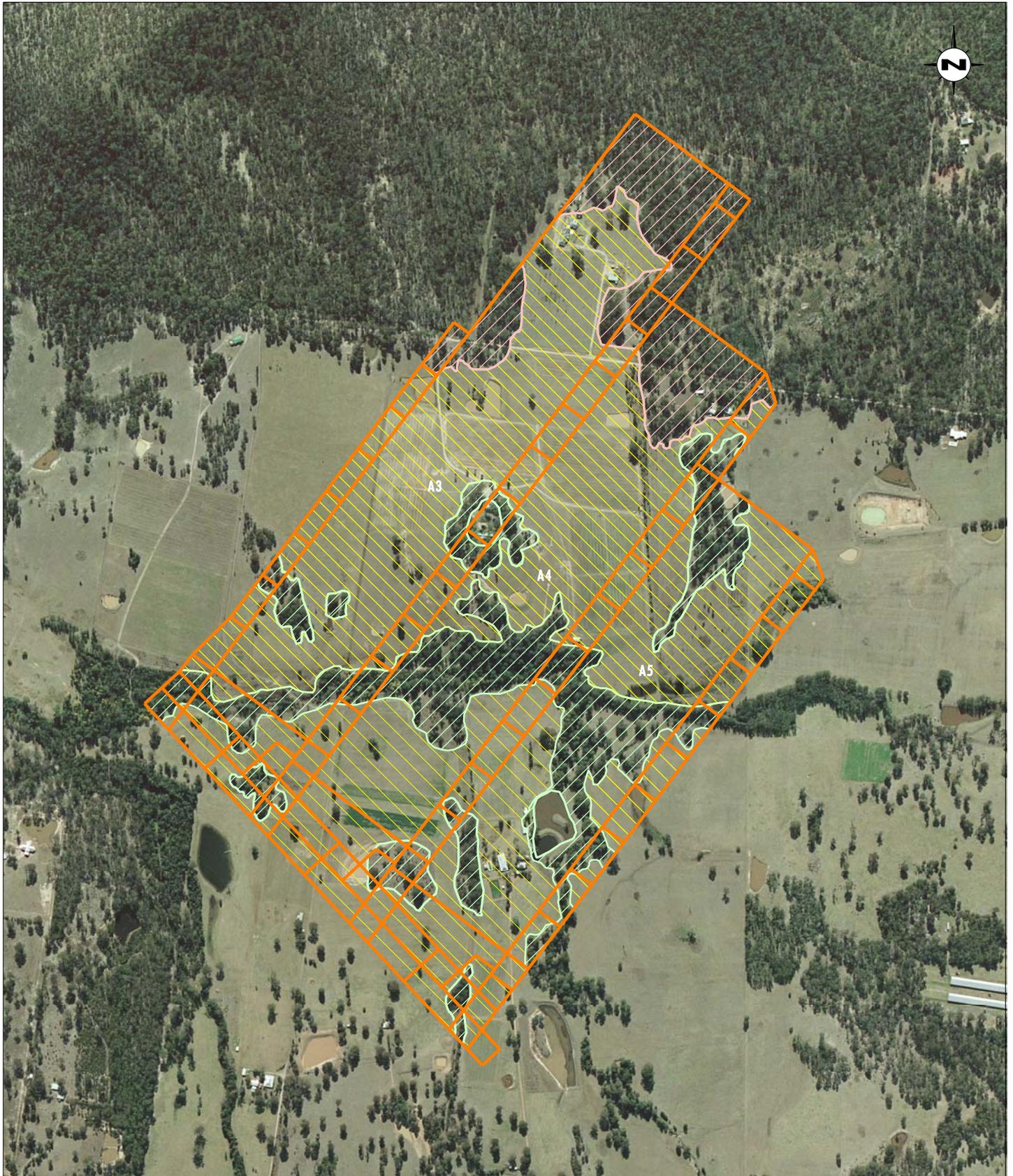
A full list of the flora species recorded during surveys of the study area is presented in **Appendix 1**. A total of 82 flora species were recorded, of which 65 are native and 17 are introduced. Four species were from the Class Filicopsida (ferns), and 77 from Magnoliopsida (flowering plants) (of which 15 were from sub-class Liliidae (monocots) and 62 from sub-class Magnoliidae (dicots)). Flora species were recorded from 42 plant families, the most speciose being Myrtaceae (14 species), Poaceae (8 species) and Fabaceae (7 species).

3.2 Vegetation Communities of the Study Area

The vegetation of the study area largely comprises cleared land supporting *Derived Grassland* vegetation (**Figure 3.1**). The riparian and floodplain areas support *Riparian Swamp Oak – Rough-barked Apple Open Forest*, while small remnants of *Spotted Gum – Ironbark Forest* occur on ridgelines in the far north of the study area (**Figure 3.1**). The majority of these remnants lack an understorey due to grazing impacts and, in some instances, previous clearing for land management purposes such as fuel load reduction.

Regional vegetation mapping undertaken for the Lower Hunter and Central Coast Regional Environmental Management Strategy (LHCCREMS) (House 2003), with vegetation community descriptions prepared by NPWS (2000), identify the vegetation of Cony Creek and Quorrobolong Creek as *Central Hunter Riparian Forest* (Map Unit 13). The *Riparian Swamp Oak – Rough-barked Apple Open Forest* recorded within the study area is most similar to this community. Similarly, the *Spotted – Gum Ironbark Forest* recorded within the study area is regarded to conform to the *Lower Hunter Spotted – Gum Ironbark Forest* as described for the LHCCREMS project (NPWS 2000).

On consideration of the structural and floristic composition of the *Riparian Swamp Oak – Rough-barked Apple Open Forest* and the geomorphology of the subject site, there is a reasonable likelihood that this community could conform to the EEC *River-flat Eucalypt Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner Bioregions* (NSW Scientific Committee 2005a). Floristically there is likely to be enough similarity between the *Riparian Swamp Oak – Rough-barked Apple Open Forest* and the EEC, however geomorphological, biophysical and climatic factors which contribute to the determination of the EEC require further investigation. A targeted, semi-quantitative floristic



Base Source: AAM Hatch, 2006
Source: Austar Coal Mine

0 100 200 400m
1:10 000

Legend

- Stage 2 Longwall Panels and Study Area Boundary
- ▨ Riparian Swamp Oak - Rough-barked Apple Open Forest (Possible River-flat Eucalypt Forest EEC)
- ▨ Spotted Gum - Ironbark Forest (Lower Hunter Spotted Gum-Ironbark Forest EEC)
- ▨ Derived Grassland

FIGURE 3.1

Vegetation Communities

survey of the community will also be necessary to support or refute its floristic similarity to the EEC.

The *Spotted Gum – Ironbark Forest* was found to be consistent with the *Lower Hunter Spotted Gum – Ironbark Forest* EEC, as described by the NSW Scientific Committee (2005b).

The *River-flat Eucalypt Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner Bioregions* and *Lower Hunter Spotted Gum – Ironbark Forest* EECs are discussed in detail in **Section 3.4**.

3.2.1 Riparian Swamp Oak – Rough-barked Apple Open Forest

The vegetation of both Quorrobolong Creek and Cony Creek is dominated by *Riparian Swamp Oak – Rough-barked Apple Open Forest*. This community comprises a canopy dominated by rough-barked apple (*Angophora floribunda*), cabbage gum (*Eucalyptus amplifolia* subsp. *amplifolia*) and forest red gum (*Eucalyptus tereticornis*). The dominance of each species varies throughout the study area, with the upper stream reaches supporting higher abundances of rough-barked apple (*Angophora floribunda*), with only scattered occurrences of cabbage gum (*Eucalyptus amplifolia* subsp. *amplifolia*) and forest red gum (*Eucalyptus tereticornis*). The lower stream reaches of the study area support higher abundances of cabbage gum (*Eucalyptus amplifolia* subsp. *amplifolia*) and forest red gum (*Eucalyptus tereticornis*), with scattered occurrences of rough-barked apple (*Angophora floribunda*), mountain blue gum (*Eucalyptus deanei*) and grey box (*Eucalyptus moluccana*). The height of the canopy ranges between 12 and 20 metres. The cover of the canopy varies widely across the study area, from 5% in more disturbed areas, up to 40% in sites with a more intact canopy.

This community supports a dense low tree stratum comprising swamp oak (*Casuarina glauca*), green wattle (*Acacia irrorata*), silver-stemmed wattle (*Acacia parvipinnula*), ball honeymyrtle (*Melaleuca nodosa*), snow-in-summer (*Melaleuca linearifolia*) and sweet pittosporum (*Pittosporum undulatum*). The cover of this stratum is approximately 50%, with a height range of 10-15 metres.

This community typically lacks an understorey, however it may be present in some locations. Commonly recorded understorey species include black thorn (*Bursaria spinosa* subsp. *spinosa*), native indigo (*Indigofera australis*), lemon-scented tea tree (*Leptospermum polygalifolium* subsp. *polygalifolium*) and *Logania albiflora*.

The ground stratum of the *Riparian Swamp Oak – Rough-barked Apple Open Forest* comprises a mixture of native and introduced grasses and small herbs. Species recorded within this stratum include couch (*Cynodon dactylon*), blady grass (*Imperata cylindrica* var. *major*), maidenhair fern (*Adiantum aethiopicum*) and spiny-headed mat-rush (*Lomandra longifolia*).

A number of weed species were recorded throughout the study area, including purple top (*Verbena bonariensis*), curled dock (*Rumex crispus*), wandering Jew (*Tradescantia fluminensis*), moth vine (*Araujia sericifera*), creeping verbena (*Verbena rigida*), wild tobacco (*Solanum mauritanum*), Pampas grass (*Cortaderia selloana*), balloon cotton bush (*Gomphocarpus fruticosus*), camphor laurel (*Cinnamomum camphora*), blackberry (*Rubus fruticosus* sp. agg.), green cestrum (*Cestrum parqui*), fireweed (*Senecio madagascariensis*) and pennywort (*Hydrocotyle bonariensis*). The weed species and their density varied throughout the study area, as a result of the different land management histories of each property.

The majority of riparian areas occurring within the study area have been fenced off from regular stock grazing on both sides by adjacent property owners. Over time, the removal of grazing pressures along the creeklines would enable the regeneration of native riparian flora species, enhancing habitats for native fauna species.

3.2.2 Spotted Gum – Ironbark Forest

A small area of Spotted Gum – Ironbark Forest occurs in the very northern extent of the study area (**Figure 3.1**). This community occupies the drier mid to upper slopes and crests of the study area, primarily on a southerly aspect. This community is widespread within the local area, and is the dominant community within the nearby Aberdare State Forest. Localised variants occur in response to environmental variables such as aspect, topography, geology and disturbance history (including fire). The Spotted Gum – Ironbark Forest recorded within the study area was found to correspond to the EEC *Lower Hunter Spotted Gum – Ironbark Forest* EEC, listed under the TSC Act.

The canopy stratum of this community is dominated by spotted gum (*Corymbia maculata*), broad-leaved ironbark (*Eucalyptus fibrosa*) and narrow-leaved ironbark (*Eucalyptus crebra*). A number of other canopy species occur within this community at different abundances, including grey box (*Eucalyptus moluccana*), brown stringybark (*Eucalyptus capitellata*) and grey gum (*Eucalyptus punctata*). The canopy has a cover ranging between 20 and 30%, and grows to a height of 20 metres.

The Spotted Gum – Ironbark Forest has a sparse shrub stratum (approximately 5 – 10% cover), which ranges in height from 0.5 metres to 4 metres. The dominant species recorded include narrow-leaved geebung (*Persoonia linearis*), coffee bush (*Breynia oblongifolia*), peach heath (*Lissanthe strigosa*), broom bitter pea (*Daviesia genistifolia*) and *Dillwynia retorta*.

The ground stratum of this community primarily comprises native grasses, however a number of small herbs, ferns and vines also occur. The more common species recorded include threeawn speargrass (*Aristida vagans*), wiry panic (*Entolasia stricta*), kangaroo grass (*Themeda australis*), blady grass (*Imperata cylindrica* var. *major*), blue flax lily (*Dianella caerulea*), poison rock fern (*Cheilanthes sieberi* subsp. *sieberi*), love creeper (*Glycine tabacina*) and *Goodenia rotundifolia*. The ground stratum has a cover of approximately 15-30%, and is generally less than 0.5 metres in height.

3.2.3 Derived Grassland

The majority of the study area comprises Derived Grassland (**Figure 3.1**). The areas of Derived Grassland are likely to have previously supported woodland vegetation similar to that of surrounding vegetation remnants, however they were cleared of tree and shrub species for agricultural purposes.

The Derived Grassland community lacks tree and shrub strata, however occasional individual trees or shrubs are scattered throughout. The community is characterised by a range of native and introduced grasses, and also a diversity of small herbs. Species commonly recorded include threeawn speargrass (*Aristida vagans*), couch (*Cynodon dactylon*), blady grass (*Imperata cylindrica* var. *major*), poison rock fern (*Cheilanthes sieberi* subsp. *sieberi*), and the introduced species scarlet pimpernel (*Anagallis arvensis*), plantain (*Plantago lanceolata*) and fireweed (*Senecio madagascariensis*). The floristic composition of the Derived Grassland varies slightly between the different properties throughout the study area, which is the result of land management practices differing between landholders.

3.3 Threatened Flora Species

No threatened flora species were recorded within the study area during the field surveys.

In order to identify threatened flora species which have potential to occur within the study area, a search of relevant ecological databases was undertaken. These database searches involved:

- a search of the DEC Atlas of NSW Wildlife (2006) for threatened flora species recorded within a 10 kilometre radius of the study area; and
- a search of the DEH Protected Matters Database (2006) for threatened flora species with potential to occur (based on DEH habitat modelling) within a 10 kilometre radius of the study area.

Table 1 of **Appendix 2** lists the nine threatened flora species recorded from these two database searches, and provides an assessment of the likelihood of their occurrence within the study area. Of the nine species listed, two are considered to have potential habitat within the study area (listed in **Table 3.1** below). Potential habitat for both species exists in the small area of spotted gum – ironbark forest occurring in the north of the study area.

Table 3.1 - Threatened Flora Species with Potential to Occur within the Study Area

Species	Status
heath wrinklewort <i>Rutidosia heterogama</i>	V (EPBC) V (TSC) *
small-flower grevillea <i>Grevillea parviflora</i> subsp. <i>parviflora</i>	V (EPBC) V (TSC) * #

Key:

* Records from DEC Wildlife Atlas Database

Records from EPBC Protected Matters Search

TSC = *Threatened Species Conservation Act 1995*

EPBC Act = *Environment Protection and Biodiversity Conservation Act 1999*

E = Endangered

V = Vulnerable

The potential for the proposed development to have a significant impact on these two threatened flora species is assessed in **Table 1** of **Appendix 2**. Due to the proposed development being underground mining, the surface disturbances are expected to be minimal, and therefore it is unlikely that it will result in a significant impact on the two potentially occurring threatened flora species. The impacts of the proposed development on threatened flora species are discussed in further detail in **Section 7.1**.

3.4 Endangered Ecological Communities

The field surveys identified one EEC and one potential EEC within the study area, being the *Lower Hunter Spotted Gum – Ironbark Forest* and *River-flat Eucalypt Forest* respectively. Descriptions of these EECs and how they relate to the study area are provided in **Sections 3.4.1** and **3.4.2** below.

An initial constraints analysis identified a further five EECs that were considered to have potential to occur within the study area. These EECs were:

- *Swamp Sclerophyll Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin, and South-east Corner Bioregions;*
- *Swamp Oak Floodplain Forest of the NSW North Coast, Sydney Basin and South-east Corner Bioregions;*
- *Hunter Lowlands Redgum Forest in the NSW Sydney Basin and North Coast Bioregions;*
- *Quorrobolong Scribbly Gum Woodland in the NSW Sydney Basin Bioregion; and*
- *Freshwater Wetlands on Coastal Floodplains of the North Coast, Sydney Basin and South-east Corner Bioregions.*

An assessment of the potential to occur for each of these five EECs is presented in **Table 1** of **Appendix 2**, which concludes that there is no potential habitat within the study area for any of these EECs.

There are no aquatic EECs listed under the FM Act occurring within or with potential to occur within the study area.

3.4.1 River-flat Eucalypt Forest EEC

The following description of this EEC is summarised from the final determination for the *River-flat Eucalypt Forest on Coastal Floodplains* (NSW Scientific Committee 2005a).

The *River-Flat Eucalypt Forest* is associated with silts, clay-loams and sandy loams, on periodically inundated alluvial flats, drainage lines and river terraces associated with coastal floodplains. The community generally occurs below 50 metres above sea level (ASL), however it may occur on localised river flats up to 250 metres ASL. The EEC ranges in structure from tall open forest to woodland, with a canopy dominated by forest red gum (*Eucalyptus tereticornis*), cabbage gum (*Eucalyptus amplifolia* subsp. *amplifolia*), rough-barked apple (*Angophora floribunda*) and broad-leaved apple (*Eucalyptus subvelutina*). A small tree layer often is present, which may comprise *Melaleuca decora*, prickly-leaved tea tree (*Melaleuca styphelioides*), grey myrtle (*Backhousia myrtifolia*), white cedar (*Melia azedarach*), river oak (*Casuarina cunninghamiana*) and swamp oak (*Casuarina glauca*). The mid-stratum is often absent, but where present may comprise species such as black thorn (*Bursaria spinosa*), forest nightshade (*Solanum prinophyllum*), native raspberry (*Rubus parvifolius*), coffee bush (*Breynia oblongifolia*) and *Ozothamnus diosmifolius*. The ground cover consists of a number of forbs, scramblers and grasses.

A comparison between the floristic and structural composition of the *River-flat Eucalypt Forest* EEC (described above) and the Riparian Swamp Oak – Rough-barked Apple Open Forest occurring within the study area (the latter described in **Section 3.2.1**) showed that the latter supports many of the characteristic species of the *River-flat Eucalypt Forest* EEC, as described in the final determination for this EEC (NSW Scientific Committee 2005a).

There are, however, potential differences between the EEC and the Riparian Swamp Oak – Rough-barked Apple Open Forest occurring within the study area, which pertain to geomorphological, climatic and biophysical factors. Further investigation of these matters will be required, as well as a targeted, semi-quantitative floristic survey of the community, to form

a rigorous opinion on whether or not the community conforms to the EEC. At this stage it appears that there is a reasonable likelihood that it may conform.

As a result, remnant vegetation occurring in riparian and floodplain zones of both Cony Creek and Quorrobolong Creek within the study area is considered to potentially comprise the *River-flat – Eucalypt Forest* EEC.

The potential for the proposed development to have a significant impact on this EEC is preliminarily assessed in **Table 1** of **Appendix 2**. This assessment found that there is potential that the proposed underground mining development could have an impact on this EEC, and therefore further assessment using the seven part test of significance under the EP&A Act was undertaken (**Appendix 2**).

3.4.2 Lower Hunter Spotted Gum – Ironbark Forest EEC

The following description of this EEC is summarised from the final determination for the *Lower Hunter Spotted Gum – Ironbark Forest EEC* (NSW Scientific Committee 2005b).

The *Lower Hunter Spotted Gum – Ironbark Forest* EEC occurs in the central to lower Hunter Valley, principally on Permian geology. The EEC is restricted to a range of approximately 65 kilometres by 35 kilometres centred on the Cessnock – Beresfield area and corresponds to the Lower Hunter Spotted Gum – Ironbark Forest as described by NSW NPWS (2000) for the Lower Hunter and Central Coast Regional Environmental Management Strategy (LHCCREMS). The dominant canopy species of this community are spotted gum (*Corymbia maculata*) and broad-leaved ironbark (*Eucalyptus fibrosa*), with grey gum (*Eucalyptus punctata*) and narrow-leaved ironbark (*Eucalyptus crebra*) present occasionally in lower frequency. An understorey comprising the following shrub species is present: silver-stemmed wattle (*Acacia parvipinnula*), gorse bitter pea (*Daviesia ulicifolia*), black thorn (*Bursaria spinosa* subsp. *spinosa*), ball honeymyrtle (*Melaleuca nodosa*) and peach heath (*Lissanthe strigosa*). The ground layer is diverse, comprising poison rock fern (*Cheilanthes sieberi* subsp. *sieberi*), barbed-wire grass (*Cymbopogon refractus*), blue-flax lily (*Dianella revoluta*), wiry panic (*Entolasia stricta*), love creeper (*Glycine clandestina*), *Lepidosperma laterale*, many-flowered mat rush (*Lomandra multiflora*), weeping grass (*Microlaena stipoides* var. *stipoides*), *Pomax umbellata*, kangaroo grass (*Themeda australis*) and white root (*Pratia purpurascens*).

A comparison between the floristic and structural composition of the *Lower Hunter Spotted Gum – Ironbark Forest* (described above) and the Spotted Gum – Ironbark Forest occurring within the study area (described in **Section 3.2.2**) showed that the latter supports the characteristic species of the *Lower Hunter Spotted Gum – Ironbark Forest*, as described in the final determination for this EEC (NSW Scientific Committee 2005b). As a result, remnant vegetation occurring in the north of the study area was found to comprise the *Lower Hunter Spotted Gum – Ironbark* EEC.

The potential for the proposed development to have a significant impact on this EEC is assessed in **Table 1** of **Appendix 2**. This assessment found that the proposed underground mining development is unlikely to have an impact on the *Lower Hunter Spotted Gum – Ironbark Forest* EEC, and therefore further assessment is not required.

3.5 Endangered Flora Populations

There are three endangered flora populations occurring within the Hunter Valley (in which the study area occurs):

- *Acacia pendula* population in the Hunter Valley;
- *Eucalyptus camaldulensis* population in the Hunter Valley; and
- *Cymbidium canaliculatum* population in the Hunter Valley.

No endangered flora populations were identified within the study area. The potential for each of these endangered flora populations is assessed in **Table 1** of **Appendix 2**, which concludes that no endangered flora populations have potential to occur within the study area.

3.6 Regionally Significant Flora Species

The study area occurs within the Hunter Region, which consists of the Gosford, Wyong, Cessnock, Maitland, Lake Macquarie, Newcastle and Port Stephens local government areas. There are numerous flora species considered to have conservation significance within this region. There a number of criteria used to list regionally significant species, some of which include:

- Endemic taxa – known distribution restricted to this region;
- Uncommon taxa – less than 50 known populations;
- Records close to the limit of the species' geographical range; and
- Significant reductions in population size or area occupied.

The Hunter Rare Plants Database (Peake et. al. 2003) provides a comprehensive list of flora species within the Hunter Region that are considered to be regionally significant. From this Database, there are seven regionally significant flora species which were recorded within the study area (**Table 3.2**).

Table 3.2 - Regionally significant species recorded within the study area

Species	Criteria	Recorded
<i>Parsonsia straminea</i>	?W	yes
<i>Maytenus silvestris</i>	U	yes
<i>Acacia parvipinnula</i>	N W	yes
<i>Corymbia maculata</i>	W	yes
<i>Eucalyptus amplifolia</i> subsp. <i>amplifolia</i>	T	yes
<i>Melaleuca styphelioides</i>	W	yes
<i>Imperata cylindrica</i> var. <i>major</i>	?W	yes

Key to Criteria

U = everywhere uncommon

N or W = distributional limit in HR

T = not the above but may be threatened

? = code is uncertain

Those seven regionally significant flora species recorded within the study area are relatively widespread throughout the region, and therefore do not pose a constraint to the proposed development.

3.7 Regionally Significant Ecological Communities

Two ecological communities which are regarded to be regionally significant are known to occur within proximity to the study area, and therefore have been considered in this ecological assessment. A description of each of these ecological communities is provided below. The field surveys of the study area did not identify either of these two ecological communities.

Abernethy, which is located to the north of the study area, is close to the north-east limit of distribution for yellow bloodwood (*Corymbia eximia*). *Corymbia eximia* appears to occur in a community in which it forms the key dominant tree species. Preliminary analysis by Bell and Driscoll (in prep.) suggests that it is a distinct community that is highly restricted and may meet criteria for listing as an EEC. It is not known whether this species, or the community, occurs in the study area, although at this stage it is considered unlikely.

Woollybutt (*Eucalyptus longifolia*) possibly forms a relictual community in the Quorrobolong area. The significance of this population is currently being investigated by Bell and Driscoll (in prep.) The community may meet criteria for listing as an EEC, or, it may form a population that should be listed as an endangered population under the TSC Act. This species, and therefore the community, is likely to occur in low numbers within the study area.

4.0 Fauna Results

Following are the results of field surveys of 24 and 25 August 2006. Included is a description of the fauna species recorded, fauna habitats of the study area, and significant findings such as threatened fauna species.

4.1 Fauna Species Recorded

As fauna surveys were restricted to habitat assessment and opportunistic records, the list of fauna species recorded within the study area, provided in **Appendix 3**, does not provide a full representation of the fauna diversity present.

A total of 61 species were recorded opportunistically during the survey of the study area, of which there were 52 bird species, one reptile species, two amphibians and six mammals. Along the creekline, small woodland birds such as the superb fairy wren (*Malurus cyaneus*), spotted pardalote (*Pardalotus punctatus*), yellow thornbill (*Acanthiza nana*) and yellow-faced honeyeater (*Lichenostomus chrysops*) were commonly encountered. The wedge-tailed eagle (*Aquila audax*) and the brown falcon (*Falco berigora*) were observed on frequent occasions soaring over the study area.

One reptile, the red-bellied black snake (*Pseudechis porphyriacus*), was recorded within the study area. Two amphibian species, the green reed frog (*Litoria fallax*) and the brown froglet (*Crinia signifera*), were recorded vocalising along the creek line within the study area. Six mammal species including the common wombat (*Vombatus ursinus*), common brushtail possum (*Trichosurus vulpecula*), eastern grey kangaroo (*Macropus giganteus*), swamp

wallaby (*Wallabia bicolor*), red-necked wallaby (*Macropus rufogriseus*) and the introduced rabbit (*Oryctolagus cuniculus*) were recorded through scats found throughout the study area.

4.2 Habitat Assessment

The study area provides a range of foraging, roosting and nesting habitat for a variety of native fauna. The two broad habitat types within the study area were found to be Riparian habitats and Open Forest habitats. Following is a description of the specific habitats within these broad habitat types.

4.2.1 Riparian Habitats

The eastern end of Cony Creek within the study area was dry at the time of the survey with only a few small ponds of water occurring. The creek bank along the eastern end of the study area contained a moderately dense stand of swamp oak (*Casuarina glauca*) which may provide foraging and nesting habitat for a number of small woodland birds. The dense grass and weed understorey may provide potential foraging habitat for small ground-dwelling mammals, reptiles and frogs. The isolated ponds of water may provide habitat for a number of frog species and a limited drinking resource for native fauna. Scattered logs and branches littered the creek bed as well as dense swamp oak needles providing a refuge and foraging habitat for reptiles and frogs. Progressing west, eucalypt species become more dominant in the riparian vegetation. These eucalypt species may provide a seasonal foraging resource for many nectarivorous birds. Larger and deeper ponds of water were present within the western end of the creekline providing a more suitable habitat for frogs and water resources for all native fauna. Visual inspection of the water indicated that the water quality was poor, and possibly had a high nutrient load. The water quality appeared to improve from very nutrient rich in the east of the study area to less nutrient rich in the west. The entire study area provides a foraging resource for micro-bats, owls and birds of prey.

A small number of swamp oak (*Casuarina glauca*) along the creek line contain tiny hollows suitable for hollow roosting micro-bats. One dead tree trunk, or stag, with multiple hollows was located to the south west of the study area and contained a number of nesting red-rumped parrots (*Psephotus haematonotus*). This stag overlooks a large farm dam and provides perching habitat for a number of bird species including the white-bellied sea-eagle (*Haliaeetus leucogaster*). No other hollow-bearing trees were present along the creek line, with nesting habitat for hollow dependent fauna species generally limited. Large, mature eucalypts were present along the creek line within the western end of the study area and may provide nesting and/or roosting opportunities for owls and large birds of prey. A large white-bellied sea-eagle nest is present at the western end of the study area, with the resident pair breeding every year (Trevor Duckworth pers. comm.).

4.2.2 Open Forest Habitats

The open forest habitats occur in the north of the study area, on the drier slopes and crests. The vegetation community dominating this habitat type within the study area is the Spotted Gum – Ironbark Forest.

The canopy in the open forest habitats is dominated by eucalypt species, which, when flowering, would provide foraging resources for nectarivorous species. This may include a diversity of birds, micro-bats and small mammals, including threatened species such as the squirrel glider (*Petaurus norfolcensis*) and the grey-headed flying-fox (*Pteropus poliocephalus*). The Eucalypt species would also harbour a diversity of invertebrate species, which would be utilised by insectivorous species such as micro-bats. The canopy trees are

predominantly younger age-classes, with few large, hollow-bearing trees observed. As such, nesting habitat for hollow-dependent fauna species is limited.

The Open Forest habitats comprise an understorey of low, prickly shrubs which provide refuge areas for small birds, mammals and reptiles. The grassy ground stratum provides foraging resources for granivorous bird species.

4.3 Threatened Fauna Species

Two threatened fauna species, the speckled warbler (*Pyrrholaemus sagittata*) and the grey-crowned babbler (*Pomatostomus temporalis temporalis*), were recorded on the perimeter of the study area during surveys of 24 and 25 August 2006. Five individual grey-crowned babblers were recorded to the north of the creekline foraging within the woodland community (**Figure 4.1**). One speckled warbler was recorded approximately 50 metres to the south of the creekline foraging within the grassland along the edge of woodland (**Figure 4.1**).

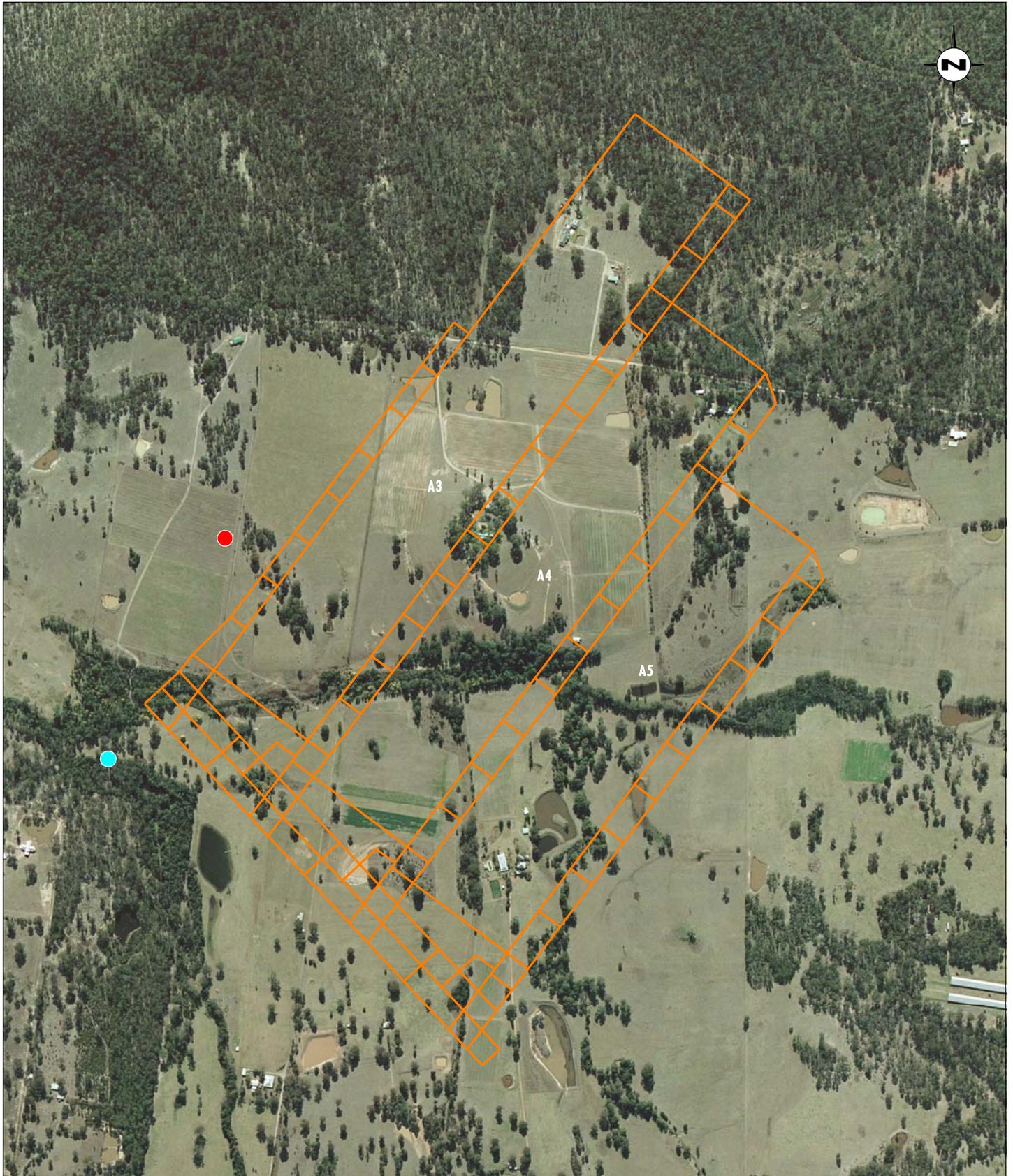
A search of relevant ecological databases was undertaken in order to identify threatened fauna species which have potential to occur within the study area. These database searches involved:

- a search of the DEC Atlas of NSW Wildlife (2006) for threatened fauna species recorded within a 10 kilometre radius of the study area; and
- a search of the DEH Protected Matters Database (2006) for threatened fauna species with potential to occur (based on DEH habitat modelling) within a 10 kilometre radius of the study area.

Table 2 of **Appendix 2** lists the 37 threatened fauna species recorded from these two database searches, and assesses the likelihood of their occurrence within the study area. Of the 37 species listed, 21 are considered to have potential habitat within the study area, and are listed in **Table 4.1** below.

Table 4.1 - Threatened Fauna Species with Potential to Occur within the Study Area

Species	Status
green and golden bell frog <i>Litoria aurea</i>	E (TSC) V (EPBC) # *
green-thighed frog <i>Litoria brevipalmata</i>	V (TSC) *
black-breasted buzzard <i>Hamirostra melanosternon</i>	V (TSC) *
red goshawk <i>Erythrotriorchis radiatus</i>	E (TSC) V (EPBC) *
swift parrot <i>Lathamus discolor</i>	E (TSC) E (EPBC) # *
regent honeyeater <i>Xanthomyza phrygia</i>	E (TSC) E (EPBC) # *



Base Source: AAM Hatch, 2006
Source: Astar Coal Mine

0 100 200 400m
1:10 000

Legend

- Stage 2 Longwall Panels and Study Area Boundary
- Grey - crowned Babbler
- Speckled Warbler

FIGURE 4.1

Threatened Species Locations

Table 4.1 - Threatened Fauna Species with Potential to Occur within the Study Area (cont)

Species	Status
glossy black-cockatoo <i>Calyptorhynchus lathami</i>	V (TSC) *
gang-gang Cockatoo <i>Callocephalon fimbriatum</i>	V (TSC) *
turquoise parrot <i>Neophema pulchella</i>	V (TSC) *
powerful owl <i>Ninox strenua</i>	V (TSC) *
barking owl <i>Ninox connivens</i>	V (TSC) *
masked owl <i>Tyto novaehollandiae</i>	V (TSC) *
brown treecreeper (eastern subsp.) <i>Climacteris picumnus victoriae</i>	V (TSC) *
black-chinned honeyeater (eastern subsp.) <i>Melithreptus gularis gularis</i>	V (TSC) *
squirrel glider <i>Petaurus norfolcensis</i>	V (TSC) *
grey-headed flying-fox <i>Pteropus poliocephalus</i>	V (TSC) V (EPBC) # *
eastern freetail-bat <i>Mormopterus norfolkensis</i>	V (TSC) *
eastern bentwing-bat <i>Miniopterus schreibersii oceanensis</i>	V (TSC) *
eastern false pipistrelle <i>Falsistrellus tasmaniensis</i>	V (TSC) *
large-eared pied bat <i>Chalinolobus dwyeri</i>	V (TSC) V (EPBC) #
large-footed myotis <i>Myotis adversis</i>	V (TSC) ^

Key:

* Records from DEC Wildlife Atlas Database

Records from EPBC Protected Matters Search

TSC = *Threatened Species Conservation Act 1995*

EPBC Act = *Environment Protection and Biodiversity Conservation Act 1999*

E = Endangered

V = Vulnerable

^ Species added from previous studies or expert knowledge

The potential for the proposed development to have an impact on threatened fauna species recorded or with potential to occur within the study area is assessed in **Table 1** of **Appendix 2**. Due to the proposed development being underground mining, the surface disturbances are expected to be minimal, and therefore it is unlikely to result in an impact on any of the threatened fauna species recorded or with potential to occur within the study area. As such, it was not required to undertake a seven part test of significance for any threatened fauna species. Further discussion of the impacts of the proposed development is provided in **Section 7.0**.

An assessment of significance under the EPBC Act was also prepared for threatened fauna species listed under that Act with potential to occur within the study area: this is provided in **Appendix 4**. Those species assessed are the green and golden bell frog (*Litoria aurea*), red goshawk (*Erythrotriorchis radiatus*), grey-headed flying-fox (*Pteropus poliocephalus*) and the large-eared pied bat (*Chalinolobus dwyeri*).

There are no threatened fauna species listed under the FM Act with potential to occur within the study area.

4.4 Endangered Fauna Populations

There are no endangered fauna populations occurring within the study area.

4.5 Critical Habitat

There are no areas of critical habitat occurring within or in proximity to the study area.

4.6 EPBC – Listed Migratory Species

A search of the DEH Protected Matters Database was undertaken in order to identify any EPBC Act listed threatened, migratory or listed marine species which could potentially occur within a 10 kilometre radius of the centre of the study area (based on DEH habitat modelling).

Threatened flora and fauna species identified in the database search are presented in **Tables 1** and **2** of **Appendix 2**, while the EPBC-listed migratory and marine species are listed in **Table 4.2** below (discounting fish, whales and pelagic bird species).

Table 4.2 - Migratory and listed marine species potentially occurring within a 10 kilometre radius of the study area (DEH Protected Matters Database)

Species	Status	Potential to Occur
white-bellied sea-eagle <i>Haliaeetus leucogaster</i>	Migratory-terrestrial Marine	Recorded
white-throated needletail <i>Hirundapus caudacutus</i>	Migratory-terrestrial Marine	Moderate
black-faced monarch <i>Monarcha melanopsis</i>	Migratory-terrestrial Marine	Low
satin flycatcher <i>Myiagra cyanoleuca</i>	Migratory-terrestrial Marine	Moderate
rufous fantail <i>Rhipidura ruffifrons</i>	Migratory-terrestrial Marine	High

Table 4.2 - Migratory and listed marine species potentially occurring within a 10 kilometre radius of the study area (DEH Protected Matters Database) (cont)

Species	Status	Potential to Occur
regent honeyeater <i>Xanthomyza phrygia</i>	Migratory-terrestrial	Moderate
Latham's snipe <i>Gallinago hardwickii</i>	Migratory-wetland Marine	Low
painted snipe <i>Rostratula benghalensis</i>	Migratory-wetland Marine	Low
fork-tailed swift <i>Apus pacificus</i>	Marine	High
great egret <i>Ardea alba</i>	Marine	Recorded
cattle egret <i>Ardea ibis</i>	Marine	Moderate
swift parrot <i>Lathamus discolor</i>	Marine	Moderate
rainbow bee-eater <i>Merops ornatus</i>	Marine	Moderate

Of the 13 EPBC-listed migratory species shown in **Table 4.2** above, two were recorded during surveys of the study area, being the great egret (*Ardea alba*) and the white-bellied sea-eagle (*Haliaeetus leucogaster*). An assessment of significance has been undertaken for migratory and marine species listed in **Table 4.2**, and is provided in **Appendix 4**.

5.0 Key Threatening Processes

A number of Key Threatening Processes (KTPs) listed under the Schedules of the TSC Act, the EPBC Act and the FM Act, are or may be relevant to the project. Each of the relevant KTPS is detailed in **Sections 5.1 to 5.3**.

5.1 TSC Act

Those KTPs listed under the TSC Act with the potential to be relevant to this proposal are listed below. For each, an assessment of the applicability of the threatening process to the proposal is provided.

- **Alterations due to subsidence associated with longwall mining:** this is likely to be the most relevant KTP associated with the proposed development. All potential ecological impacts associated with the underground mining operations must be identified, and their significance assessed. Appropriate management measures will need to be implemented to mitigate any impacts of the underground mining development that are identified during monitoring.
- **Clearing of native vegetation:** the clearing of native vegetation is listed as a major factor contributing to the loss of biological diversity. Given that the proposed development will involve underground mining, there is expected to be minimal clearing of native vegetation and, as a result, the implications of this KTP are expected to be able to

be minimal, being limited to small scale surface facilities and localised subsidence remediation works.

- **Invasion of native plant communities by exotic perennial grasses:** there is minor potential that operations associated with the proposed development may introduce exotic perennial grasses into native plant communities. Should regular monitoring of the disturbance area detect exotic perennial grasses becoming invasive within native plant communities (particularly within the EECs), appropriate management measures should be implemented.
- **High frequency fire resulting in the disruption of life cycle processes in plants and animals and loss of vegetation structure and composition:** there is minor potential that operations associated with the proposed development may cause an increase in frequency of fire in native vegetation areas. In the event that the vegetation of the disturbance area experiences high frequency of fire, appropriate management measures will need to be implemented.
- **Alteration to the natural flow regimes of rivers, streams, floodplains and wetlands:** The proposed underground mining has the potential to cause alteration to the natural flow regime of waterways as a result of subsidence. Appropriate amelioration measures will need to be implemented if monitoring reveals any significant alteration to the natural flow regimes of the study area.

5.2 EPBC Act

There is one KTP listed under the EPBC Act with potential relevance to this proposal. This KTP is detailed below:

- **Land clearance:** given that the proposed development will involve underground mining, clearing of native vegetation is expected to be minimal, and is likely to be limited to disturbance for small scale surface facilities and subsidence remediation works. As such, the implications of this key threatening process are expected to be minimal.

5.3 Fisheries Management Act

Key Threatening Processes currently listed under the FM Act with potential relevance to this proposal are listed below:

- **The removal of large woody debris:** the proposed development is not likely to require the removal of large woody debris from watercourses. However, should this be required, the implications of this must be considered and appropriately ameliorated.
- **The degradation of native riparian vegetation along New South Wales water courses:** the proposed development may result in the degradation of riparian vegetation as a result of subsidence due to longwall mining. Appropriate amelioration measures will need to be implemented if monitoring reveals any significant alterations that will result in degradation of native riparian vegetation.

6.0 Koala Habitat Assessment – [SEPP 44]

SEPP 44 aims to encourage the proper conservation and management of areas of natural vegetation that provide habitat for koalas, to ensure permanent free-living populations over their present range and to reverse the current trend of population decline. Any development application in an identified local government area, affecting land one hectare or greater, including adjoining lands on the same holding, must be assessed under the policy.

Assessment under SEPP 44 is based on an initial determination of whether the land constitutes potential koala habitat. This is determined by assessing whether the eucalypt species present in Schedule 2 constitutes 15% or more of the total number of trees in the upper or lower strata of the tree component. If potential koala habitat is present, the area must be further assessed to determine if the land is core koala habitat.

The species listed in Schedule 2 of the policy are:

Scientific Name	Common Name
<i>Eucalyptus tereticornis</i>	forest red gum
<i>Eucalyptus microcorys</i>	tallowwood
<i>Eucalyptus punctata</i>	grey gum
<i>Eucalyptus viminalis</i>	ribbon or manna gum
<i>Eucalyptus camaldulensis</i>	river red gum
<i>Eucalyptus haemastoma</i>	broad leaved scribbly gum
<i>Eucalyptus signata</i>	scribbly gum
<i>Eucalyptus albens</i>	white box
<i>Eucalyptus populnea</i>	bimble box or poplar box
<i>Eucalyptus robusta</i>	swamp mahogany

One SEPP 44 listed tree species, forest red gum (*Eucalyptus tereticornis*), was recorded within the *Riparian Swamp Oak – Rough-barked Apple Open Forest* community of the study area. A further SEPP 44 species, grey gum (*Eucalyptus punctata*), was recorded in the *Spotted Gum – Ironbark Forest* in the north of the study area. The results of the SEPP 44 assessment for each tree species in each vegetation community of the study area are presented in **Table 6.1** below.

Table 6.1 - Results of SEPP 44 Assessment

Tree Species	Vegetation Community		
	Riparian Swamp Oak – Rough-barked Apple Open Forest	Spotted Gum – Ironbark Forest	Derived Grassland
<i>Eucalyptus tereticornis</i>	Approximately 5-10% of total trees (averaged across community)	absent	absent
<i>Eucalyptus punctata</i>	absent	Approximately 5% of total trees (averaged across community)	absent

The SEPP 44 Assessment shows that both forest red gum (*Eucalyptus tereticornis*) and grey gum (*Eucalyptus punctata*) comprise less than 15% of the total trees present within the vegetation communities they occur in. Therefore the study area does not comprise potential koala habitat as defined under SEPP 44. Furthermore, the study area is only poorly connected to important habitat areas for koalas such as the Watagans National Park to the south. As such, the study area is not considered to comprise potential koala habitat.

7.0 Assessment of Subsidence Impacts

The proposed development will involve the underground mining of longwall panels A3, A4 and A5, the locations of which are shown on **Figure 1.1**.

The potential ecological impacts of the proposed development will be concentrated within riparian and floodplain areas, while the ecology of all other parts of the study area are expected to remain unaffected.

Potential changes as a result of longwall mining that may impact on riparian ecosystems include:

- changes to runoff and flow volumes through subsidence induced changes to catchment boundaries;
- changes to bank stability or channel alignment;
- changes to in channel and out of channel ponding through changes to the bed profile of the creeks which may result in drying or waterlogging of root systems; and
- changes to groundwater availability through cracking of the underlying strata.

A detailed analysis of predicted subsidence has been undertaken by MSEC (2007) with predictions provided for maximum subsidence and upper bound subsidence. This modelling and analysis has included development of profiles of predicted subsidence, upsidence and valley closure along Cony Creek and Quorrobolong Creek systems within the Stage 2 study area and estimates of tilt and strain along the creek system.

Subsidence predictions along Quorrobolong and Cony Creeks (MSEC 2007) are summarised in **Table 7.1**

Table 7.1 – Maximum and Upper Bound Predicted Subsidence Along Cony Creek and Quorrobolong Creek

Creek	Longwall	Maximum Predicted Cumulative Net Subsidence (mm)	Upper Bound Predicted Cumulative Net Subsidence (mm)
Quorrobolong Creek	After LWA3	100	240
	After LWA4	675	1480
	After LWA5	980	2230
Cony Creek	After LWA3	<20	20
	After LWA4	65	185
	After LWA5	745	1635

This analysis has been used as a basis for determining potential changes to the surface and groundwater regimes that are important to the survival of riparian ecosystems they support. Using this information predictive models of the potential changes to the surface hydrology as a result of longwall mining of these panels have been developed by Umwelt (2007).

Analysis of changes to surface terrain, creek bed profiles and surface and groundwater regimes as a result of the predicted and upper bound subsidence indicate that:

- there will be no significant changes to catchment boundaries;
- there will be no significant change to channel alignment or bank stability;
- there will be no significant change to in channel or out of channel ponding; and
- groundwater availability to riparian vegetation is not likely to substantially change as a result of mining.

7.1 Impacts on Threatened Flora Species and EECs

As described in **Section 7.0**, the surface disturbances associated with the proposed longwall mining development are expected to be minimal, with only minor subsidence and minor changes to the surface and groundwater patterns predicted. Riparian and floodplain areas only are expected to be affected. Based on the predicted levels of surface and groundwater disturbance resulting from subsidence, any impacts on flora species or vegetation communities resulting from the proposed development are likely to be negligible.

Appendix 2 provides an assessment of the potential for the proposed development to impact on the two TSC Act listed threatened flora species with potential to occur within the study area, being heath wrinklewort (*Rutidosis heterogama*) and small-flower grevillea (*Grevillea parviflora* subsp. *parviflora*). Given that both threatened flora species do not typically occur in riparian or floodplain environments, it is unlikely that the proposed development will impact on these species. Due to the negligible impacts of the proposed development on fauna species, no seven part test of significance under the EP&A Act was required for any threatened fauna species.

An assessment of the significance of the proposed development under the EPBC Act was undertaken and is provided in **Appendix 4**. This assessment considers the impacts on the threatened flora species with potential to occur within the study area, listed under this Act, being heath wrinklewort (*Rutidosis heterogama*) and small-flower grevillea (*Grevillea parviflora* subsp. *parviflora*). This assessment concluded that there will be no significant impact on EPBC-listed threatened flora species as a result of the proposed development.

As discussed in **Section 3.4**, two EECs are regarded to have a reasonable likelihood of occurrence within the study area: *River-flat Eucalypt Forest on Coastal Floodplains* and *Lower Hunter Spotted Gum – Ironbark Forest*. The latter EEC occurs only on slopes and ridges throughout the study area, therefore there will be negligible impacts on this community. However, the potential River-flat Eucalypt Forest EEC occurs on riparian and floodplain environments (**Figure 3.1**) and is a groundwater dependent ecosystem, therefore it has potential to be impacted upon by the proposed underground mining. A seven part test of significance under the TSC Act was prepared for this EEC to determine the significance of the likely impacts of the proposed development on this community, based on the assumption that this community is present. The conclusion of this assessment, which is provided in **Appendix 2**, is that the proposed development will not result in a significant impact on the *River-flat Eucalypt Forest* EEC, based on the predicted levels of subsidence, and estimated

changes to surface and groundwater flow patterns. Although the predicted disturbances suggest that there will be no significant impact on this EEC, monitoring of the community will need to be undertaken for a period of time to ensure that there are no long term impacts. If significant impacts are detected then these would need to be appropriately managed. Recommendations on the nature of the monitoring program are described in **Section 8.0**.

7.2 Impacts on Fauna

Based on the predicted levels of change to surface and groundwater flows resulting from underground mining, the proposed development is not likely to lead to significant alteration to fauna habitats.

Of the 21 threatened fauna species with potential to occur within the study area (**Table 2, Appendix 2**) it is not expected that the proposed development will have an impact on any species. There is potential for underground mining to impact on the threatened frog species green and golden bell frog (*Litoria aurea*) and green-thighed frog (*Litoria brevipalmata*) and also the large-footed myotis (*Myotis adversus*), however, predicted changes in surface and groundwater patterns associated with the proposed development are likely to have negligible impacts on these species. Due to the negligible impacts of the proposed development on fauna species, no seven part test of significance under the TSC Act was required for any threatened fauna species.

An assessment of the significance of the proposed development under the EPBC Act was undertaken and is provided in **Appendix 4**. This assessment considers the impacts on the threatened fauna species with potential to occur within the study area listed under this Act, being green and golden bell frog (*Litoria aurea*), red goshawk (*Erythrotriorchis radiatus*), grey-headed flying-fox (*Pteropus poliocephalus*) and the large-eared pied bat (*Chalinolobus dwyeri*). The assessment also considers the impact of the proposed development on EPBC Act-listed migratory and marine species. The assessment concluded that there will be no significant impact on EPBC-listed threatened fauna species, migratory species or marine species as a result of the proposed development.

8.0 Recommended Monitoring Program

To ensure the continued protection of significant ecological values of the study area, regular monitoring of the disturbance area should be undertaken following mining in order to identify unforeseen impacts of the underground mining, and to enable appropriate mitigation measures to be implemented to ameliorate these impacts. In addition, monitoring should ensure that mitigation measures are successfully implemented. The monitoring program should be specifically targeted towards identifying changes to the potential *River-flat Eucalypt Forest* EEC.

Specific surveys targeting fauna groups is not deemed necessary given the minimal surface disturbances predicted and the extensive effort required to collect sufficient data on fauna species to allow reliable comparisons to be made. Should the results of monitoring surveys reveal reason to conduct fauna surveys, the monitoring program should be appropriately adapted.

Baseline monitoring should be undertaken a minimum of one month prior to commencement of mining, and should subsequently be conducted every six months. Two monitoring events per year are preferable to one, as this minimises the effects of natural seasonal variation on the data, enabling patterns of change to be more readily detected. It is essential that

baseline surveys be conducted prior to the commencement of mining, so that quantitative baseline information can be established with which the results of subsequent monitoring surveys can be compared. The duration of the monitoring program should be reviewed five years after the commencement of mining, and will be largely dependant on the results obtained up to that stage.

The monitoring program should involve three key survey methods: quantitative survey plots; vegetation condition assessment and photo monitoring. Brief descriptions of these survey methods are provided below.

8.1.1 Permanent Vegetation Plots

A total of four quantitative vegetation plots should be established within the potential *River-flat Eucalypt Forest* EEC in representative sites. Each plot should be 400 m² and should have dimensions of either 20 metres by 20 metres or 10 metres by 40 metres, the latter being more appropriate in narrow, riparian bands of vegetation. Each plot should be permanently marked with a metal stake in each corner, and a GPS reading of the location of the plot should be taken to ensure it can be readily located. Within each plot, all species observed should be recorded, and the cover-abundance noted using a scale such as the Braun-Blanquet six-point scale.

8.1.2 Condition Assessment

Within each vegetation plot, an assessment of the condition of the vegetation should be made, using key indicators to ensure that comparison between the results from different monitoring events can be made. The key indicators should include but not be limited to:

- density and diversity of weed species;
- extent of dieback in vegetation;
- evidence of insect attack and presence of mistletoe; and
- evidence of or lack of recruitment of species.

8.1.3 Photo Monitoring

Photo monitoring should be undertaken at each vegetation plot, with photos being taken from at least two of the four corners of the plot. The bearing of the photo should be recorded to ensure that the photo can be replicated as closely as possible on subsequent monitoring events. The photos should be used to identify any observable changes in the vegetation condition over time.

9.0 Conclusion

Analysis of the predicted levels of subsidence and associated changes to hydrology has identified that the impacts of the proposed development on the ecology of the study area are likely to be negligible. The proposed development is not expected to have a significant impact on any threatened species, populations or EECs recorded or with potential to occur within the study area.

In order to make certain that there will be no impacts on the potential *River-flat Eucalypt Forest* EEC recorded within the study area as a result of the proposed development due to

unforeseen circumstances, a monitoring program specifically focused on this EEC is recommended. If impacts resulting from the mining operation are recorded, means to remediate the impacts of prevent future impacts should be developed and implemented.

10.0 References

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APPENDIX 1

Flora Species List

Appendix 1 – Flora Species List

The following list was developed from surveys of the study area detailed in **Section 2.1** of the main report. It includes all species of vascular plants observed on the study area during fieldwork. Not all species are readily detected at any one time of the year, and therefore the list will not necessarily include all plant species likely to occur in the study area. Many species flower only during restricted periods of the year, and some flower only once in several years. In the absence of flowering material, many of these species cannot be identified, or even detected.

Names of classes and families follow a modified Cronquist (1981) System.

The following abbreviations or symbols are used in the list:

sp.	specimens that are identified to genus level only;
asterisk (*)	denotes species not indigenous to the study area;
subsp.	subspecies;
var.	variety; and
prob.	specimens for which identification was highly likely but not definite.

All vascular plants recorded or collected were identified using keys and nomenclature in Harden (1992, 1993, 2000 & 2002) and Wheeler et al. (2002). Where known, changes to nomenclature and classification have been incorporated into the results, as derived from *PlantNET* (Botanic Gardens Trust 2007), the on-line plant name database maintained by the National Herbarium of New South Wales.

Common names used follow Harden (1992, 1993, 2000 & 2002) where available, and draw on other sources such as local names where these references do not provide a common name.

Family/Subfamily	Scientific Name	Common Name
Filicopsida (Ferns)		
Adiantaceae	<i>Adiantum aethiopicum</i>	common maidenhair
Adiantaceae	<i>Cheilanthes seeberi</i> subsp. <i>sieberi</i>	poison rock fern
Blechnaceae	<i>Doodia aspera</i>	prickly rasp fern
Dennstaedtiaceae	<i>Pteridium esculentum</i>	bracken
Magnoliopsida (Flowering Plants) – Liliidae (Monocots)		
Commelinaceae	* <i>Tradescantia fluminensis</i>	wandering Jew
Cyperaceae	<i>Carex appressa</i>	tall sedge
Juncaceae	<i>Juncus</i> prob. <i>usitatus</i>	common rush
Juncaginaceae	<i>Triglochin striatum</i>	streaked arrowgrass
Lomandraceae	<i>Lomandra longifolia</i> var. <i>longifolia</i>	spiny-headed mat-rush
Phormiaceae	<i>Dianella caerulea</i> var. <i>caerulea</i>	blue-flax lily
Poaceae	<i>Aristida vagans</i>	three-awn speargrass
Poaceae	* <i>Cortaderia selloana</i>	Pampas grass
Poaceae	<i>Cynodon dactylon</i>	common couch
Poaceae	<i>Entolasia stricta</i>	

Family/Subfamily	Scientific Name	Common Name
Poaceae	<i>Imperata cylindrica</i> var. <i>major</i>	blady grass
Poaceae	* <i>Pennisetum clandestinum</i>	kikuyu grass
Poaceae	<i>Phragmites australis</i>	common reed
Poaceae	<i>Themeda australis</i>	kangaroo grass
Typhaceae	<i>Typha orientalis</i>	broad-leaved cumbungi
Magnoliopsida (Flowering Plants) – Magnoliidae (Dicots)		
Apiaceae	* <i>Hydrocotyle bonariensis</i>	
Apocynaceae	<i>Parsonsia straminea</i>	common silkpod
Asclepiadaceae	* <i>Araujia sericiferum</i>	moth vine
Asclepiadaceae	* <i>Gomphocarpus fruticosus</i>	narrow-leaved cotton bush
Asteraceae	* <i>Senecio madagascariensis</i>	fireweed
Asteraceae	* <i>Sonchus oleraceus</i>	common sowthistle
Bignoniaceae	<i>Pandorea pandorana</i> subsp. <i>pandorana</i>	wonga wonga vine
Casuarinaceae	<i>Casuarina glauca</i>	swamp oak
Celastraceae	<i>Maytenus silvestris</i>	narrow-leaved orange bark
Convolvulaceae	<i>Dichondra repens</i>	kidney weed
Dilleniaceae	<i>Hibbertia scandens</i>	climbing Guinea flower
Ericaceae (Styphelioideae)	<i>Lissanthe strigosa</i>	peach heath
Euphorbiaceae	<i>Breynia oblongifolia</i>	coffee bush
Fabaceae (Faboideae)	<i>Daviesia genistifolia</i>	broom bitter pea
Fabaceae (Faboideae)	<i>Dillwynia retorta</i>	
Fabaceae (Faboideae)	<i>Glycine tabacina</i>	love creeper
Fabaceae (Faboideae)	<i>Indigofera australis</i>	Australian indigo
Fabaceae (Mimosoideae)	<i>Acacia irrorata</i>	green wattle
Fabaceae (Mimosoideae)	<i>Acacia longifolia</i>	coast wattle
Fabaceae (Mimosoideae)	<i>Acacia parvipinnula</i>	silver-stemmed wattle
Fabaceae (Mimosoideae)	<i>Acacia ulicifolia</i>	prickly Moses
Geraniaceae	<i>Geranium solanderi</i>	native geranium
Goodeniaceae	<i>Goodenia rotundifolia</i>	
Lauraceae	* <i>Cinnamomum camphora</i>	camphor laurel
Lauraceae	<i>Cassytha glabella</i>	devil's twine
Lobeliaceae	<i>Pratia purpurascens</i>	whiteroot
Loganiaceae	<i>Logania albiflora</i>	
Malvaceae	* <i>Sida rhombifolia</i>	Paddy's lucerne
Myrtaceae	<i>Angophora floribunda</i>	rough-barked apple
Myrtaceae	<i>Callistemon linearis</i>	narrow-leaved bottlebrush
Myrtaceae	<i>Corymbia maculata</i>	spotted gum

Family/Subfamily	Scientific Name	Common Name
Myrtaceae	<i>Eucalyptus amplifolia</i> subsp. <i>amplifolia</i>	cabbage gum
Myrtaceae	<i>Eucalyptus capitellata</i>	brown stringy-bark
Myrtaceae	<i>Eucalyptus deanei</i>	mountain blue gum
Myrtaceae	<i>Eucalyptus fibrosa</i>	red ironbark
Myrtaceae	<i>Eucalyptus moluccana</i>	grey box
Myrtaceae	<i>Eucalyptus punctata</i>	grey gum
Myrtaceae	<i>Eucalyptus tereticornis</i>	forest red gum
Myrtaceae	<i>Leptospermum polygalifolium</i> subsp. <i>polygalifolium</i>	lemon-scented tea-tree
Myrtaceae	<i>Melaleuca decora</i>	ball honeymyrtle
Myrtaceae	<i>Melaleuca linariifolia</i>	snow-in-summer
Myrtaceae	<i>Melaleuca nodosa</i>	ball honeymyrtle
Myrtaceae	<i>Melaleuca styphelioides</i>	prickly-leaved paperbark
Myrtaceae	<i>Syncarpia glomulifera</i> subsp. <i>glomulifera</i>	turpentine
Oleaceae	<i>Notelaea longifolia</i>	large mock-olive
Pittosporaceae	<i>Bursaria spinosa</i> subsp. <i>spinosa</i>	native blackthorn
Pittosporaceae	<i>Pittosporum undulatum</i>	sweet pittosporum
Plantaginaceae	* <i>Plantago lanceolata</i>	plantain
Polygonaceae	* <i>Rumex crispus</i>	curled dock
Polygonaceae	<i>Persicaria</i> sp.	
Primulaceae	* <i>Anagallis arvensis</i>	scarlet/blue pimpernel
Proteaceae	<i>Persoonia linearis</i>	narrow-leaved geebung
Ranunculaceae	<i>Clematis glycinoides</i> var. <i>glycinoides</i>	headache vine
Rhamnaceae	<i>Pomaderris</i> sp.	
Rosaceae	* <i>Rubus fruticosus</i> sp. agg.	blackberry
Rutaceae	<i>Melicope micrococca</i>	hairy-leaved doughwood
Santalaceae	<i>Exocarpos cupressiformis</i>	native cherry
Solanaceae	* <i>Cestrum parqui</i>	green cestrum
Solanaceae	<i>Solanum aviculare</i>	kangaroo apple
Solanaceae	* <i>Solanum mauritianum</i>	wild tobacco bush
Solanaceae	<i>Solanum</i> sp.	
Verbenaceae	* <i>Verbena bonariensis</i>	purpletop

APPENDIX 2

Test of Significance (EP&A Act)

Appendix 2 – Assessment of Threatened Species, Populations and EECs Likely to Occur under the EP&A Act

Threatened species, endangered populations, or endangered ecological communities (EECs) recorded during the current surveys of the study area are listed in **Tables 1** and **2** below, as are the results of the searches of the DEC Atlas of NSW Wildlife and DEH Protected Matters Database. These database searches provided lists of species, populations or EECs previously recorded within a 10 kilometre radius of the study area, or with potential habitat within that radius.

Tables 1 and **2** contain the relevant ecological details used as part of the impact assessment, as well as an assessment of the potential impact (if any) that may occur as a result of the underground mining operations. Where there is the potential for an impact on any species, population or EEC, a detailed assessment of significance is provided following the tables. An assessment of significance for species listed under the Commonwealth EPBC Act is provided in **Appendix 4**.

Table 1 - Threatened Flora Assessment

Species	Legal Status	Specific Habitat	Distribution in relation to Survey Area	Reservation in the Region	Occurrence in Survey Area and Potential for Significant Impact	Detailed Assessment of Significance Required?
Bynoe's wattle <i>Acacia bynoeana</i>	V (EPBC) E (TSC) * #	Occurs mainly in heath and dry sclerophyll forest on sandy soils (Kodala and Harden 2002), and appears to prefer open and sometimes slightly disturbed sites such as road edges and recently burnt areas (DEC 2007).	Occurs in central eastern NSW from Morisset to the Illawarra region and west to the Blue Mountains (DEC 2007, Kodala and Harden 2002). It has also been found in the Parma Creek and Colymea areas west of Nowra (DEC 2007) and in the Kurri Kurri and Cessnock areas in the lower Hunter Valley. The study area is within the known distribution of this species.	Lake Macquarie SCA – count 1	May occur in spotted gum - ironbark forest in the north of the study area however, is unlikely to be significantly impacted by the proposed underground mining.	No.
heath wrinklewort <i>Rutidosia heterogama</i>	V (EPBC) V (TSC) *	Occurs mostly in heath, often along disturbed roadsides, in coastal districts.	In coastal districts from Maclean to the Hunter Valley and inland to Torrington (Harden 1992). It has also been recently recorded at Cooranbong on the Central Coast. The study area is within the known distribution of this species.	Glenrock SCA – count 5 This species is likely to occur within Werakata National Park, although there are no known records.	May occur in spotted gum - ironbark forest in the north of the study area, however is unlikely to be significantly impacted by the proposed underground mining.	No.

Species	Legal Status	Specific Habitat	Distribution in relation to Survey Area	Reservation in the Region	Occurrence in Survey Area and Potential for Significant Impact	Detailed Assessment of Significance Required?
<i>Callistemon linearifolius</i>	V (TSC) *	Typically grows in dry sclerophyll forest on the coast and adjacent ranges.	Recorded from the Georges River to Hawkesbury River in the Sydney area, and north to the Nelson Bay area of NSW (DEC 2007). The study area is within the known distribution of this species.	Munmorah NR – count 1 Werakata NP Yengo NP	Not likely to occur within the study area. There is no potential for a significant impact on this species.	No.
Parramatta red gum <i>Eucalyptus parramattensis</i> subsp. <i>decadens</i>	V (EPBC) V (TSC) * #	Typically grows on deep, low-nutrient sands, often subject to periodic inundation (DEC 2007). Occurs in dry sclerophyll woodland with a dry heath understorey and also as an emergent in dry or wet heathland (DEC 2007).	Occurs in two separate meta-populations, in the Kurri Kurri and Tomago areas (DEC 2007). The study area is outside the known distribution of this species.	Werakata NP	Not likely to occur within the study area. There is no potential for a significant impact on this species.	No.
small-flower grevillea <i>Grevillea parviflora</i> subsp. <i>parviflora</i>	V (EPBC) V (TSC) * #	Occurs in heath and shrubby woodland to open forest (DEC 2007), on sandy or light clay soils, usually over thin shales (Makinson 2002). The species is found over a range of altitudes, and can occur in open and slightly disturbed areas (DEC 2007).	The main occurrence of the species is centred around Picton, Appin and Bargo in the Sydney Basin, where it occurs sporadically (DEC 2007). Separate populations are known further north from Putty to Wyong, Lake Macquarie, Cessnock and Kurri Kurri (DEC 2007). The study area is within the known distribution of this species.	Werakata NP	May occur in spotted-gum ironbark forest in the north of the study area, however is unlikely to be significantly impacted by the proposed underground mining.	No.

Species	Legal Status	Specific Habitat	Distribution in relation to Survey Area	Reservation in the Region	Occurrence in Survey Area and Potential for Significant Impact	Detailed Assessment of Significance Required?
<p>leafless tongue orchid <i>Cryptostylis hunteriana</i></p>	<p>V (EPBC) V (TSC) #</p>	<p>Favours moist soils on the flat coastal plains. Occupies swamp heath, but may occupy sclerophyll forest and woodland, often on sandy soils (Weston 1993a). Typically found in communities containing <i>Eucalyptus haemastoma</i>, <i>E. capitellata</i> and <i>Corymbia gummifera</i>.</p>	<p>Recorded from Gibraltar Range National Park south into Victoria around the coast as far as Orbost. Known historically from a number of localities on the NSW south coast and has been observed in recent years at many sites between Batemans Bay and Nowra (although it is uncommon at all sites). Also recorded at Nelson Bay, Wyee, Washpool National Park, Nowendoc State Forest, Ku-Ring-Gai Chase National Park, Ben Boyd National Park (DEC 2007). The study area is within the known distribution of this species.</p>	<p>This species is not known from any conservation reserves in the region.</p>	<p>Potentially occurs within the study area in various habitats, however, the proposed underground mining development is unlikely to significantly impact this species.</p>	<p>No.</p>

Species	Legal Status	Specific Habitat	Distribution in relation to Survey Area	Reservation in the Region	Occurrence in Survey Area and Potential for Significant Impact	Detailed Assessment of Significance Required?
Charmhaven apple <i>Angophora inopinata</i>	V (EPBC) V (TSC) * #	Typically occurs on the shallow sandy soils of the Narrabeen Group, on exposed ridges and slopes with a westerly or northerly aspect. It has also been recorded on shallow alluvial soils of this geological type, in upper catchments and in embedded clay soil lenses with sandstone (Bell 2001).	Distribution confined to the Wyong, Lake Macquarie and Port Stephens Shires of New South Wales (Bell 2001). Pure forms of this species have been recorded from the Wallarah catchment in the south and north to the Toronto area. Disjunct populations have been identified at Karuah (Bell 2001). The study area is outside the known distribution of this species.	Karuah NR – count 5 Lake Macquarie SCA – count 3	Not likely to occur within the study area. There is no potential for a significant impact on this species.	No.
slaty red gum <i>Eucalyptus glaucina</i>	V (EPBC) V (TSC) #	Typically grows in grassy woodland on deep, moderately fertile and well-watered soil and can be locally frequent but very sporadic.	Occurs near Casino and from Taree to Broke in the North Coast botanical subdivision (Hill 2002). The study area is within the known distribution of this species.	This species is not known from any conservation reserves in the region.	Not likely to occur within the study area. There is no potential for a significant impact on this species.	No.
North Rothbury persoonia <i>Persoonia pauciflora</i>	CE (EPBC) E (TSC) (Preliminary nomination to list as CE under the TSC Act) #	Typically occurs in dry open forest or woodland with a moderate to sparse shrub layer and a high percentage of groundcover species, especially grasses (NSW NPWS 1999).	Very restricted distribution with all known individuals occurring within 2.5 km of the type specimen collected near North Rothbury in the Cessnock LGA (NSW NPWS 1999). The study area is outside the known distribution of this species.	This species is not known from any conservation reserves in the region.	Not likely to occur within the study area due to very restricted distribution. There is no potential for a significant impact on this species.	No.

Species	Legal Status	Specific Habitat	Distribution in relation to Survey Area	Reservation in the Region	Occurrence in Survey Area and Potential for Significant Impact	Detailed Assessment of Significance Required?
River Flat Eucalypt Forest	EEC (TSC) ^	Associated with silts, clay-loams and sandy loams, on periodically inundated alluvial flats, drainage lines and river terraces associated with coastal floodplains (NSW Scientific Committee 2005a).	This EEC was potentially recorded within the study area. This EEC occurs in the NSW North Coast, Sydney Basin and South-east corner bioregions.	This EEC is not known from any conservation reserves in the region.	This EEC was potentially recorded within riparian and floodplain habitats of the study area. There is potential for the proposed underground mining to have significant impacts on this EEC.	Yes.
Lower Hunter Spotted Gum - Ironbark Forest	EEC (TSC) ^	The <i>Lower Hunter Spotted gum – Ironbark Forest</i> EEC occurs in the central to lower Hunter Valley, principally on Permian geology.	This EEC was recorded within the study area. The EEC is restricted to a range of approximately 65 kilometres by 35 kilometres centred on the Cessnock – Beresfield area.	This EEC has been recorded in Werakata NP.	This EEC was recorded within the study area, on the drier slopes and ridges. The proposed underground mining is not likely to significantly impact on this EEC.	No.
Swamp Oak Floodplain Forest	EEC (TSC) ^	This EEC is associated with grey-black clay-loams and sandy loams, where the groundwater is saline or sub-saline, on waterlogged or periodically inundated flats, drainage lines, lake margins and estuarine fringes associated with coastal floodplains.	This EEC occurs throughout the North Coast, Sydney Basin and South-East Corner bioregions of NSW. The study area is within the known distribution of this EEC.	This EEC is not known from any conservation reserves in the region.	Not likely to occur within the study area due to very restricted distribution. There is no potential for a significant impact on this EEC.	No.

Species	Legal Status	Specific Habitat	Distribution in relation to Survey Area	Reservation in the Region	Occurrence in Survey Area and Potential for Significant Impact	Detailed Assessment of Significance Required?
Quorrobolong Scribbly Gum Woodland	EEC (TSC) ^	This EEC occurs on a residual sand deposit overlying the Permian clay sediments in the Hunter Valley.	This EEC is known from a small area between Quorrobolong and Mulbring in the Cessnock Local Government Area but may occur elsewhere. The study area is adjacent to the known distribution of this EEC.	This EEC is not known from any conservation reserves in the region.	Not likely to occur within the study area and no potential to occur. There is no potential for a significant impact on this EEC.	No.
Swamp Sclerophyll Forest	EEC (TSC) ^	This EEC is associated with humic clay loams and sandy loams, on waterlogged or periodically inundated alluvial flats and drainage lines associated with coastal floodplains.	This EEC occurs throughout the North Coast, Sydney Basin and South-East Corner bioregions of NSW. The study area is within the known distribution of this EEC.	This EEC is not known from any conservation reserves in the region.	Not recorded within the study area, and no potential to occur. There is no potential for a significant impact on this EEC.	No.
Freshwater Wetlands on Coastal Floodplains	EEC (TSC) ^	This EEC is associated with periodic or semi-permanent inundation by freshwater, although there may be minor saline influence in some wetlands. They typically occur on silts, muds or humic loams in depressions, flats, drainage lines, backswamps, lagoons and lakes associated with coastal floodplains.	This EEC occurs throughout the North Coast, Sydney Basin and South-East Corner bioregions of NSW. The study area is within the known distribution of this EEC.	Hexham Swamp NR Pambalong NR	Not recorded within the study area. There is no potential for a significant impact on this EEC.	No.

Species	Legal Status	Specific Habitat	Distribution in relation to Survey Area	Reservation in the Region	Occurrence in Survey Area and Potential for Significant Impact	Detailed Assessment of Significance Required?
Hunter Lowlands Red Gum Forest	EEC (TSC) ^	Occurs on gentle slopes arising from depressions and drainage flats on permian sediments of the Hunter Valley floor.	Recorded from Maitland, Cessnock and Port Stephens LGAs (in the Sydney Basin Bioregion) and Muswellbrook and Singleton LGAs (in the NSW North Coast Bioregion) but may occur elsewhere in these bioregions. The study area is within the known distribution of this EEC.	Werakata NP	Not recorded within the study area, and no potential to occur. There is no potential for a significant impact on this EEC.	No.

Species	Legal Status	Specific Habitat	Distribution in relation to Survey Area	Reservation in the Region	Occurrence in Survey Area and Potential for Significant Impact	Detailed Assessment of Significance Required?
White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland	CEEC (EPBC) #	This ecological community occurs in areas where rainfall is between 400 and 1200 mm per annum, on moderate to highly fertile soils at altitudes of 170 metres to 1200 metres.	<p>This EEC occurs in an arc along the western slopes and tablelands of the Great Dividing Range from Southern Queensland through NSW to central Victoria (Beadle 1981). It occurs in the Brigalow Belt South, Nandewar, New England Tableland, South Eastern Queensland, Sydney Basin, NSW North Coast, South Eastern Highlands, South East Corner, NSW South Western Slopes, Victorian Midlands and Riverina Bioregions (Environment Australia 2000).</p> <p>The study area is within the known range of this EEC.</p>	There are no known occurrences of this EEC within the conservation reserves of the region.	Not recorded within the study area and no potential to occur There is no potential for a significant impact on this EEC.	No.

Species	Legal Status	Specific Habitat	Distribution in relation to Survey Area	Reservation in the Region	Occurrence in Survey Area and Potential for Significant Impact	Detailed Assessment of Significance Required?
weeping myall <i>Acacia pendula</i>	EP (TSC) ^	Grows on major river floodplains on heavy clay soils, sometimes as the dominant species and forming low open woodlands. Within the Hunter catchment it typically occurs on heavy soils, sometimes at the margins of small floodplains, but also in more undulating locations remote from floodplains, such as at Jerrys Plains.	There are 17 confirmed and four unconfirmed naturally occurring remnants of the <i>A. pendula</i> population in the Hunter catchment. These range as far east as Warkworth, and as far west as Kerrabee, west of Sandy Hollow. <i>Acacia pendula</i> is not known to occur naturally further north than the Muswellbrook-Wybung area. Eight planted <i>A. pendula</i> populations (not naturally occurring) have been recorded in the Hunter, and it is likely that numerous more planted populations occur. The study area occurs to the east of the known distribution of this species.	No known natural remnants/populations of <i>Acacia pendula</i> occur on land zoned for conservation and only two stands, both part of the same population (at Jerrys Plains Cemetery), occur on community-owned land that is managed by a Council (Singleton).	No individuals of <i>Acacia pendula</i> were recorded within the study area. There is no potential for this endangered population to occur within the study area.	No.
tiger orchid <i>Cymbidium canaliculatum</i>	EP (TSC) ^	This species occurs within dry sclerophyll forests and woodlands of tablelands and western slopes, growing in hollows of trees. It is usually found occurring singly or as a single clump, typically between two and six metres above the ground.	The population of <i>Cymbidium canaliculatum</i> in the Hunter Catchment is at the south-eastern limit of the geographic range for this species. The study area occurs within the known distribution of this endangered population.	This species is not known from any conservation reserves within the region.	No individuals of <i>Cymbidium canaliculatum</i> were recorded within the study area. There is no potential for this endangered population to occur within the study area.	no

Species	Legal Status	Specific Habitat	Distribution in relation to Survey Area	Reservation in the Region	Occurrence in Survey Area and Potential for Significant Impact	Detailed Assessment of Significance Required?
river red gum <i>Eucalyptus camaldulensis</i>	EP (TSC) ^	This endangered population may occur with <i>Eucalyptus tereticornis</i> , <i>Eucalyptus melliodora</i> , <i>Casuarina cunninghamiana</i> subsp. <i>cunninghamiana</i> and <i>Angophora floribunda</i> .	The Hunter population occurs from the west at Bylong, south of Merriwa, to the east at Hinton, on the bank of the Hunter River. It has been recorded in the LGAs of Lithgow, Maitland, Mid-Western Regional, Muswellbrook, Port Stephens, Singleton and Upper Hunter. The study area occurs within the known distribution of this endangered population.	This species is not known from any conservation reserves in the region.	No individuals of <i>Eucalyptus camaldulensis</i> were recorded within the study area. There is no potential for this endangered population to occur within the study area.	No.

Key: * Records from DEC Wildlife Atlas Database
Records from EPBC Protected Matters Search
^ Records added from previous studies or expert knowledge
TSC = *Threatened Species Conservation Act 1995*
EPBC Act = *Environment Protection and Biodiversity Conservation Act 1999*
E = Endangered
V = Vulnerable
EP = endangered population
EEC = Endangered Ecological Community
CEEC = Critically Endangered Ecological Community
CE = critically endangered

EP = Endangered Population
NP – National Park
SCA – State Conservation Area
NR – Nature Reserve

Table 2 - Threatened Fauna Assessment

Species	Legal Status	Specific Habitat	Distribution in relation to Survey Area	Reservation in the Region	Occurrence in Survey Area and Potential for Significant Impact	Detailed Assessment of Significance Required?
giant burrowing frog <i>Heleioporus australiacus</i>	V (TSC) V (EPBC) #	This species prefers woodland and heath in Hawkesbury sandstone ridge-top habitat and broader upland valleys. In particular, it is found in small headwater creek lines and slow flowing or intermittent creek lines (DEC 2007).	Occurs from the central coast of NSW to Victoria (Cogger 1994). The study area is within the known distribution of this species.	This species is not known from any conservation reserves in the region.	There is no potential for this species to occur due to absence of sandstone habitats. There is no potential for a significant impact on this species.	No.
stuttering frog <i>Mixophyes balbus</i>	E (TSC) V (EPBC) # *	This species is found near streams in rainforest and wet, tall open forest in the foothills and escarpments (DEC 2007).	Occurs along the east coast from southern Queensland to north-east Victoria, on the eastern side of the Great Dividing Range (DEC 2007).	Jilliby SCA – count 7 Watagans NP – count 7	There is no potential for this species to occur due to absence of rainforest or tall open forest habitat. There is no potential for a significant impact on this species.	No.
giant barred frog <i>Mixophyes iteratus</i>	E (TSC) E (EPBC) # *	This species forages and lives amongst deep, damp leaf litter in rainforest, moist eucalypt forest and nearby dry eucalypt forest, at elevations below 1000 metres (DEC 2007). Breeds in shallow, flowing rocky streams (DEC 2007).	Occurs along the coast and ranges from south-eastern Queensland to the Hawkesbury River in NSW (DEC 2007). The Coffs Harbour-Dorrigo area, is now a stronghold (DEC 2007). The study area is within the known distribution of this species.	Jilliby SCA – count 2 Watagans NP – count 15	There is no potential habitat for this species due to absence of flowing water and rainforest habitats. There is no potential for a significant impact on this species.	No.

Species	Legal Status	Specific Habitat	Distribution in relation to Survey Area	Reservation in the Region	Occurrence in Survey Area and Potential for Significant Impact	Detailed Assessment of Significance Required?
green and golden bell frog <i>Litoria aurea</i>	E (TSC) V (EPBC) # *	Occurs among vegetation in permanent water bodies (Cogger 1994), particularly where bullrush (<i>Typha</i> spp.) and spikerush (<i>Eleocharis</i> spp.) occur (DEC 2007). Known to occur in degraded water bodies such as brick-pits and industrial sites (DEC 2007).	Occurs in eastern and south-eastern NSW to far eastern Victoria, largely at low altitudes (Cogger 1994). Once widespread, it is now restricted to isolated coastal populations. The study area is within the known distribution of this species.	Kooragang NR – count 11 Hexham Swamp NR – count 3	There is a low potential for this species to occur in farm dams within the study area. Due to the minimal surface disturbances associated with the proposed development, there will be negligible impacts, if any, on this species.	No.
green-thighed frog <i>Litoria brevipalmata</i>	V (TSC) *	Occurs in a range of habitats from rainforest and moist eucalypt forest to dry eucalypt forest and heath, typically in areas where surface water gathers after rain (DEC 2007). Breeding occurs around grassy semi-permanent ponds and flood-prone grassy areas (DEC 2007).	Recorded in isolated locations in wet sclerophyll forest along the north coast of NSW and south east Queensland (DEC 2007). The study area is within the known distribution of this species.	This species is not known from any conservation reserves in the region.	Potential habitat for this species occurs within the study area. Due to the minimal surface disturbances associated with the proposed development, there will be negligible impacts, if any, on this species.	No.

Species	Legal Status	Specific Habitat	Distribution in relation to Survey Area	Reservation in the Region	Occurrence in Survey Area and Potential for Significant Impact	Detailed Assessment of Significance Required?
Littlejohn's tree frog <i>Litoria littlejohni</i>	V (TSC) V (EPBC) #	Occurs along permanent rocky streams with thick fringing vegetation associated with eucalypt woodlands and heaths among sandstone outcrops (DEC 2007). Prefers wet forest margins for breeding.	Occurs along the eastern slopes of the Great Dividing Range from the Watagans near Wyong, south to Buchan in north-eastern Victoria. It has not been recorded in coastal habitats (DEC 2007). The study area is slightly north of the known distribution of this species.	This species is not known from any conservation reserves in the region.	There is no potential for this species to occur within the study area due to the absence of permanent rocky streams. There is no potential for a significant impact on this species.	No.
broad-headed snake <i>Hoplocephalus bungaroides</i>	E (TSC) V (EPBC) #	This species appears to prefer sites where exposed sandstone outcrops and benches occur, particularly in woodland and heath vegetation. It is often found sheltering under rock crevices (winter) and tree hollows (summer) (DEC 2007).	Restricted to a 200 kilometre radius of the Sydney basin (Swan 1990). This range extends from Wollemi National Park to the eastern edge of the Clyde River Catchment, near Bateman's Bay. The study area is slightly north of the known distribution of this species.	This species is not known from any conservation reserves in the region.	Due to the absence of sandstone outcrops, this species is not likely to occur within the study area. There is no potential for a significant impact on this species.	No.

Species	Legal Status	Specific Habitat	Distribution in relation to Survey Area	Reservation in the Region	Occurrence in Survey Area and Potential for Significant Impact	Detailed Assessment of Significance Required?
painted snipe <i>Rostratula benghalensis australis</i>	E (TSC) V (EPBC) #	Occurs in ephemeral and permanent wetlands where there is a cover of vegetation. Such areas may include shallows and margins of wetlands, dams, sewage ponds, wet pastures, marshy areas, irrigation systems, lignum, tea-tree scrub and open timber (Pizzey & Knight 1997).	Scattered distribution throughout Australia. Nomadic in response to suitable conditions, and may be migratory (DEC 2007). The study area is within the known distribution of this species.	This species is not known from any conservation reserves in the region.	Due to the absence of permanent wetlands, this species is unlikely to occur within the study area. There is no potential for a significant impact on this species.	No.
freckled duck <i>Stictonetta naevosa</i>	V (TSC) *	Generally nomadic between ephemeral inland wetlands. Occurs in large numbers on brackish to hyposaline wetlands that are densely vegetated with Lignum, where they breed (Garnett & Crowley 2000). Other habitat types include large open lakes, creeks, farm dams, sewage ponds and floodwaters (DEC 2007).	Broadly distributed, from eastern and south-western Australia, occurring elsewhere, particularly during years of inland drought (DEC 2007). Has been recorded west of the study area at Ellalong Lagoon. The study area is within the known distribution of this species.	Kooragang NR – count 4	The study area lacks wetland habitats, and therefore this species is not likely to occur. There is no potential for a significant impact on this species.	No.

Species	Legal Status	Specific Habitat	Distribution in relation to Survey Area	Reservation in the Region	Occurrence in Survey Area and Potential for Significant Impact	Detailed Assessment of Significance Required?
black-breasted buzzard <i>Hamirostra melanosternon</i>	V (TSC) *	Habitat varies, however often includes wooded and open habitats, especially riverine woodlands (Debus 2001). Often recorded in dry open country, arid areas and savannah woodlands (Hollands 2003).	This species is recorded from the majority of the mainland, except for high rainfall areas of the south and south east (Debus 2001). The study area is within the known distribution of this species.	This species is not known from any conservation reserves in the region.	This species has potential to occur within the study area, however is unlikely to be significantly impacted by the proposed underground mining development.	No.
red goshawk <i>Erythroriorchis radiatus</i>	E (TSC) V (EPBC) *	In NSW, preferred habitat is mixed tropical rainforest Melaleuca Swamp Forest and Open Eucalypt forest along coastal rivers, often in rugged terrain (DEC 2007). Prefers mosaic vegetation types; hunts along the ecotones (NPWS 2002). Habitats are generally close to permanent bodies of freshwater, nest sites being only up to 1 kilometre away from such water bodies.	Restricted to coastal/subcoastal regions of Australia. Occurs across northern Australia south through eastern Queensland to far north-east NSW (DEC 2007). The study area is within the known distribution of this species.	This species is not known from any conservation reserves in the region.	This species has potential to forage within habitats of the study area, or be seen flying over when moving between nearby habitats. Due to the mobile nature of this species, the proposed underground mining development is unlikely to significantly impact on this species.	No.

Species	Legal Status	Specific Habitat	Distribution in relation to Survey Area	Reservation in the Region	Occurrence in Survey Area and Potential for Significant Impact	Detailed Assessment of Significance Required?
glossy black-cockatoo <i>Calyptorhynchus lathami</i>	V (TSC) *	Habitat for this species includes forests on low-nutrient soils, specifically those containing key <i>Allocasuarina</i> feed species (DEC 2007).	<p>The glossy black-cockatoo has a sparse distribution along the east coast and adjacent inland areas from western Victoria to Rockhampton in Queensland. In NSW, it has been recorded as far inland as Cobar and Griffith.</p> <p>The study area is within the known distribution of this species.</p>	<p>Wallaroo NR – count 1 Karuah NR – count 2 Lake Macquarie SCA – count 1 Jilliby SCA – count 2 Worimi NR – count 1 Watagans NP – count 4</p>	This species potentially forages on the <i>Casuarina glauca</i> occurring within the study area. The proposed underground mining development is unlikely to have a significant impact on this species.	No.
gang gang Cockatoo <i>Callocephalon fimbriatum</i>	V (TSC) *	In summer, it occupies tall montane forests and woodlands (DEC 2007), and may also occur in sub-alpine woodland and occasionally in temperate rainforests (DEC 2007). In winter, it occurs at lower altitudes in drier, open eucalypt forests/woodlands, or in dry forest in coastal areas (DEC 2007). May undertake nomadic or seasonal movements.	<p>In NSW, distribution extends from the south-east coast to the Hunter region and inland to the Central Tablelands and south-west slopes. Isolated records are known from as far north as Coffs Harbour and as far west as Mudgee and the Australian Capital Territory (DEC 2007).</p> <p>The study area is within the known distribution of this species.</p>	<p>Tomaree NP – count 2 Jilliby SCA – count 2 Watagans NP – count 1</p>	<p>This species potentially forages within the study area, or may be seen flying over when travelling between more suitable habitats nearby.</p> <p>There is no potential for a significant impact on this species.</p>	No.

Species	Legal Status	Specific Habitat	Distribution in relation to Survey Area	Reservation in the Region	Occurrence in Survey Area and Potential for Significant Impact	Detailed Assessment of Significance Required?
<p>swift parrot <i>Lathamus discolor</i></p>	<p>E (TSC) E (EPBC) # *</p>	<p>Often visits box-ironbark forests, feeding on nectar and lerp (Garnett & Crowley 2000). In NSW, typical feed species include mugga ironbark, grey box, swamp mahogany, spotted gum, red bloodwood, narrow-leaved red ironbark, forest red gum and yellow box (Swift Parrot Recovery Team 2001).</p>	<p>Breeds in Tasmania, migrating to the mainland in May to August, mainly foraging in Victoria and NSW (Swift Parrot Recovery Team 2001). In NSW, it has been recorded from the western slopes region along the inland slopes of the Great Dividing Range, as well as forests along the coastal plains from southern to northern NSW (Swift Parrot Recovery Team 2001). Has been recorded west of the study area near Ellalong. The study area is within the known distribution of this species.</p>	<p>Tomaree NP – count 1 Lake Macquarie SCA – count 2</p>	<p>The winter-flowering <i>Corymbia maculata</i> occurs within the study area which may provide foraging resources for this species. This species therefore could potentially occur within the study area. Due to the negligible surface disturbances associated with the proposed development, there is no potential for a significant impact on this species.</p>	<p>No.</p>

Species	Legal Status	Specific Habitat	Distribution in relation to Survey Area	Reservation in the Region	Occurrence in Survey Area and Potential for Significant Impact	Detailed Assessment of Significance Required?
regent honeyeater <i>Xanthomyza phrygia</i>	E (TSC) E (EPBC) # *	Semi-nomadic, generally occurs in temperate eucalypt woodlands and open forests, commonly recorded from box-ironbark eucalypt associations, wet lowland coastal forests dominated by swamp mahogany, spotted gum and riverine <i>Casuarina</i> woodlands (DEC 2007).	Patchily distributed across the eastern states of Australia (DEC 2007), from Adelaide, to Dalby, Queensland, and from the coast to the western foothills of the Great Dividing Range (Garnett and Crowley 2000). Has been recorded west of the study area near Ellalong. The study area is within the known distribution of this species.	This species is not known from any conservation reserves in the region.	The winter-flowering <i>Corymbia maculata</i> occurs within the study area which may provide foraging resources for this species. This species therefore could potentially occur within the study area. Due to the negligible surface disturbances associated with the proposed development, there is no potential for a significant impact on this species.	No.
turquoise parrot <i>Neophema pulchella</i>	V (TSC) *	The turquoise parrot occupies a variety of habitats, primarily eucalypt woodland and open forest near open water and forested hills. Also found in coastal heath, pasture, roadsides and orchards (Pizzey & Knight 1997).	Occurs from southern Queensland through to northern Victoria, from the coastal plains to the western slopes of the Great Dividing Range (DEC 2007). The study area is within the known distribution of this species.	Wallaroo NR – count 1	This species potentially forages within the study area at some time, however is unlikely to be nesting due to limited availability of hollow trees. There is no potential for a significant impact on this species.	No.

Species	Legal Status	Specific Habitat	Distribution in relation to Survey Area	Reservation in the Region	Occurrence in Survey Area and Potential for Significant Impact	Detailed Assessment of Significance Required?
powerful owl <i>Ninox strenua</i>	V (TSC) *	The powerful owl inhabits a range of vegetation types, from woodland and open sclerophyll forest to tall open wet forest and rainforest (Garnett and Crowley 2000). The powerful owl requires large tracts of forest or woodland habitat but can occur in fragmented landscapes as well. The species breeds and hunts in open or closed sclerophyll forest or woodlands and occasionally hunts in open habitats. It roosts by day in dense vegetation.	Occurs mostly on the coastal side of the Great Dividing Range, from south western Victoria to Bowen in Queensland (Garnett & Crowley 2000). The study area is within the known distribution of this species.	Wallarah NP – count 3 Wallaroo NR – count 2 Karuah NR – count 1 Medowie SCA – count 3 Tomaree NP – count 2 Lake Macquarie SCA – count 1 Kooragang NR – count 1 Moffats Swamp NR – count 1 Munmorah SCA – count 1 Jilliby SCA – count 4	This species may visit the study area for hunting, however is not likely to nest due to the limited availability of suitable hollows. There is no potential for a significant impact on this species.	No.

Species	Legal Status	Specific Habitat	Distribution in relation to Survey Area	Reservation in the Region	Occurrence in Survey Area and Potential for Significant Impact	Detailed Assessment of Significance Required?
barking owl <i>Ninox connivens</i>	V (TSC) *	Habitat for this species includes dry forests and woodlands (Kavanagh 2002), often in association with hydrological features such as rivers and swamps (Taylor et al. 2002). Large hollows are required for breeding.	Distributed sparsely throughout temperate and semi-arid areas of mainland Australia, however is most abundant in the tropical north (Kavanagh 2002). Most records are west of the Great Dividing Range (Kavanagh 2004). There is a record of this species just outside the southern boundary of the study area. The study area is within the known distribution of this species.	Watagans NP – count 1	This species may visit the study area for hunting, however is not likely to nest due to the limited availability of suitable hollows. There is no potential for a significant impact on this species.	No.
masked owl <i>Tyto novaehollandiae</i>	V (TSC) *	Generally recorded from open forest habitat with sparse mid-storey but patches of dense, low ground cover. It is also recorded from ecotones between wet and dry eucalypt forest, along minor drainage lines and near boundaries between forest and cleared land (Kavanagh 2004).	Occurs sparsely throughout the continent and nearby islands, including Tasmania and New Guinea (Kavanagh 2002). The study area is within the known distribution of this species.	Karuah NR – count 1 Tomaree NP – count 2 Watagans NP – count 1 Medowie SCA – count 2 Jilliby SCA – count 2	This species may visit the study area for hunting, however is not likely to be nesting due to the limited availability of suitable hollows. There is no potential for a significant impact on this species.	No.

Species	Legal Status	Specific Habitat	Distribution in relation to Survey Area	Reservation in the Region	Occurrence in Survey Area and Potential for Significant Impact	Detailed Assessment of Significance Required?
brown treecreeper (eastern subsp.) <i>Climacteris picumnus victoriae</i>	V (TSC) *	<p>Typical habitat for this species includes drier forests, woodlands, scrubs, with fallen branches; river red gums on watercourses and around lake-shores; paddocks with standing dead timber; and margins of denser wooded areas (Pizzey & Knight 1997). This species prefers areas without dense understorey (DEC 2007).</p>	<p>This species occurs over central NSW, west of the Great Dividing Range and sparsely scattered to the east of the Divide in drier areas such as the Cumberland Plain of Western Sydney, and in parts of the Hunter, Clarence, Richmond and Snowy River valleys (DEC 2007). Has been recorded west of the study area near Ellalong.</p> <p>The study area is within the known distribution of this species.</p>	<p>This species is not known from any conservation reserves in the region.</p>	<p>Potential habitat for this species occurs within the study area.</p> <p>There is no potential for a significant impact on this species.</p>	No.
black-chinned honeyeater (eastern subsp.) <i>Melithreptus gularis gularis</i>	V (TSC) *	<p>In NSW, it is mainly found in woodlands with annual rainfall of 400-700mm containing box-ironbark associations and river red gum (Garnett & Crowley 2000). It is also known from drier coastal woodlands of the Cumberland Plain, Western Sydney and in the Hunter, Richmond and Clarence valleys (DEC 2007).</p>	<p>Found mainly west of the Great Dividing Range through NSW into southern Queensland, and south into Victoria and South Australia (DEC 2007).</p> <p>The study area is within the known distribution of this species.</p>	<p>This species is not known from any conservation reserves in the region.</p>	<p>There is potential for this species to occur within the study area.</p> <p>There is no potential for a significant impact on this species.</p>	No.

Species	Legal Status	Specific Habitat	Distribution in relation to Survey Area	Reservation in the Region	Occurrence in Survey Area and Potential for Significant Impact	Detailed Assessment of Significance Required?
speckled warbler <i>Pyrrholaemus saggitata</i>	V (TSC) *	In NSW, occupies eucalypt and cypress woodlands, generally on the western slopes of the Great Dividing Range. Inhabits woodlands with a grassy understorey, leaf litter and shrub cover, often on ridges or gullies (Garnett & Crowley 2000).	The speckled warbler has a distribution from south-eastern Queensland, through central and eastern NSW to Victoria. The study area is within the known distribution of this species.	Belford NP – 1 count (T Peake pers. obs.)	This species was recorded during surveys of the study area, however, there is no potential for a significant impact on this species.	No.
grey-crowned babbler (eastern form) <i>Pomatostomus temporalis temporalis</i>	V (TSC) *	Habitat for this species includes open forest and woodland, acacia scrubland and adjoining open areas (Garnett & Crowley 2000).	Occurs on the western slopes and plains of NSW (DEC 2007). Isolated populations are known from coastal woodlands on the North Coast, in the Hunter Valley and from the South Coast near Nowra (DEC 2007). The study area is within the known distribution of this species.	Munmorah SCA – count 1 Belford NP – count 1 (T Peake pers. obs.)	This species was recorded during surveys of the study area, however, there is no potential for a significant impact on this species.	No.

Species	Legal Status	Specific Habitat	Distribution in relation to Survey Area	Reservation in the Region	Occurrence in Survey Area and Potential for Significant Impact	Detailed Assessment of Significance Required?
diamond firetail <i>Stagonopleura guttata</i>	V (TSC) *	Habitat includes a range of eucalypt-dominated communities with a grassy understorey, including woodland, forest and mallee (Garnett & Crowley 2000). Populations appear unable to persist where remnants are less than 200 hectares in area (DEC 2007).	In NSW, it mainly occurs west of the Great Dividing Range, although populations are known from drier coastal areas such as the Cumberland Plain and the Hunter, Clarence, Richmond and Snowy River valleys (DEC 2007). The study area is within the known distribution of this species.	This species is not known from any conservation reserves in the region.	This species is unlikely to occur within the study area. There is no potential for a significant impact on this species.	No.
spotted-tailed quoll <i>Dasyurus maculatus maculatus</i>	V (TSC) E (EPBC) # *	Highly varied habitat, ranging from sclerophyll forest, woodlands, coastal heathlands and rainforests. Records exist from open country, grazing lands and rocky outcrops (DEC 2007). Suitable den sites including hollow logs, tree hollows, rocky outcrops or caves are necessary (DEC 2007).	In NSW, the spotted-tailed quoll occurs on both sides of the Great Dividing Range, with highest densities occurring in the north east of the state. It occurs from the coast to the snowline and inland to the Murray River (Edgar & Belcher 2002). The study area is within the known distribution of this species.	Wallaroo NR – count 2	The study area provides very marginal habitat for this species, which may occur at some time passing between habitats of greater significance. There is no potential for a significant impact on this species.	No.

Species	Legal Status	Specific Habitat	Distribution in relation to Survey Area	Reservation in the Region	Occurrence in Survey Area and Potential for Significant Impact	Detailed Assessment of Significance Required?
koala <i>Phascolarctos cinereus</i>	V (TSC) *	This species inhabits eucalypt forest and woodland. Known to feed on a large number of eucalypt and non-eucalypt species, however tends to specialise on a small number in different areas (DEC 2007).	Fragmented distribution throughout eastern Australia, the majority of records from NSW being on the central and north coasts, and some areas further west (DEC 2007). The study area is within the known distribution of this species.	Wallaroo NR – count 5 Karuah NR – count 13 Worimi NR – count 5 Tomaree NP – count 68 Pulbah Island NR – count 3 Medowie SCA – count 11 Moffats Swamp NR – count 3 Lake Macquarie SCA – count 1 Jilliby SCA – count 5 Watagans NP – count 1	Known koala food trees occur within the study area, however in low density. The study area is not likely to be utilised by koalas as it is fragmented from areas of suitable habitat. There is no potential for a significant impact on this species.	No.
yellow-bellied glider <i>Petaurus australis</i>	V (TSC) *	Generally found at low population densities in habitat that is patchily distributed (DEC 2007). Prefers tall, mature sclerophyll forests in regions of high rainfall particularly where hollows and year-round food resources are abundant (DEC 2007).	Essentially coastal in NSW and extending inland to adjacent ranges (DEC 2007). The Hunter region may represent a break in the north/south distribution. The study area is within the known distribution of this species.	Jilliby SCA – count 13 Watagans NP – count 9	The study area does not contain suitable habitat for this species, and therefore it is not likely to be present. There is no potential for a significant impact on this species.	No.

Species	Legal Status	Specific Habitat	Distribution in relation to Survey Area	Reservation in the Region	Occurrence in Survey Area and Potential for Significant Impact	Detailed Assessment of Significance Required?
squirrel glider <i>Petaurus norfolcensis</i>	V (TSC) *	Generally inhabits dry sclerophyll forest and woodland (Suckling 2002). Preferred foraging habitat contains a regenerating understorey of eucalypts, wattles and flowering shrubs. Winter flowering species such as red ironbark, spotted gum and coast banksia are particularly important when other food sources are limited (NSW Scientific Committee 2000).	Occupies a range along the east coast and immediate inland districts from western Victoria to north Queensland (DEC 2007). Has been recorded to the west of the study area, near Ellalong. The study area is within the known distribution of this species.	Wallarah NP – count 1 Karuah NP – count 2 Tomaree NP – count 4 Lake Macquarie SCA – count 3 Medowie SCA – count 4 Munmorah SCA – count 2	The squirrel glider potentially forages within the study area, however is not likely to be nesting due to the limited hollows present. There is no potential for a significant impact on this species.	No.
long-nosed potoroo <i>Potorous tridactylus</i>	V (TSC) V (EPBC) #	Occupies a variety of habitats from coastal heath to dry or wet sclerophyll forest. Restricted to areas with rainfall greater than 760 mm per year (Strahan 1995) and it prefers habitats with a dense ground cover and light, sandy soils.	Range extends from south-east Queensland to Tasmania. The study area is within the known distribution of this species.	This species is not known from any conservation reserves in the region.	The study area does not contain suitable habitat for this species. There is no potential for a significant impact on this species.	No.

Species	Legal Status	Specific Habitat	Distribution in relation to Survey Area	Reservation in the Region	Occurrence in Survey Area and Potential for Significant Impact	Detailed Assessment of Significance Required?
brush-tailed rock-wallaby <i>Petrogale penicillata</i>	E (TSC) V (EPBC) # *	This species occupies rocky escarpments, outcrops and cliffs showing a preference for complex structures with fissures, caves and ledges facing north (DEC 2007). Forage in or adjacent to rocky areas (DEC 2007).	In NSW occurs from the Queensland border in the north to the Shoalhaven in the south, with the population in the Warrumbungle Ranges being the western limit (DEC 2007). The study area is within the known distribution of this species.	Watagans NP – count 4	This species is not likely to occur within the study area due to an absence of suitable rocky habitat. There is no potential for a significant impact on this species.	No.
grey-headed flying-fox <i>Pteropus poliocephalus</i>	V (TSC) V (EPBC) # *	This species feeds on a variety of flowering and fruiting plants, including native figs and palms, blossoms from eucalypts, angophoras, tea-trees and banksias (Tidemann 2002). Camps sites are usually formed in gullies, usually in vegetation with a dense canopy and not far from water (Tidemann 2002).	Recorded along the eastern coastal plain from Bundaberg in Queensland, through NSW and south to eastern Victoria. The study area is within the known distribution of this species.	Wallaroo NR – count 1 Karuah NR – count 1 Lake Macquarie SCA – count 2 Glenrock SCA – count 1 Munmorah SCA – count 6	This species is likely to utilise the foraging resources of the study area, however, is not known to be utilising the study area as a roost site. There is no potential for a significant impact on this species.	No.

Species	Legal Status	Specific Habitat	Distribution in relation to Survey Area	Reservation in the Region	Occurrence in Survey Area and Potential for Significant Impact	Detailed Assessment of Significance Required?
eastern freetail-bat <i>Mormopterus norfolkensis</i>	V (TSC) *	Occurs mostly in dry eucalypt forest and woodland. Also recorded over a rocky river in rainforest and wet sclerophyll forest (Churchill 1998). Generally roosts in tree hollows, but may use man-made structures (Churchill 1998).	Has a distribution along the east coast of NSW from south of Sydney north into south east Queensland, near Brisbane (Churchill 1998). Has been recorded to the west of the study area near Ellalong. The study area is within the known distribution of this species.	Tomaree NP – count 1	This species is likely to utilise the foraging resources of the study area, however is not likely to be roosting. There is no potential for a significant impact on this species.	No.
eastern bentwing-bat <i>Miniopterus schreibersii oceanensis</i>	V (TSC) *	Habitat varies widely, from rainforest, wet and dry sclerophyll forest, monsoon forest, open woodland, paperbark forests and open grasslands (Churchill 1998). Requires caves for roosting and maternity sites.	This species has an eastern distribution from Cape York along the coastal side of the Great Dividing Range, and into the southern tip of South Australia (Churchill 1998). There are records of this species north of the study area. The study area is within the known distribution of this species.	Wallaroo NR – count 2 Kooragang NR – count 1 Lake Macquarie SCA – count 1 Munmorah SCA – count 1	This species is likely to utilise the foraging resources of the study area, however is not likely to be roosting. There is no potential for a significant impact on this species.	No.

Species	Legal Status	Specific Habitat	Distribution in relation to Survey Area	Reservation in the Region	Occurrence in Survey Area and Potential for Significant Impact	Detailed Assessment of Significance Required?
eastern false pipistrelle <i>Falsistrellus tasmaniensis</i>	V (TSC) *	Habitat includes sclerophyll forest from the Great Dividing Range to the coast. It appears to prefer wet habitats, with trees over 20 metres high (Churchill 1998). It generally roosts in tree hollows or trunks, in groups of 6 – 36, but is occasionally recorded from caves or buildings (Churchill 1998).	<p>This species has a range from south eastern Queensland, through NSW and Victoria and into Tasmania (Churchill 1998).</p> <p>The study area is within the known distribution of this species.</p>	This species is not known from any conservation reserves in the region.	This species is not likely to occur within the study area. There is no potential for a significant impact on this species.	No.
large-eared pied bat <i>Chalinolobus dwyeri</i>	V (TSC) V (EPBC) #	Generally found in a variety of drier habitats, including the dry sclerophyll forests and woodlands, however probably tolerates a wide range of habitats (Hoye & Dwyer 2002). Tends to roost in the twilight zones of mines and caves (Churchill 1998).	<p>Has a distribution from south western Queensland to Bungonia in southern NSW, from the coast to the western slopes of the Great Dividing Range (Churchill 1998, Strahan 1995).</p> <p>The study area is within the known distribution of this species.</p>	Watagans NP – count 1	<p>This species is likely to utilise the foraging resources of the study area, however is not likely to be roosting.</p> <p>There is no potential for a significant impact on this species.</p>	No.

Species	Legal Status	Specific Habitat	Distribution in relation to Survey Area	Reservation in the Region	Occurrence in Survey Area and Potential for Significant Impact	Detailed Assessment of Significance Required?
large-footed myotis <i>Myotis adversis</i>	V (TSC)	Occurs in most habitat types providing they are near to water (Richards 1995). Commonly cave-dwelling, however it is also recorded from tree hollows, dense vegetation, bridges, mines and drains (Churchill 1998).	This is a coastal species, ranging from the Kimberley to South Australia (Churchill 1998). The study area is within the known distribution of this species. The study area is within the known distribution of this species.	This species is not known from any conservation reserves in the region.	The species potentially forages within the open waters and farm dams of the study area. It is known to occur nearby at Ellalong, where it was likely foraging over Ellalong Lagoon. Due to the minimal surface disturbances associated with the proposed development, there will be negligible impacts on this species.	No.
Hastings River mouse <i>Pseudomys oralis</i>	E (TSC) E (EPBC) #	This species inhabits a variety of dry open forest types with dense, low ground cover and a diverse mixture of ferns, grass, sedges and herbs (DEC 2007). Access to seepage zones, creeks and gullies is important, as is permanent shelter such as rocky outcrops (DEC 2007).	This species has a patchy distribution along the east side of the Northern Tablelands and great escarpment of north-eastern NSW, usually but not always at elevations between 500 metres and 1100 metres (DEC 2007). The study area is slightly south-east of the known distribution of this species.	This species is not known from any conservation reserves in the region.	There is no potential habitat for this species within the study area. There is no potential for a significant impact on this species.	No.

Key: * Records from DEC Wildlife Atlas Database
Records from EPBC Protected Matters Search
^ records added from previous studies or expert knowledge
TSC = *Threatened Species Conservation Act 1995*
EPBC Act = *Environment Protection and Biodiversity Conservation Act 1999*

E = Endangered
V = Vulnerable
NR = Nature Reserve
NP = National Park
SCA – State Conservation Area

From **Tables 1 and 2**, only the *River-flat Eucalypt Forest* EEC requires further assessment. Below is a seven part test of significance for this species, prepared in accordance with the TSC Act.

1.0 *River-flat Eucalypt Forest on Coastal Floodplains* EEC

- a) **in the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction**

Not applicable.

- b) **in the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction**

Not applicable.

- c) **in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:**

- i) **is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction; or**

The proposed underground mining development is expected to result in minimal subsidence and negligible disturbance of surface and groundwater flow patterns. As such, it is not likely that the proposed development will result in the loss of any areas of this potential EEC and therefore the local occurrence of the community will not be placed at risk of extinction.

- ii) **is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction**

The proposed development is predicted to have negligible surface impacts, and negligible changes to the surface and groundwater flows are predicted. As such, it is not likely that the proposed development will adversely modify the composition of the potential EEC such that its local occurrence will be placed at risk of extinction.

- d) **in relation to the habitat of a threatened species, population or ecological community:**

- i) **the extent to which habitat is likely to be removed or modified as a result of the action proposed**

The proposed development will not lead to the loss or removal of habitat for this potential EEC. It is predicted that there will be negligible changes to the local conditions currently present resulting from the proposed development.

- ii) **whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action; and**

The proposed development will not cause any habitat of this potential EEC to become fragmented or isolated from other areas in which this community occurs.

iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality

The study area comprises a small proportion of this potential EEC which is thought to occur in numerous other areas within the locality. The proposed development will not involve the removal of any areas of habitat for this potential EEC, and therefore will not affect the long-term viability of this EEC within the locality.

e) whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly)

The study area does not support any critical habitat for this potential EEC or any other threatened species or populations.

f) whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan

There is not currently a recovery plan or threat abatement plan which relates to this potential EEC and the proposed development.

g) whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process.

The proposed development directly relates to the KTP: alterations due to subsidence relating to longwall mining. There are several other KTPs which may be relevant to the project: these are discussed in **Section 5.0** of the main report.

Conclusion

The proposed development will not result in a significant impact on the *River-flat Eucalypt Forest* EEC, that is regarded as being potentially present in the study area.

APPENDIX 3

Fauna Species List

Appendix 3 – Fauna Species List

The following list was developed from surveys of the study area detailed in **Section 2.2** of the main report. It includes all species of vertebrate fauna observed on the study area during fieldwork.

The following abbreviation or symbols are used to identify the method of detection in the appendix table:

- ✓ Identified from visual sighting or characteristic call;
- S Identified from scat sample(s) in field.

The following abbreviations or symbols are used in the list:

asterisk (*) denotes species not indigenous to the study area;

- MAR Listed marine species under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act);
- MIG Listed migratory species under the EPBC Act;
- V Vulnerable under Schedule 2 of the *Threatened Species Conservation Act 1995* (TSC Act); and
- E Endangered under Schedule 2 of the TSC Act.

Birds recorded were identified using descriptions in Slater et al. (2003) and the scientific and common name nomenclature of *Birds Australia*. Reptiles recorded were identified using keys and descriptions in Cogger (1994), Swan et al. (2004), Weigel (1990) and Wilson & Swan (2003) and the scientific and common name nomenclature of Cogger (1994).

Amphibians recorded were identified using keys and descriptions in Cogger (1994), Robinson (1998), Anstis (2002) and Barker et al. (1995) and the scientific and common name nomenclature of Cogger (1994). Mammals recorded were identified using keys and descriptions in Strahan (1995), Churchill (1998) and Menkhorst & Knight (2004) and the scientific and common name nomenclature of Strahan (1995) for non-bat species and Churchill (1998) for bats.

Scientific Name	Common Name	Conservation Status		Opportunistic recordings
		TSC Act	EPBC Act	
Birds				
Anatidae				
<i>Cygnus atratus</i>	black swan			✓
<i>Anas superciliosa</i>	Pacific black duck		MIG	✓
Phalacrocoracidae				
<i>Phalacrocorax varius</i>	piebald cormorant			✓
<i>Phalacrocorax sulcirostris</i>	little black cormorant			✓
Ardeidae				
<i>Egretta novaehollandiae</i>	white-faced heron			✓
<i>Ardea alba</i>	great egret		MAR	✓
Threskiornithidae				
<i>Threskiornis spinicollis</i>	straw-necked ibis		MAR	✓
Accipitridae				
<i>Haliaeetus leucogaster</i>	white-bellied sea-eagle		MIG & MAR	✓
<i>Aquila audax</i>	wedge-tailed eagle			✓
Falconidae				
<i>Falco berigora</i>	brown falcon		MIG	✓
Charadriidae				
<i>Vanellus miles</i>	masked lapwing		MIG	✓
Columbidae				
<i>Macropygia amboinensis</i>	brown cuckoo-dove			✓
<i>Ocyphaps lophotes</i>	crested pigeon			✓
Cacatuidae				
<i>Cacatua roseicapilla</i>	galah			✓
Psittacidae				
<i>Platycercus eximius</i>	eastern rosella			✓
<i>Psephotus haematonotus</i>	red-rumped parrot			✓
Alcedinidae				
<i>Ceyx azurea</i>	azure kingfisher			✓
Halcyonidae				
<i>Dacelo novaeguineae</i>	laughing kookaburra			✓
Maluridae				
<i>Malurus cyaneus</i>	superb fairy wren			✓
<i>Malurus lamberti</i>	variegated fairy-wren			✓
Pardalotidae				
<i>Pardalotus punctatus</i>	spotted pardalote			✓
<i>Pyrrholaemus sagittata</i>	speckled warbler	V		✓
<i>Smicromnis brevirostris</i>	weebill			✓
<i>Acanthiza pusilla</i>	brown thornbill			✓
<i>Acanthiza chrysorrhoa</i>	yellow-rumped thornbill			✓

Scientific Name	Common Name	Conservation Status		Opportunistic recordings
		TSC Act	EPBC Act	
<i>Acanthiza nana</i>	yellow Thornbill			✓
<i>Acanthiza lineata</i>	striated Thornbill			✓
Meliphagidae				
<i>Philemon corniculatus</i>	noisy Friarbird			✓
<i>Manorina melanocephala</i>	noisy Miner			✓
<i>Lichenostomus chrysops</i>	yellow-faced Honeyeater			✓
Petroicidae				
<i>Microeca leucophaea</i>	Jacky Winter			✓
<i>Petroica rosea</i>	rose Robin			✓
<i>Eopsaltria australis</i>	eastern yellow Robin			✓
Pomatostomidae				
<i>Pomatostomus temporalis temporalis</i>	grey-crowned Babbler	V		✓
Cinclosomatidae				
<i>Psophodes olivaceus</i>	eastern Whipbird			✓
Pachycephalidae				
<i>Pachycephala pectoralis</i>	golden Whistler			✓
<i>Pachycephala rufiventris</i>	rufous Whistler			✓
<i>Colluricincla harmonica</i>	grey Shrike-thrush			✓
Dicruridae				
<i>Myiagra inquieta</i>	restless Flycatcher			✓
<i>Grallina cyanoleuca</i>	magpie-lark		MAR	✓
<i>Rhipidura fuliginosa</i>	grey Fantail			✓
<i>Rhipidura leucophrys</i>	willie Wagtail			✓
Campephagidae				
<i>Coracina novaehollandiae</i>	black-faced Cuckoo-shrike		MAR	✓
Artamidae				
<i>Cracticus torquatus</i>	grey Butcherbird			✓
<i>Cracticus nigrogularis</i>	pie Butcherbird			✓
<i>Gymnorhina tibicen</i>	Australian Magpie			✓
<i>Strepera graculina</i>	pie Currawong			✓
Corvidae				
<i>Corvus coronoides</i>	Australian Raven			✓
Corcoracidae				
<i>Corcorax melanorhamphos</i>	white-winged Cough			✓
Ptilonorhynchidae				
<i>Ptilonorhynchus violaceus</i>	satin Bowerbird			✓
Passeridae				
<i>Taeniopygia bichenovii</i>	double-barred Finch			✓
Hirundinidae				
<i>Hirundo neoxena</i>	welcome Swallow		MAR	✓

Scientific Name	Common Name	Conservation Status		Opportunistic recordings
		TSC Act	EPBC Act	
Reptiles				
Elapidae				
<i>Pseudechis porphyriacus</i>	red-bellied black snake			✓
Amphibians				
Myobatrachidae				
<i>Crinia signifera</i>	brown froglet			✓
Hylidae				
<i>Litoria fallax</i>	green reed frog			✓
Mammals				
Vombatidae				
<i>Vombatus ursinus</i>	common wombat			S
Phalangeridae				
<i>Trichosurus vulpecula</i>	common brushtail possum			S
Macropodidae				
<i>Macropus giganteus</i>	eastern grey kangaroo			✓
<i>Macropus rufogriseus</i>	red-necked wallaby			✓
<i>Wallabia bicolor</i>	swamp wallaby			✓
Leporidae				
* <i>Oryctolagus cuniculus</i>	rabbit			✓

APPENDIX 4

Assessment of Significance (EPBC Act)

Appendix 4 – Assessment of Significance under Environment Protection and Biodiversity Conservation Act 1999

Under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act), approval from the Commonwealth Minister for Environment and Heritage is required for any action that may have a significant impact on matters of national environmental significance (NES). These matters are:

- Listed threatened species and ecological communities;
- Migratory species protected under international agreements;
- Ramsar wetlands of international importance ;
- The Commonwealth marine environment;
- World Heritage properties;
- National Heritage places; and
- Nuclear actions.

A search of the DEH Protected Matters Search Tool (DEH 2006) identified (discounting fishes and marine species) one threatened ecological community, 29 threatened species and 13 migratory species with potential to occur (on the basis of DEH habitat modelling) within a 10 kilometre radius of the study area. Those species and ecological communities with potential habitat within the study area are shown in **Table 1** below, accompanied with an assessment of the potential for these species to occur within the study area. No invertebrate species were listed on the DEH Protected Matters database within a 10 kilometre radius of the study area.

Table 1 - Species listed under the EPBC Act Potentially Occurring within 10km of the study area (DEH 2006)

Common Name	Scientific Name	Legal Status	Potential to Occur
Threatened Flora			
Bynoe's wattle	<i>Acacia bynoeana</i>	V (EPBC) E (TSC) * #	No
heath wrinklewort	<i>Rutidosia heterogama</i>	V (EPBC) V (TSC) *	Yes
Parramatta red gum	<i>Eucalyptus parramattensis</i> subsp. <i>decadens</i>	V (EPBC) V (TSC) * #	No
small-flower grevillea	<i>Grevillea parviflora</i> subsp. <i>parviflora</i>	V (EPBC) V (TSC) * #	Yes
leafless tongue orchid	<i>Cryptostylis hunteriana</i>	V (EPBC) V (TSC) #	

Common Name	Scientific Name	Legal Status	Potential to Occur
Charmhaven apple	<i>Angophora inopina</i>	V (EPBC) V (TSC) * #	No.
Slaty red gum	<i>Eucalyptus glaucina</i>	V (EPBC) V (TSC) #	No.
North Rothbury persoonia	<i>Persoonia pauciflora</i>	CE (EPBC) E (TSC) (Preliminary nomination to list as CE under the TSC Act) #	No.
Endangered Ecological Communities			
White-box – Yellow-box – Blakely’s Red Gum Grassy Woodland and Derived Native Grassland		CEEC (EPBC) #	No.
Threatened Fauna			
giant burrowing frog	<i>Heleioporus australiacus</i>	V (TSC) V (EPBC) #	No
stuttering frog	<i>Mixophyes balbus</i>	E (TSC) V (EPBC) # *	No
giant barred frog	<i>Mixophyes iteratus</i>	E (TSC) E (EPBC) # *	No
green and golden bell frog	<i>Litoria aurea</i>	E (TSC) V (EPBC) # *	Yes
Littlejohn’s tree frog	<i>Litoria littlejohni</i>	V (TSC) V (EPBC) #	No
broad-headed snake	<i>Hoplocephalus bungaroides</i>	E (TSC) V (EPBC) #	No
painted snipe	<i>Rostratula benghalensis australis</i>	E (TSC) V (EPBC) #	No
red goshawk	<i>Erythrotriorchis radiatus</i>	E (TSC) V (EPBC) *	Yes
swift parrot	<i>Lathamus discolor</i>	E (TSC) E (EPBC) # *	Yes
regent honeyeater	<i>Xanthomyza phrygia</i>	E (TSC) E (EPBC) # *	Yes
spotted-tailed quoll	<i>Dasyurus maculatus maculatus</i>	V (TSC) E (EPBC) # *	No

Common Name	Scientific Name	Legal Status	Potential to Occur
long-nosed potoroo	<i>Potorous tridactylus</i>	V (TSC) V (EPBC) #	No
brush-tailed rock-wallaby	<i>Petrogale penicillata</i>	E (TSC) V (EPBC) # *	No
grey-headed flying-fox	<i>Pteropus poliocephalus</i>	V (TSC) V (EPBC) # *	Yes
large-eared pied bat	<i>Chalinolobus dwyeri</i>	V (TSC) V (EPBC) #	Yes
Hastings River mouse	<i>Pseudomys oralis</i>	E (TSC) E (EPBC) #	No
Migratory/Marine Species			
white-bellied sea-eagle	<i>Haliaeetus leucogaster</i>	Migratory-terrestrial Marine	Recorded
white-throated needletail	<i>Hirundapus caudacutus</i>	Migratory-terrestrial Marine	Moderate
black-faced monarch	<i>Monarcha melanopsis</i>	Migratory-terrestrial Marine	Low
satin flycatcher	<i>Myiagra cyanoleuca</i>	Migratory-terrestrial Marine	Moderate
rufous fantail	<i>Rhipidura ruffifrons</i>	Migratory-terrestrial Marine	High
regent honeyeater	<i>Xanthomyza phrygia</i>	Migratory-terrestrial	Low
Latham's snipe	<i>Gallinago hardwickii</i>	Migratory-wetland Marine	Low
painted snipe	<i>Rostratula benghalensis</i>	Migratory-wetland Marine	Low
fork-tailed swift	<i>Apus pacificus</i>	Marine	High
great egret	<i>Ardea alba</i>	Marine	Recorded
cattle egret	<i>Ardea ibis</i>	Marine	Moderate
swift parrot	<i>Lathamus discolor</i>	Marine	Low
rainbow bee-eater	<i>Merops ornatus</i>	Marine	Moderate

Key: * Records from DEC Wildlife Atlas Database
Records from EPBC Protected Matters Search
^ Species added from previous studies or expert knowledge
TSC = *Threatened Species Conservation Act 1995*;
EPBC Act = *Environment Protection and Biodiversity Conservation Act 1999*;
E = Endangered;
V = Vulnerable;
EEC = endangered ecological community; and
CEEC = critically endangered ecological community.

An assessment of significance is provided below for those species recorded within the study area, or considered to have potential to be significantly impacted by the proposed development.

An action requires approval from the Minister for the Environment & Heritage if the action has, will have, or is likely to have a significant impact on any matter of NES. An assessment of whether or not a significant impact occurs is undertaken using a test of significance. This is presented below for each of the species listed in **Table 1** above.

Vulnerable Species

This assessment refers to the following species listed as vulnerable under the EPBC Act: heath wrinklewort (*Rutidosia heterogama*) small-flower grevillea (*Grevillea parviflora* subsp. *parviflora*), green and golden bell frog (*Litoria aurea*), red goshawk (*Erythrotriorchis radiatus*), grey-headed flying-fox (*Pteropus poliocephalus*) and the large-eared pied bat (*Chalinolobus dwyeri*).

An assessment according to the DEH principal significant impact guidelines is provided below for these species.

In this case, an *important population* is a population that is necessary for a species' long-term survival and recovery. This may include populations that are:

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

Based on these definitions, the proposed development does not support an important population of any of the above-listed vulnerable species.

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

- **lead to a long-term decrease in the size of an important population of a species;**

The proposed development will not lead to a long-term decrease in the size of an important population of any of the above-listed vulnerable species.

- **reduce the area of occupancy of an important population, or;**

The proposed development will not reduce the area of occupancy of an important population of any of the above-listed vulnerable species.

- **fragment an existing important population into two or more populations, or;**

The proposed development will not fragment an important population of any of the above-listed vulnerable species.

- **adversely affect habitat critical to the survival of a species, or;**

The proposed development will not lead to the loss of habitat critical to the survival of any of the above-listed vulnerable species.

- **disrupt the breeding cycle of an important population, or;**

The proposed development will not disrupt the breeding cycle of an important population.

-
- **modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline, or;**

The proposed development will not lead to the loss of habitat critical to the extent that any of the above-listed vulnerable species is likely to decline.

- **result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat, or;**

The proposed development is not likely to lead to the introduction of invasive species into any of the above-listed vulnerable species' habitat.

- **interferes substantially with the recovery of the species.**

The proposed development will not substantially interfere with the recovery of any of the above-listed vulnerable species.

Migratory Species

This assessment refers to all migratory or marine species listed in **Table 1** above.

An area of *important habitat* is:

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

The study area does not support important habitat for any of the migratory or marine species listed in **Table 1** above.

An action is likely to have a significant impact on a migratory species if there is a real chance or possibility that it will:

- **substantially modify (including by fragmenting, altering fire regimes, altering nutrient cycles or altering hydrological cycles), destroy or isolate an area of important habitat for a migratory species;**

The study area does not support important habitat for any of the EPBC Act listed migratory species listed in **Table 1**. The proposed development will not substantially modify, destroy or isolate an area of important habitat for any migratory species.

- **result in an invasive species that is harmful to the migratory species becoming established in an area of important habitat for the migratory species; or**

The study area does not support important habitat for any of the EPBC Act listed migratory species listed in **Table 1**. The proposed development is not likely to result in the establishment of any invasive species that would be harmful to any migratory species.

-
- **seriously disrupt the lifecycle (breeding, feeding, migration or resting behaviour) of an ecologically significant proportion of the population of a migratory species.**

The study area does not support important habitat for any of the EPBC Act listed migratory species listed in **Table 1**. The proposed development will not lead to the disruption of the lifecycle of any proportion of the population of a migratory species.

Conclusion

From the assessment of significance, it is concluded that the proposed underground mining will not pose a significant impact on matters of NES as listed under the Schedules of the EPBC Act. The proposed development is not a controlled action, and will not require referral to the Minister for determination.

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