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Appin Colliery Area 7 – Longwalls 705-710 Impacts of Subsidence on Terrestrial Flora and Fauna

June 2008

Biosis Research

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Report for

BHP Billiton – Illawarra Coal

APPIN COLLIERY
AREA 7 – LONGWALLS 705-710
IMPACTS OF SUBSIDENCE ON TERRESTRIAL FLORA AND FAUNA

JUNE 2008

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ABBREVIATIONS

BHPBIC	BHP Billiton Illawarra Coal
CPW	Cumberland Plain Woodland
DECC	NSW Department of Environment and Climate Change
DEC	Department of Environment and Conservation (now DECC)
DEWHA	Commonwealth Department of the Environment, Water, Heritage and the Arts
DNR	NSW Department of Natural Resources
DO	Dissolved Oxygen
EEC	Endangered Ecological Community
EIS	Environmental Impact Statement
EP&A Act	*Environmental Planning and Assessment Act* 1979
EPBC Act	*Environmental Protection and Biodiversity Conservation Act* 1999
KTP	Key Threatening Process
LGA	Local Government Area
MSEC	Mine Subsidence Engineering Consultants
NPWS	National Parks and Wildlife Service (now part of DECC)
RFEF	River-flat Eucalypt Forest
RFI Act	*Rivers and Foreshores Improvement Act* 1948
ROTAP	Rare or Threatened Australian Plants
SEPP	State Environmental Planning Policy
SIS	Species Impact Statement
SMP	Subsidence Management Plan
sp.	Species
spp.	Species (plural)
ssp.	Subspecies
SSTF	Shale Sandstone Transition Forest
Threatened Species	Species listed on the threatened species schedules of the TSC or EPBC Acts.
TSC Act	*Threatened Species Conservation Act* 1995
Var.	Variety
WM Act	Water Management Act 2000

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1.0 SUMMARY

Biosis Research Pty. Ltd. was commissioned by BHP Billiton Illawarra Coal to undertake a terrestrial flora and fauna impact assessment for potential subsidence impacts predicted for the proposed longwall mining in Appin Area 7, specifically Longwalls 705 to 710.

Four Endangered Ecological Communities (EECs) were recorded within the Study Area: Cumberland Plain Woodland, Shale Sandstone Transition Forest, River-flat Eucalypt Forest and Moist Shale Woodland. These communities are listed as EECs under the NSW *Threatened Species Conservation Act* 1995 (TSC Act) and/or the Commonwealth *Environment Protection and Biodiversity Conservation Act* 1999 (EPBC Act). This assessment has concluded that the proposal is unlikely to have a significant impact on any of these EEC's.

Twenty one threatened flora species are considered in this report. No threatened flora species were recorded in the Study Area; however *Pultenaea pedunculata* has previously been recorded in the Study Area. The Study Area provides potential habitat for three threatened flora species: *Eucalyptus benthamii, Pomaderris brunnea* and *Pterostylis saxicola*. The proposal has the potential to alter habitat for these species. This assessment has concluded that the proposal is unlikely to have a significant impact on any of these threatened plant species.

The Study Area contains limited potential habitat for a total of 42 threatened and/or migratory animal species. As possible impacts from subsidence are likely to be restricted to changes in surface flow and water quality in the Nepean River and its tributaries, only animal species which rely on these natural features for their survival were considered in the detailed impact assessment. Four of the 42 threatened and/or migratory animal species with potential habitat in the Study Area are likely to be dependent on surface water for breeding or foraging. This assessment has concluded that the proposal is unlikely to have a significant impact on any of these threatened and/or migratory animal species.

2.0 INTRODUCTION

Biosis Research Pty. Ltd. was commissioned by BHP Billiton Illawarra Coal (BHPBIC) to undertake a terrestrial flora and fauna assessment of the potential subsidence impacts of the proposed mining of Longwalls 705-710 in Appin Area 7 (Figure 1).

The Study Area includes the area that could be potentially affected by vertical subsidence and additional areas where additional subsidence effects may occur in gorges and valleys associated with rivers. The Study Area is shown in Figure 2.

Section 2 of the report describes in detail the background and aims of the current assessment and explains key technical terms used in the report. Sections 2.4 and 2.5 describe the natural features of the Study Area that may be impacted by subsidence due to the extraction of coal from Longwalls 705-710 insofar as these features may provide habitat for threatened terrestrial flora and fauna values or represent these values themselves.

Section 2.6 of this report discusses the listing of Subsidence Due to Longwall Mining as a Key Threatening Process (KTP) under the TSC Act. The listing of subsidence as a KTP takes into consideration all longwall mining operations in NSW. Therefore, the KTP refers to some terrestrial ecological values that do not occur within the current Study Area and in some cases not even within the region. A discussion of the KTP has been included in this report to deal specifically with the NSW Scientific Committee listing as they relate to the current application.

2.1 Project background

Any coal mining which may lead to surface subsidence requires the lease holder to prepare and submit a Subsidence Management Plan (SMP) along with an application for its approval by the Director-General of the Department of Primary Industries.

BHP Billiton Illawarra Coal proposes to extend its underground coal mining operations at the Appin Colliery by extracting coal from the Bulli Seam using longwall mining techniques. This proposal will utilise existing surface facilities at Appin Colliery and also Appin West Colliery to facilitate the movement of personnel and materials and as such a new 'pit top' is not required and does not form part of this application.

This report constitutes an assessment of the potential impacts of subsidence on terrestrial ecological values within the Study Area in accordance with the *Environment Planning and Assessment Act* 1979 (EP&A Act) and *Environment Protection and Biodiversity Conservation Act* 1995 (EPBC Act). It also details

the terrestrial ecological values of the Study Area including threatened species, populations and ecological communities that have previously been recorded or thought likely to occur within the Study Area as listed on the *Threatened Species Conservation Act 1995* (TSC Act) and the EPBC Act.

Biosis Research has previously conducted assessments of ecological values in Appin Area 7. These previous assessments related to the mining of Longwalls 701-704 (Biosis Research 2004; Biosis Research 2006).

2.2 Aims

The general aim of this report is to undertake a terrestrial flora and fauna assessment of the Study Area in order to determine the potential impacts of longwall mining within Appin Area 7 (Longwalls 705-710).

The specific aims are to:

1. conduct a literature review and database search for the Study Area and surrounding area;
2. provide an assessment of the habitat values of the Study Area;
3. undertake targeted field surveys for habitat of threatened terrestrial flora and fauna species, populations or ecological communities that are listed on the TSC and/or EPBC Acts and have been identified as potentially occurring in the area;
4. undertake Assessments of Significance under the TSC and EPBC Acts for significant flora and fauna species, populations and ecological communities existing or potentially occurring in the Study Area;
5. determine if a Species Impact Statement (TSC Act) and/or a Referral (EPBC Act) is required; and
6. provide recommendations to minimise the environmental impacts of the proposed development.

2.3 Terminology

For consistency with other reports associated with Appin Area 7 Subsidence Management Plan (SMP), the following terminology is used:

- Subsidence – in terms of this assessment, subsidence is taken to mean the sum total of vertical (upsidence and subsidence) and horizontal surface movements due to the extraction of coal using longwall mining

techniques. The MSEC report (MSEC 2008) describes these mechanisms in detail; and

- The MSEC Report – Mine Subsidence Engineering Consultants have predicted the subsidence parameters and assessed mine subsidence impacts on surface and subsurface features due to mining longwalls 705 to 710 at Appin Area 7. It is cited above as MSEC (2008). The report will hereafter be referred to as the MSEC report unless otherwise stated.

2.4 Natural Features of the Study Area

The Study Area contains a range of natural that may or may not be subject to impacts from subsidence. This section of the report details the natural features of the Study Area and specifically details the natural features that are at risk of impact by subsidence associated with the extraction of coal from Longwalls 705-710.

The Study Area is located to the northeast of Douglas Park in the Wollondilly Local Government Area (Figure 1). It includes a section of the Nepean River (south of Ousedale Creek to north of Leafs Gully), part of Foot Onslow Creek, Navigation Creek and Harris Creek and a number of unnamed creeks and drainage lines associated with these creeklines and the Nepean River. The Study Area includes an area to the west of the Nepean River that extends to the foothills of the Razorback Range. This area is largely cleared for agricultural purposes and is traversed by both the Hume Highway and the Main Southern Railway. The Study Area also includes a smaller area to the east of the Nepean River although longwalls do not extend into this area.

The topography of the Study Area is generally flat to undulating, with the exception of the Nepean River gorge and the footslopes of the Razorback Range. The depth of cover of above the proposed longwalls varies from 470 metres at the eastern end of Longwall 707 to 620 metres at the western end of Longwall 708.

Aerial photography of the Study Area (Figure 3) shows that the majority is cleared agricultural land, with scattered patches of vegetation, mostly along creeks and drainage lines or on the lower slopes of the Razorback Range. Relatively intact vegetation occurs only along the Nepean River. These areas and other natural features within the Study Area that may provide important habitat values for terrestrial flora and fauna are described generally below and, with specific reference to threatened flora and fauna values, elsewhere in this report. Discussion of the natural features within the Study Area (this section) and subsidence impact predictions (Section 2.5) follow the MSEC report unless otherwise noted.

2.4.1 Rivers and Creeks

The Nepean River will not be directly mined beneath by the proposed longwalls, however a section of this feature is within the Study Area. The total length of the river within the Study Area is approximately 3.6 km. This section of the river does not form part of a water supply catchment area or Declared Special Area. The closest distance between the proposed longwalls and the edge of the river is 180 m.

Water levels within the Study Area are predominantly regulated by the downstream weir at Menangle which acts as a dam. The section of the river within the Study Area therefore is a flooded valley and the weir ensures that the river remains fully charged at all times, even in periods of low flow. Flows into the Nepean River include natural catchment runoff, licensed discharges of water (including Appin Colliery and Tahmoor Colliery) and stormwater runoff from urban and agricultural areas. Water levels in the river vary depending on the amount of rainfall in the catchment.

There are a number of tributaries that flow into the Nepean River within the Study Area including Foot Onslow Creek, Harris Creek and Navigation Creek and other unnamed tributaries. These creeks are ephemeral and generally have beds of Wianamatta shale, with some sedimentary deposits in upper reaches. Foot Onslow Creek and Harris Creek are directly above the proposed Longwalls, while Navigation Creek is not located above any Longwalls but is in the general SMP area.

2.4.2 Natural Dams

No natural dams have been identified within the Study Area. There are, however, some farm dams that may provide limited habitat for some native terrestrial flora and fauna species.

2.4.3 Cliffs or Pagodas

Cliffs are defined by MSEC as continuous rock faces with a minimum height of ten metres and a minimum slope of 2 in 1 or a minimum angle to the horizontal of 63 degrees. A total of 33 cliffs have been identified in the Study Area, as shown on MSEC Drawings 342-09 (MSEC 2008). None of these cliffs are directly above the proposed Longwalls.

A number of rock outcrops (continuous rock faces with a minimum height of five metres and a minimum slope of 2 in 1) have also been identified in the Study Area (MSEC Drawings 342-09, (MSEC 2008)).

2.4.4 Banks of the Nepean River Within the Study Area

The banks of the Nepean River within the Study Area are typically steep with some sections forming vertical faces rising directly from the water level. In most areas the banks rise steeply for several metres from the water level and then flatten out to form an alluvial terrace or river flat that rises gradually to the base of steeper cliff lines of the valley walls. These alluvial terraces have been typically subjected to disturbances including grazing and in some places clearing of vegetation. The current condition of these alluvial terraces is poor due to weed infestation and, in some areas, the continued access of livestock within the river valley.

2.4.5 Land Prone to Flooding or Inundation

No major flood prone areas have been identified within the Study Area. The banks of the Nepean River are typically steep. However, the banks of the Nepean River and a number of irregular, narrow 'river flats' and river islands are susceptible to inundation during major flood events.

It should be noted that the entire Nepean River Valley is subject to periodic flooding however these events are typically short lived.

2.4.6 Steep Slopes

Steep slopes are defined by MSEC as those areas where existing ground slopes are considered to be marginally stable. These are typically considered to be slopes with gradient between 1 in 3 (33% or 18.3°) and 2 in 1 (200% or 63.4°). The maximum slope of 2 to 1 represents the threshold adopted for defining a cliff. The majority of steep slopes within the Study Area are in the Nepean River gorge and the associated creek valleys that join it although there are some steep slopes along the hills at the western end of the Study Area (locations shown on MSEC Drawing 342-09 (MSEC 2008)).

2.4.7 Swamps, Wetlands or Water Related Ecosystems

No swamps or wetlands have been identified within the Study Area. The Nepean River is an aquatic ecosystem and the potential impacts of subsidence on aquatic values are being assessed by The Ecology Lab.

Degraded natural vegetation occurs within the Nepean River valley (see Section 4.1 for a description of the plant communities found within the Study Area).

2.5 Potential Impacts of Mine Subsidence

Subsidence of the surface is an unavoidable consequence of coal extraction using longwall mining methods. As well as vertical subsidence, upsidence will occur in the base of the valleys (creek lines) that cross the proposed longwalls due to valley movement. Upsidence within watercourses has the potential to result in surface fracturing, which could lead to redirection of water into the strata below and the consequential draining of pools. Differential subsidence movements could result in additional pools being formed or existing pools becoming deeper. Upsidence and subsidence impacts have been considered collectively and are grouped under the heading of subsidence impacts throughout the remainder of this report.

2.5.1 Applicability of Previous Mining Experiences Near Rivers to the Study Area

The MSEC report describes in detail a comparison of the observed impacts of previous mining in the Southern Coalfield with that predicted for the current Study Area, including Tower Colliery which mined very close to this section of the Nepean River. Although there will always be some differences between previously mined areas and the current Study Area, many useful observations can be made of changes to the environment as a result of previous mining and these have informed the current assessment. Where applicable, a comparison of the impacts previously observed to those predicted for the current Study Area is provided.

2.5.2 The Nepean River

In relation to terrestrial flora and fauna values, mine subsidence within any river valley has the potential to alter habitat such that fauna may no longer be able to utilise previously existing habitat, or that the distribution of riparian or instream vegetation may be altered. In the case of the current proposal, mine subsidence may manifest in several ways and these are discussed below.

Subsidence Predictions for the Nepean River

The predicted cumulative subsidence contours, at the completion of each longwall are shown in MSEC Drawings 342-20 to 342-25 (MSEC 2008). Uplift is most pronounced when the river valley is closest to an area of direct coal extraction (goaf). The proposed Longwalls 705-710 are set at a minimum of 180 metres from the banks of the Nepean River. MSEC predict that the Nepean River valley will typically experience a net uplift of the valley floor with a maximum predicted uplift of 345 mm near Longwall 707, post completion of Longwall 710. This is a conservative, cumulative impact prediction, not expected to occur

for some years after the commencement of mining Longwall 705. Predicted uplift within the remainder of the Nepean River and creeks in the Study Area is less than the predicted maximum of 345 mm.

Potential for Desiccation (Banks of the Nepean River and Land Prone to Flooding)

Desiccation of the Nepean River is unlikely to occur. As described in Section 2.4.1, water levels in the Nepean River within the Study Area are controlled by Menangle Weir such that this section of the river is a flooded valley, even in periods of low flow.

Given that no subsidence movements are predicted to occur downstream at Menangle Weir, MSEC predict that the water level along the Nepean River will remain essentially unchanged after mining. The river bed will uplift as a result of mining the longwalls. Given that the minimum depth of the river is typically greater than 2 m and the maximum predicted net uplift is approximately 345 mm, it is unlikely that any sections of the river will become completely exposed as a result of mining.

The predicted uplift of the valley floor may result in some drying of the banks within small sections of the Nepean River, although the area of land that may be affected by desiccation during and after mining is very small. This is due to the steepness of the river banks. However, there are some areas along the river, where the banks are shallow and these areas may be more prone to desiccation.

The effect of the predicted uplift of the banks is to reduce the frequency of inundation of some elevations of the river banks. Areas which currently require a certain flow of water before they become inundated would require a marginally higher flow before they become inundated as a result of the predicted uplift of the banks. This means these areas are likely to become less frequently inundated as a result of mining the proposed longwalls.

During periods of low flow, areas that are currently permanently below the baseline water level of the Nepean River are expected to experience some periods of desiccation as a result of the predicted movements. During moderate to high flows, the predicted desiccation of the banks may be partially offset by a slight change to the manner in which the river responds to increases in water flow. Predicted movements are likely to slightly reduce the cross section area of the open river, thus resulting in a slightly greater rise in water levels during moderate to high flows.

Potential for Scouring of the River Bed and Banks

Scouring of the banks and bed already occurs naturally in response to variable flow conditions, particularly during high flows. Given that the river bank and beds are predicted to uplift as a result of mining, MSEC predicts that the higher sections of the banks will become less frequently exposed to scouring than they currently are.

Potential for Fracturing of the River Bed and Rock Bars

Fracturing occurs naturally from erosion and weathering processes, however, longwall mining can result in additional fracturing. The MSEC report notes that fracturing of the bedrock within river systems is commonly associated with sections of the river that have been directly mined beneath. Only minor fracturing may occur within river valleys beyond the goaf edge. Longwalls 705-710 are at least 180 metres from the banks of the Nepean river and as such, only minor fracturing of the Nepean River bed rock is predicted. Any fracturing that does occur is expected to be minor in nature and located in isolated areas within the limit of subsidence. Fractures may be visible within the base of the river valley in exposed areas such as river banks and alluvial flats, or be inferred from the emission of gas bubbles in the river.

Surface Water Flow Diversion

Mine subsidence has been observed to impact surface water flow in a number of situations. The MSEC report states that potential diversions may occur into subterranean layers, rockbar leakages and groundwater infiltration through fractured or buckled bedrock strata.

For the current proposal the potential for subterranean flow diversion or rockbar leakage is very low as the river bed is flooded and the gradient of the river is very flat. Any fractures in the bedrock that develop as a result of mining are likely to be immediately filled by water or sediment. It was been observed that any minor fracturing within Hawkesbury Sandstone that does occur has a maximum depth of 10-15 m. The volume of water that fills these fractures is likely to be small when compared to the total volume of water in the Nepean River within the Study Area.

Potential redirection of surface water flows to the groundwater system is very low as the Nepean River represents the bottom of the regional water table.

Given the volume of water in the Nepean River within the Study Area and the very low likelihood of surface flow diversions, the volume of water available for use by terrestrial ecosystems within the Study Area is not expected to be significantly impacted. Those species or vegetation types that may be reliant on

surface water for ongoing existence within the Study Area are not likely to experience a reduction in the availability of this resource due to the mining of Longwalls 705 to 710.

Water Quality

The gradient of the Nepean River is significantly flatter than the Cataract, Georges or Bargo Rivers. This means that the potential diverted flow volume due to uplift and bedrock fracturing is significantly lower and is not expected to have a significant impact on water quality.

Ecoengineers (2008b) state that there are two mechanisms for adverse aquatic ecotoxicological impacts in the watercourses within the SMP Area. These are exacerbation of existing ferruginous springs or the creation of new springs and emission of strata gas from the Hawkesbury or Bulgo sandstone.

There is a minor likelihood of springs emerging in or adjacent to the Nepean River, Harris Creek, upper Foot Onslow Creek and upper Navigation Creek. Ecoengineers (2008a) predict that springs are more likely to emerge in smaller creeks and tributaries in the Study Area, than in the Nepean River. Such springs would have little or no impacts on the ecological health of Harris Creek, upper Foot Onslow Creek and upper Navigation Creek due to the existing impacts of the agricultural land use of stream water quality (Ecoengineers 2008a). However, emergence of springs would have a major impact on the ecological health of the immediate downstream area of the Nepean River under low flow conditions only (<0.3 ML/day; 3.5 percentile or less) (Ecoengineers 2008a).

Ecoengineers (2008a) state that strata gas emissions into Nepean River and their biogeochemical impact constitutes a risk to the aquatic ecological integrity of the Nepean River from the proposed longwall mining. There is a high likehood of gas emission arising in the Nepean River, however the impact of these gas emissions to the ecological health of the River would be negligible under all but low flow conditions (>12 ML/day) which occur up to 25% of the time. Under low flow conditions reduction of Dissolved Oxygen (DO) in the River under baseflow conditions may occur (Ecoengineers 2008a).

Given the existing alkalinity of the River, the impacts of river sub-bed flow diversions on water quality of the Nepean River are likely to be negligible (Ecoengineers 2008a).

It is not envisaged that impacts will be observed on water quality for the majority of flows in the Nepean River. At minimum flows an enhanced signature of pollutants may be observed within the immediate vicinity of any groundwater discharge location. Given the low levels of subsidence impacts and the relatively

large base flow of the Nepean River it is predicted that there is unlikely to be a significant impact to water quality resulting from the proposed longwall mining.

2.5.3 Drainage Lines

As described above there are a number of small tributaries that flow into the Nepean River within the Study Area. The majority of these creeks are ephemeral and only flow after significant rain events. These include Foot Onslow Creek, Harris Creek, Navigation Creek and other small tributaries. It is likely that some of the larger pools in these drainage lines may retain water between rainfall events.

Potential for Ponding, Flooding and Desiccation

The MSEC report states that where drainage lines have low natural gradients there could be some localised increase in the levels of ponding and flooding. However, this is expected to be minor and not affect the drainage lines significantly.

Potential for Fracturing and Surface Flow Diversions in the Creeks

Creeks in the Study Area that will be directly mined beneath may experience some cracking. These systems are ephemeral and likely to flow only in periods of high rainfall in which case MSEC state that the majority of the runoff would flow over the beds of these watercourses and would not divert into the dilated strata. It is possible in areas of creekline with exposed Wianamatta Shale that some surface water may be diverted, however, if any water is diverted it is likely to re-emerge downstream. Where creeklines have alluvial deposits above the Wianamatta Shale bedrock any cracking is likely to be filled by alluvial deposits during subsequent flow events.

2.5.4 Natural or Farm Dams

While there are no natural dams within the Study Area, farm dams have a limited potential to provide habitat for some terrestrial flora and fauna. The MSEC report states that the extraction of Longwalls 705-710 is unlikely to result in significant impacts to farm dams and that if, for example, leaks were observed, they would be easily identifiable, enabling immediate repair. Given that farm dams are unlikely to be impacted by the proposal, and that they provide only marginal habitat for some terrestrial plants and animals, it is not likely that impacts to dams would have a major impact on terrestrial flora and fauna values within the Study Area.

2.5.5 Cliffs or Pogodas

A total of 33 cliffs have been identified within the Study Area, none of which will be directly mined beneath. The MSEC report assesses the likelihood of cliff instabilities as very low due to the minimal predictions for tilt within these areas, and notes that, although minor rock falls have occurred outside goaf areas, few cliff instabilities have occurred that are not directly above longwall extraction in the Southern Coalfields. Fracturing of the sandstone along clifflines is considered unlikely given the predictions for systematic strains, however it is possible that fractures could occur along existing bedding planes or joints and this may result in minor 'toppling' rockfalls.

2.5.6 Steep Slopes

Steep slopes occur in the Nepean River Gorge and on the hills at the western end of the Study Area. The MSEC report states that given the depth of cover over the steep slopes is greater than 500 metres and the gradients are less than 1 in 2, slippage of soils and significant tensile cracks at the top of the slopes is unlikely. It is possible that minor cracking and erosion events could occur but these would be unlikely to have any significant environmental impact.

2.5.7 Rock Shelves – Overhangs

Rock shelves and overhang structures are located within the Nepean River gorge. The MSEC report assesses the impacts on these structures in terms of the impact that subsidence may have on overhangs that contain art or other items of cultural heritage significance. This report does not seek to discuss issues of cultural heritage significance although it is important to note that overhangs and rock shelves may provide habitat for a range of terrestrial fauna.

The MSEC report notes that sites of cultural heritage significance in overhangs or on rock shelves, are unlikely to be impacted by the extraction of Longwalls 705 to 710. As such it is considered unlikely that the proposal will have a significant impact on habitat provided by these types of structures.

2.5.8 The Likelihood of Gas Emissions at the Surface

Gas emissions may result from the liberation of gases that are trapped below the ground surface when surface fracturing or cracking occurs. In the vicinity of Study Area, emission of gas associated with longwall mining has been observed within the Cataract and Nepean Rivers including minor emissions observed in the vicinity of Longwall 701 adjacent to the Study Area. Historically, the majority of emissions have occurred when rivers are directly mined beneath. As

the proposed longwalls 705-710 are set at least 180 metres from the Nepean River, the MSEC report states that any gas emissions within the Nepean River are likely to be isolated and minor. The impact of these gas emissions to water quality the Nepean River would be negligible under all but low flow conditions, where impacts to DO levels in the River may occur (Ecoengineers 2008a). Gas emissions may be observed in exposed areas such as river banks and alluvial flats, or be observed by the emission of gas bubbles in the river.

Gas emissions, under certain environmental conditions, may result in vegetation dieback. This phenomenon has previously been observed once within the Cataract River gorge where small patches of vegetation were impacted. Any such impacts are short lived and in the case of the riparian vegetation within the Cataract River gorge regeneration occurs rapidly.

Monitoring of the riparian vegetation affected by gas emissions within the Cataract River gorge was undertaken by Suzanne Fyfe, a botanist, between 1997 and 2000. Four small areas of riparian vegetation, ranging from 160 m^2 to 525 m^2 were initially affected by gas emissions. These emissions resulted in the loss of approximately 90 trees, most of which were saplings or young trees. An inspection of the area undertaken in 2006 showed that large, hollow bearing trees were unaffected by the emissions. Some small shrub and groundcover species were affected.

Regular monitoring of the gas affected vegetation showed regeneration of shrub, tree and grass seedlings occurring almost immediately following the initial die back. Episodic gas emissions hindered regeneration on occasion after the initial event at one of the sites and tubestock planting was undertaken to improve regeneration at two of the sites.

At the cessation of monitoring in 2000, substantial regeneration of the riparian vegetation had occurred at all affected sites, although at one site not all the original vegetation layers had yet regenerated. Fyfe (2000) concluded that longwall mining had resulted in only very minor impacts on vegetation of the Cataract River with a total area of 0.12 ha of affected riparian vegetation. The report also concluded that the minor revegetation works and weed control undertaken at the sites assisted with the regeneration of the gas affected area. This report further notes that no vegetation dieback was observed within the Nepean River gorge in areas that were mined beneath.

An inspection of the previously affected areas within the Cataract River gorge as part of a previous assessment (undertaken in February 2006) showed that these areas have regenerated further since the last inspection in 2000 with a good covering of all vegetation layers in a condition at least equivalent to other sections of the Cataract River gorge where dieback was not observed. Areas within the Nepean River and Elladale Creek, where gas emissions were recorded

during the extraction of coal from Tower Colliery Longwalls 14-20, were briefly inspected for the current assessment. There were no identifiable impacts on riparian vegetation in these areas.

As stated above, minor gas emissions have been observed as small, isolated gas bubble trails within the Nepean River in areas adjacent to the already extracted Longwall 701. Regular environmental monitoring undertaken by BHPBIC throughout the period of extraction of this longwall has not observed any vegetation die back along the bank of the Nepean River. The nature of gas emissions that may lead to vegetation die back are such that the time frame elapsed since the first gas emissions were observed within the Nepean River are sufficient for any such changes to occur or at the very least begin to be noticed. It is considered unlikely that any such vegetation die off will occur in this area.

The MSEC report states that, given the proximity of the proposed longwalls to the Nepean River and tributary creeks within the Study Area, it is possible, but unlikely, that gas emissions would result in vegetation dieback in the Nepean River gorge. In the unlikely event that vegetation dieback was observed in the Nepean River gorge, it is likely that these areas would be isolated and relatively small in size and not represent a significant impact to terrestrial flora and fauna within the Study Area.

2.6 Key Threatening Process: Subsidence due to Longwall Mining

Alteration of habitat following subsidence due to longwall mining is listed as a Key Threatening Process (KTP) under the TSC Act. A discussion of this KTP has been included in the report in order to focus the broader terms of reference within the listing to the terrestrial ecological values located within the Study Area and surrounds.

As described above, subsidence due to longwall mining can result in deformation of ground surfaces, cracking of valley floors and creeklines and destabilisation of cliff faces. This can affect water flow regimes and water quality. The magnitude of any impacts will depend on factors such as the width of the crack, riverbed steepness, the riverbed material and the presence of organic matter. In turn, these impacts can lead to the alteration of habitats and changes to the ecological function of communities. Impacts can be temporary or long-term. Species and ecological communities that depend on aquatic and semi aquatic habitats can be particularly susceptible to the impacts of subsidence.

Threatened species and ecological communities are known to occur in areas affected by subsidence due to longwall mining and their habitats may be altered by subsidence and mining-associated activities. Species listed on the final

determination are outlined in Table 1 along with their potential to be affected by the current proposal.

Table 1: Consideration of threatened species listed within the final determination of the TSC Act Key Threatening Process relating to subsidence due to longwall coal mining

Listed Species	Distribution and Habitat	Consideration in the Current Assessment
Threatened flora		
Epacris hamiltonii	Not known to occur within 10 km of the Study Area and habitat for this species does not occur within the Study Area (NPWS 2005b). Species is known only from the Blue Mountains (NPWS 2005b) from the area near to the western coal fields where longwall coal extraction and subsidence may pose a threat to this species or its habitat.	Not considered further in this assessment.
Acacia baueri subsp. *aspera*	Not known to occur within 10 km of the Study Area. This species is known to occur to the east of Appin township and was recorded at the site of the proposed Rifle Range on the Appin Bulli Road. Its habitat is low, damp heath, often on exposed rocky outcrops (NPWS 2000a). Habitat for this species is considered highly unlikely to be present within the Study Area.	Not considered further in this assessment.
Apatophyllum constablei	This species is known from four sites, three of which are within Wollemi National Park near Gospers Mountain and Coorongooba Creek, the fourth of which is about 2 km from Glen Davis (NPWS 2005a). This species has not been recorded within 10km of the Study Area and habitat is not present within the Study Area.	Not considered further in this assessment.
Boronia deanei	This species has not been recorded within 10 km of the Study Area and although it is known to occur within the Hawkesbury Nepean Catchment, habitat for this species in the form of wet heath does not occur within the Study Area.	Not considered further in this assessment.
Epacris purpurascens var. *purpurascens*	This species has been recorded within 10 km of the Study Area (Figure 5).	Considered further in this assessment.
Grevillea longifolia	This species is known by the authors to be locally abundant within the sandstone creeks and rivers to the east of Appin including the upper Georges River and within the Dharawal State Conservation Area. This species has not been recorded in the Study Area nor does habitat for this species occur.	This species is not listed on the TSC Act or the EPBC Act and is therefore not required to be considered further in the impact assessment for this proposal.
Leucopogon exolasius	This species has apparently been recorded from the upper Georges River (NPWS 2005c) though it is not recorded on the NSW Atlas of NSW Wildlife (see Figure 5). This species is also known to occur within the Heathcote National Park and has been recorded by the authors within the rocky upper reaches of the Woronora River. This species has not been recorded from within a 10 km radius of the Study Area, though habitat is considered likely to occur.	Considered further in this assessment.
Melaleuca deanei	This species has been recorded within 10 km of the Study Area (Figure 5).	Considered further in this assessment.

Listed Species	Distribution and Habitat	Consideration in the Current Assessment
Persoonia acerosa	This species has not been recorded within 10 km of the Study Area It is known to occur only on the central coast and in the Blue Mountains, from Mt Tomah in the north to as far south as Hill Top where it is now believed to be extinct. Mainly occurring in the Katoomba, Wentworth Falls, Springwood area (NPWS 2000c). Further, habitat for this species including the plant communities within the Hawkesbury Nepean Catchment as described by the threatened species profile do not occur within the Study Area.	Not considered further in this assessment.
Pterostylis pulchella	This species has not been recorded within 10 km of the Study Area. Further, the threatened species profile for this species (NPWS 2005d) states that this species is known only from Fitzroy Falls, Belmore Falls, upper Bundanoon Creek (Meryla) and Minnamurra Falls.	Not considered further in this assessment.
Pultenaea aristata	This species has been recorded within 10 km of the Study Area.	Considered further in this assessment.
Pultenaea glabra	This species has not been recorded within 10 km of the Study Area. Further, this species is known to occur at swamp margins, a habitat type not present within the Study Area, and is restricted to the higher Blue Mountains and has been recorded from the Katoomba-Hazelbrook and Mount Victoria areas, with unconfirmed sightings in the Mount Wilson and Mount Irvine areas. All known populations occur within the Blue Mountains Local Government Area (NPWS 2005e).	Not considered further in this assessment.
Tetratheca juncea	This species has not been recorded within 10 km of the Study Area. It is known to be restricted in distribution to the northern portion of the Sydney Basin bioregion and the southern portion of the North Coast bioregion in the local government areas of Wyong, Lake Macquarie, Newcastle, Port Stephens, Great Lakes and Cessnock (NPWS, 2000).	Not considered further in this assessment.
Threatened Fauna		
Eulamprus leuraensis (Blue Mountains Water Skink)	This species has not been recorded within 10 km of the Study Area. Further, it is restricted in distribution to the middle and upper Blue Mountains west of Sydney. The lizard is known from 30 locations extending from Newnes Plateau in the north-west to just south of Hazelbrook in the south-east. This species requires swamp habitat (NPWS 2001).	Not considered further in this assessment.
Hoplocephalus bungaroides (Broad-headed Snake)	This species has not been recorded within 10 km of the Study Area however suitable habitat has been recorded within rock outcrops in the Nepean River Gorge.	Considered further in this assessment.
Isoodon obesulus (Southern Brown Bandicoot)	This species has not been recorded within 10 km of the Study Area however it is listed as potentially occurring in the area (DEWHA, 2008a)	Considered further in this assessment.
Petalura gigantean (Giant Dragonfly)	This species' habitat is permanent swamps and bogs (DEC, 2005g).	Not considered further in this assessment

Listed Species	Distribution and Habitat	Consideration in the Current Assessment
Cercartetus nanus (Eastern Pygmy Possum)	This species has been recorded within 10 km of the Study Area (Figure 6).	Considered further in this assessment.
Heleioporus australiacus (Giant Burrowing Frog)	This species has been recorded within 10 km of the Study Area (Figure 6).	Considered further in this assessment.
Ixobrychus flavicollis (Black Bittern)	This species has not been previously recorded within 10 km of the Study Area. Habitat for this species is not present within the Study Area.	Not considered further in this assessment.
Litoria littlejohni (Littlejohn's Tree Frog)	This species has not been recorded within 10 km of the Study Area, however it has been recorded to the east of the Study Area within 15 km (DECC 2007b) and is listed as potentially occurring in the area (DEWHA, 2008a).	Considered further in this assessment.
Mixophyes balbus (Stuttering Frog)	This species has not been recorded within 10 km of the Study Area, however it is listed as potentially occurring in the area (DEWHA, 2008a)	Considered further in this assessment.
Myotis macropus (Large-footed Myotis)	This species has been recorded within 10 km of the Study Area (Figure 6).	Considered further in this assessment.
Potorous tridactylus (Long-nosed Potoroo)	This species has not been recorded within 10 km of the Study Area, however it is listed as potentially occurring in the area (DEWHA, 2008a)	Considered further in this assessment.
Pseudophryne australis (Red-crowned Toadlet)	This species has been recorded within 10 km of the Study Area (Figure 6).	Considered further in this assessment.
Pteropus poliocephalus (Grey-headed Flying Fox)	This species has been recorded within 10 km of the Study Area (Figure 6).	Considered further in this assessment.
Varanus rosenbergi (Rosenberg's Goanna)	This species has been recorded within 10 km of the Study Area (Figure 6).	Considered further in this assessment.

Endangered Ecological Communities (EECs) considered to be at risk from subsidence on the final determination include Genowlan Point *Allocasuarina nana* heathland, O'Hares Creek Shale Forest, Shale Sandstone Transition Forest and Newnes Plateau shrub swamp in the Sydney Basin Bioregion. Shale Sandstone Transition Forest occurs within the Study Area and has been considered further in this assessment. The other three communities do not occur within the Study Area, nor is there habitat present for them within the Study Area and they have not been considered further.

In addition, the KTP lists the species considered in Table 2 which are not currently listed as threatened but may become so as a result of habitat alteration following subsidence due to longwall mining.

Table 2: Consideration of other species listed within the final determination of the TSC Act Key Threatening Process relating to subsidence due to longwall coal mining

Listed Species	Habitat	Consideration in the Current Proposal
Flora		
Acacia ptychoclada	Grows usually in damp and swampy sites on sandstone; from near Woodford to Mt Victoria in the Blue Mountains (Harden, 1991). Habitat is not considered to be present in the Study Area.	Not considered further in this assessment.
Almaleea incurvata	This species occurs in swamps dominated by sedges and/or shrubs, on sandstone; restricted to the Blue Mountains (Harden 1991). Habitat is not considered to be present in the Study Area.	Not considered further in this assessment.
Darwinia grandiflora	Grows in dry sclerophyll forest and woodland on poorly drained sandy soil; Woronora plateau and Illawarra region (Harden, 1991). Habitat is considered to be present in the Study Area.	Considered further in this assessment.
Epacris coriacea	Grows in skeletal sandy soils on sandstone cliffs and in rock crevices on Woronora plateau west to Bare Rock (40 km east of Rylstone) (Harden, 1992). Habitat is considered to be present in the Study Area.	Considered further in this assessment.
Grevillea acanthifolia subsp. *acanthifolia*	Grows in swampy areas or wet rock shelves, sand or peat over sandstone; Blue Mountains above 450 m altitude (Harden, 1991). Habitat is not considered to be present in the Study Area.	Not considered further in this assessment.
Lomandra fluviatilis	Grows in creek beds on sandy soils; in the Royal NP to the Colo River (Harden, 1993). Habitat is considered to be present in the Study Area.	Considered further in this assessment.
Olearia quercifolia	Grows in swampy or moist terrain; confined to the Blue Mountains (Harden, 1992). Habitat is not considered to be present in the Study Area.	Not considered further in this assessment.
Pseudanthus pimelioides	Grows in sandy soils in moist gullies (Harden, 1990). Habitat is considered to be present in the Study Area.	Considered further in this assessment.
Fauna		
Hydromys chrysogaster (Water Rat)	Restricted to the non-arid regions and in particular to areas adjacent to permanent water bodies. Throughout this range it occurs in freshwater rivers, lakes and coastal and estuarine habitats. Within the Hawkesbury-Nepean catchment it has been recorded as known in eight of the subcatchments and rare in the Upper-Nepean subcatchment	Considered further in this assessment.

3.0 METHODS

The Study Area has been the subject of several site inspections with specific reference to longwall mining. It was initially inspected as part of the larger Appin Area 7 assessment on several occasions between the 9th September 2003 and the 26th of February 2004. The general condition of the site was assessed and observations of flora and fauna species, plant communities and land use patterns were made. This assessment is detailed in Biosis Research (2004).

Further detailed site inspections were undertaken on 7th through 9th and 16th of February 2006 to assess the impact of proposed Appin Colliery Longwalls 701 to 704 (Biosis Research 2006). Targeted searches for threatened flora and fauna and their habitats were conducted, and vegetation and land use mapping was updated. During the 2006 field surveys the weather was warm to hot and partly cloudy. No rainfall was recorded during the field surveys.

The Study Area was inspected as part of the current surveys on 31st of March through to 1st of April and 3rd through 4th of April 2008. Targeted searches for threatened flora and fauna and their habitats were conducted and vegetation mapping was ground-truthed. An assessment of flora and fauna habitats present and their condition were made.

3.1 Taxonomy

The plant taxonomy (method of classification) used in this report follows Harden (1990, 1992, 1993, 2002), Fairley and Moore (2000), Robinson (1994) and subsequent advice from the National Herbarium of NSW. In the body of this report, plants are referred to by their scientific names only (with the exception of threatened plant species listed in Table 4). Common names, where available, have been included in the Appendices.

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

3.2 Literature and Database Review

Records of threatened species were obtained from the DECC *Atlas of NSW Wildlife* within a 10 km radius of the Study Area, using the Wollongong 1:100,000 map sheet. Records for threatened species, populations and

communities listed on the EPBC Act were obtained from the *Protected Matters Online Database* (DEWHA, 2008a). Furthermore, the final list of threatened species, populations and ecological communities considered in this assessment (Table 3 to Table 5) is based on other assessments and surveys undertaken by Biosis Research in the vicinity of the Study Area (Biosis Research 2002b; Biosis Research 2002a; Biosis Research 2003; Biosis Research 2004; Biosis Research 2005; Biosis Research 2006; Biosis Research 2007b).

This assessment has included reference to species, populations and communities listed on the NSW TSC Act as well as species listed on the Commonwealth EPBC Act. These and other relevant Commonwealth and State Acts and Policies that apply to the Study Area with regard to terrestrial flora and fauna are discussed below.

3.2.1 *Environment Protection and Biodiversity Conservation Act 1999* (Commonwealth)

Under the provisions of the EPBC Act any action (activity or development) that requires Commonwealth approval is deemed a controlled action. This is usually the case when an action is likely to have a significant effect on the environment of Commonwealth land or any 'Matter of National Environmental Significance' listed below:

- World Heritage areas;
- Wetlands protected by international treaty (Ramsar Convention);
- Nationally listed threatened species and ecological communities;
- Internationally listed migratory species: Japan-Australia Migratory Bird Agreement, China-Australia Migratory Bird Agreement and Bonn Convention;
- All nuclear actions; and,
- The environment of Commonwealth marine areas.

Where an impact is of potential significance then those affected species or habitats must be referred (Referral) to DEWHA for assessment in accordance with specific criteria outlined in the Guidelines for Significance Assessment. These guidelines provide separate criteria for Extinct, Vulnerable, Endangered and Migratory species against which the significance of the impact can be assessed and whether a Referral is required. The purpose of the referral stage is to determine whether a proposed action requires approval under the EPBC Act. If the Minister determines that an approval is required, the proposed action will proceed through the assessment and approval process.

A Referral is a set of information that includes brief descriptions of the proposal, its location and potential impacts on matters of national environmental significance. The EPBC Regulations set out what information must be included in the referral.

If a proposed action has been referred to the Commonwealth Environment Minister and the Minister has decided that the action requires approval, an environmental assessment must be carried out in accordance with DEWHA requirements.

The purpose of an environmental assessment is to bring together all the information on the impacts that a proposed action would have on matters protected by the EPBC Act, to ensure that the Minister makes an informed decision on whether or not to approve the action.

If the Commonwealth has signed a bilateral agreement with a State or Territory in which the action is to be carried out, the State or Territory will assess the action under the terms of that agreement. Similarly, the environmental assessment may be carried out by another Commonwealth agency if a Ministerial Declaration has been signed with that agency. If no bilateral agreement or Ministerial Declaration is in place, the assessment may nonetheless be carried out by a State or Territory under an accredited assessment process. The bilateral agreement between the Commonwealth and New South Wales has been signed.

If none of these assessment processes is applicable, the Commonwealth will carry out the assessment using one of the following assessment approaches:

- Preliminary documentation;
- Public environment report;
- Environmental impact statement; or
- Public inquiry.

The proponent, or the person proposing to take the action, will be asked to supply preliminary information on the impacts of the proposed action in order to help the Minister select an appropriate assessment approach.

3.2.2 *Threatened Species Conservation Act 1995* (NSW), *Threatened Species Conservation Amendment Act 2002* and *Environmental Planning and Assessment Act 1979* (NSW)

One objective of the EP&A Act is to encourage the protection of the environment, including the protection and conservation of native animals and plants, including threatened species, populations and ecological communities and their habitats. A second objective is to encourage the principles of ecologically sustainable

development, including the precautionary principle as defined under the *Protection of the Environment Administration Act* 1991. The *Threatened Species Conservation Act* 1995 and *Threatened Species Conservation Amendment Act* 2002 protect all threatened plants and animals native to NSW (with the exception of fish and marine plants). They provide for the identification, conservation and recovery of threatened species and their populations and communities, and aim to reduce the threats faced by those species.

If a planned development or activity will have an impact on a threatened species, this must be taken into account in the development approval process. The TSC Act Assessment of Significance is a statutory mechanism under Section 5A of the EP&A Act, as amended by the *Threatened Species Conservation Amendment Act* 2002, for assessing whether a proposed development activity may have a significant impact on threatened species, populations or ecological communities or their habitats.

When a threatened species is known to occur within the vicinity of the Study Area but is not recorded during the field survey, the presence of potential habitat for this species is used to determine the need to undertake an Assessment of Significance. Where there is no potential habitat in the Study Area for threatened species, there is unlikely to be any impact on these species and therefore Assessments of Significance are not required.

An assessment of the results of each test indicates the potential significance of the impact. If the application of the Assessment of Significance reveals that a significant effect is likely then:

- The proposal may be modified such that a significant effect on threatened species, populations or ecological communities, or their habitats is unlikely; and/or
- A Species Impact Statement (SIS) must be prepared for each species potentially occurring or known to occur within the Study Area and the concurrence of the Director General of the DECC, or consultation with the Minister for the Environment is required (NPWS 1996).

3.2.3 State Environmental Planning Policy 44 – Koala Habitat Protection (NSW)

SEPP 44 aims to encourage the proper conservation and management of areas of natural vegetation that provide habitat for Koalas, ensuring a permanent free-living population over their present range and attempting to reverse the current trend of Koala population decline:

a) by requiring the preparation of plans of management before development consent can be granted in relation to areas of core Koala habitat;

b) by encouraging the identification of areas of core Koala habitat; and

c) by encouraging the inclusion of areas of core Koala habitat in environment protection zones.

Under this policy the distinction is made between 'potential' and 'core' Koala habitat.

'Potential Koala habitat' means areas of native vegetation where the trees of the types listed in Schedule 2 of the Policy constitute at least 15% of the total number of trees in the upper or lower strata of the tree component.

'Core Koala habitat' means an area of land with a resident population of Koalas, evidenced by attributes such as breeding females (that is, females with young) and recent sightings of and historical records of a population.

SEPP 44 applies to land within Local Government Areas (LGAs) listed in SEPP 44, Schedule 1 (including Wollondilly LGA) for which a development application has been made (SEPP 44, Section 6) and Council is the determining authority. SEPP 44 does not apply to land dedicated or reserved under the *National Parks and Wildlife Act* 1974 or to land dedicated under the *Forestry Act* 1916 as State Forest or flora reserve (SEPP 44, Section 5). Nor does it apply to land where Council is not the determining authority. Thus, in instances where State agencies undertake Part 5 activities under the EP&A Act, SEPP 44 does not apply, even if an EIS is required. Consequently SEPP 44 does not apply to this project.

3.3 Field Survey Scope

This study was by design a habitat level assessment and was conducted in accordance with the methodology required for an assessment under Section 5A of the EP&A Act. As such, no trapping, spotlighting, call-playback or vegetation quadrat sampling techniques were used. As the assessment is based on presence or absence of suitable habitat for threatened species, such techniques are not necessary. The survey effort and associated investigations are considered sufficient to record threatened species (and/or their habitats), or the potential for them to occur.

The methodology employed for this assessment is sufficient to determine if mining Longwalls 705-710 would have a significant impact on any threatened terrestrial species, populations or ecological communities. Such an assessment is considered conservative, in that the presence of habitat for a threatened species, population or ecological community is sufficient to warrant further consideration

in the impact assessment process. The assessment does not need to rely on actual records of threatened species.

A detailed consideration of precisely what impacts, if any, may occur as a result of the project is also important when determining which threatened species to include in the impact assessment. That is, not all threatened species occurring or potentially occurring within the Study Area will require assessment under the TSC and EPBC Acts if they are not directly or indirectly impacted by the proposed development. Sections 2.4 and 2.5 of this report detail the natural features of the Study Area and the predicated impacts on those features resulting from mining Longwalls 705 to 710. Any impact assessment for terrestrial flora and fauna values, including threatened species, populations, ecological communities and/or their habitats, that may or do occur within the Study Area must be considered in light of these two sections. The presence of a threatened species or its habitat within the Study Area is not sufficient in itself to warrant further consideration in the impact assessment. The approach taken in this assessment is to undertake impact assessments for those threatened terrestrial ecological values that occur or may occur within the Study Area (based on the presence of suitable habitat) and which may be subject to alteration by subsidence.

It is also important to note that the methodology employed in this impact assessment does not allow for a quantitative pre and post mining impact analysis to be conducted.

3.4 Flora Survey

Flora assemblages and broad vegetation types were assessed by the random-meander method, as described by Cropper (1993). The meander route is designed to traverse all communities and topographical features within the Study Area, recording plants as they are encountered. This approach does not seek to provide an exhaustive list of plants that occur within the Study Area, as may be achieved through a prolonged vegetation quadrat sampling program but rather aims to provide a list of dominant flora species within the Study Area. A species list for the Study Area is provided in Appendix 1.

Targeted searches for threatened species (listed on the TSC Act) known to occur in the vicinity of the Study Area were conducted in areas of suitable habitat within the Study Area.

Plant Community Classification

Plant community classification was determined by the observed differences in species composition and comparison to known/previous descriptions of plant

communities in the region. Vegetation classification closely follows that of Benson and Howell (1994), NPWS (1997) and NPWS (2002).

Vegetation Mapping

Vegetation mapping in this report is adapted from the Vegetation Mapping of the Cumberland Plain (2002) and the existing mapping was determined to be largely accurate. Any significant differences between the vegetation recorded within the Study Area and the existing mapping have been described in the plant community descriptions below.

3.4.1 Flora Habitat Assessment

Vegetation condition was assessed according to the degree it resembles relatively natural, undisturbed vegetation. Vegetation was assessed as being in good, moderate, poor or disturbed condition according to the following criteria:

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

The categories of vegetation conditions are as follows:

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

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

Poor: containing a low number of indigenous species; high level of weed invasion; weeds occurring in dense patches or scattered throughout; one or more of the original layers of vegetation are highly modified; one or more original vegetation layers (ground, shrub, canopy etc.) are modified or missing, but natural soil profile intact; able to be regenerated to Moderate or Good condition with substantial management; and,

Disturbed: highly modified landscape containing few or no indigenous species; exotic species dominant; original native vegetation layers removed; natural soil profile disturbed; unable to be regenerated to natural condition.

3.5 Fauna Survey

Animal species were surveyed by undertaking active searching and listening, as well as recording incidental observations. Trapping of terrestrial animals was not undertaken for the current assessment.

3.5.1 Fauna Habitat Assessment

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

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

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

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

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

3.6 Impact Assessment

Impact assessments were carried out on listed species, populations and ecological communities that occur or have the potential to occur within the Study Area (based on the presence of suitable habitat) and where there is potential for subsidence associated with mining of Longwalls 705 to 710 to impact the species/community or its habitat.

Where subsidence may impact individuals/communities (or their potential habitat) listed on the TSC Act, Assessments of Significance are required to assess the potential significance of the impact. In the instance that an Assessment of Significance identifies that a significant impact on a species is likely, a Species Impact Statement may be required.

Where subsidence may impact individuals/communities (or their potential habitat) listed on the EPBC Act, Assessments of Significance are required. In the instance that an Assessment of Significance identifies that a significant impact on a species is likely, a Referral to the Commonwealth Minister for the Environment, Water, Heritage and the Arts is required.

It should be noted that in some cases habitat for a threatened species may be recorded within the Study Area, however the nature of subsidence related impacts may be such that there is no known mechanism for subsidence to impact that particular habitat feature (e.g. tree hollows). In the absence of direct or indirect impacts on a habitat for a threatened species, further impact assessments are not considered necessary.

Assessing the impacts of any proposal on terrestrial flora and fauna values is limited in nature by State and Federal planning and threatened species legislation to include only those values listed as threatened on either the TSC Act or the EPBC Act. Additionally, it may be appropriate to consider some values under the State Environmental Planning Policies or SEPP's. Consequently, such assessments may not take into account all species that may be important to the local community, especially if they are not listed as a threatened species on the TSC or EPBC Acts. While there is no mechanism to consider these species within the legislated impact assessment prepared for this report, it is important to recognise that all native flora and fauna are afforded conservation protection within Australia. The impact assessment process, which considers potential impacts to habitat features and environmental aspects, does provide a good indication of the likely level of impact to all species and ecological communities within the assessment area.

3.7 Limitations

Some plant species that occur in the local area are annuals (completing their life cycle within a single season) and are present only in the seed bank for much of the year. Other plant species are perennial but are inconspicuous unless flowering. Similarly, some fauna may be seasonally absent from the Study Area. However, as the assessment of the impact is based on the presence or absence of suitable habitat for threatened flora and fauna (which is adequate to satisfy the requirements of the EP&A Act), such species are taken into account during the assessment even though they may not be identified during the survey.

Access to some private properties was not secured during the current assessment (Figure 3). As such not all of the Study Area has been field inspected. Discussions of ecological values including vegetation mapping for lands not available for fieldwork for this report are based on previously published works and interpretation of recent high-resolution aerial photography.

Vegetation mapping used in this reports is derived from NPWS (2002b). Misinterpretations in this mapping may occur on lands where access was not secured though these are likely to be minor.

4.0 RESULTS

4.1 Plant Communities

4.1.1 Threatened Ecological Communities Known to Occur in the Region

The vegetation of the Cumberland Plain has been extensively cleared in the past two centuries rendering much of the remaining vegetation of high conservation significance. Past and present agricultural practices, such as unrestricted grazing, have resulted in the degradation of much of the remnant vegetation on the Cumberland Plain.

Eleven Endangered Ecological Communities (EECs) listed on the TSC Act are known to occur in Wollondilly LGA, three of which are also listed as Endangered or Critically Endangered on the EPBC Act (Table 3). The Study Area contains potential habitat for seven of these EECs. Not all communities with potential habitat in the Study Area are present- the occurrence of EECs in the Study Area is described in Section 4.1.2.

Table 3. Endangered Ecological Communities known to occur in the Wollondilly Local Government Area

Threatened Ecological Community	TSC Act	EPBC Act	Habitat	Potential habitat in Study Area	Occurring within the Study Area and considered further in this assessment
Blue Mountains Swamps in the Sydney Basin Bioregion	E	-	Typically associated with the poorly drained headwaters of streams on the predominantly sandstone plateaux of the Blue Mountains.	No	No
Cumberland Plain Woodland	E	E	Soils derived from shale on the Cumberland Plain.	Yes	Yes
Freshwater Wetlands on Coastal Floodplains	E	-	Typically occurs on silts, muds or humic loams in depressions, flats, drainage lines, lagoons and lakes of coastal floodplains. Freshwater Wetlands on Coastal Floodplains generally occur below 20 m elevation in the NSW North Coast, Sydney Basin and South East Corner bioregion.	No	No
Moist Shale Woodland in the Sydney Basin Bioregion	E	-	Usually occurs on soils derived from Wianamatta Shale on higher country in the southern half of the Cumberland Plain. Moist Shale Woodland is found in very similar environments to Western Sydney Dry Rainforest, but tends to occupy upper slopes while Western Sydney Dry Rainforest is often found on lower slopes and in gullies.	Yes	Yes

Threatened Ecological Community	TSC Act	EPBC Act	Habitat	Potential habitat in Study Area	Occurring within the Study Area and considered further in this assessment
O'Hares Creek Shale Forest Community	E	-	Occurs on deep, well drained red loam on small outcrops of Hawkesbury shale in the Darkes Forest area on the Woronora Plateau. Occurs on flat ridgetops and adjacent slopes.	No	No
River-flat Eucalypt Forest on Coastal Floodplains	E	-	Associated with silts, clay-loams and sandy loams, on periodically inundated alluvial flats, drainage lines and river terraces of coastal floodplains. Generally occurs below 50 m elevation, but may occur on localised river flats up to 250 m above sea level.	Yes	Yes
Shale Sandstone Transition Forest	E	E	Occurs on areas transitional between the clay soils derived from Wianamatta Shale and the sandy soils derived from Hawkesbury Sandstone on the margins of the Cumberland Plain.	Yes	Yes
Southern Sydney sheltered forest on transitional sandstone soils in the Sydney Basin Bioregion	E	-	Typically associated with sheltered heads and upper slopes of gullies on transitional zones where sandstone outcrops may exist, but where soils are influenced by lateral movement of moisture, nutrients and sediment from more fertile substrates, such as shale/ironstone caps or dolerite dykes, in adjacent areas.	Yes	No
Swamp Oak Floodplain Forest	E	-	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 of coastal floodplains. Swamp Oak Floodplain Forest generally occurs below 20 m (rarely above 10 m) elevation.	No	No
Turpentine-Ironbark Forest of the Sydney Basin Bioregion	E	CE	Occurs primarily on clay soils derived from Wianamatta Shale, including clay lenses of Wianamatta Shale within Hawkesbury Sandstone. Not listed as occurring in Wollondilly LGA in TSC Act Final Determination.	Yes	No
Western Sydney Dry Rainforest in the Sydney Basin Bioregion	E	-	Recorded at Razorback Ridge in Wollondilly LGA. Typically associated with gullies and sheltered slopes of hilly, relatively steep sections of the generally elevated Cumberland Plain in the Razorback Range from Cobbitty to Picton, and sporadically elsewhere in Western Sydney including Fairfield City Farm, Grose Vale and Cattai. Soils are clay soils on Wianamatta Shale.	Yes	No

4.1.2 Plant Communities That Occur in the Study Area

Although much of the Study Area has been cleared of native vegetation, five broad plant communities were recorded within the Study Area (Figure 4, adapted from NPWS 2002c). Four of the plant communities in the Study Area are listed as EECs on the TSC and/or EPBC Acts:

- Shale Sandstone Transition Forest

    - High Sandstone Influence
    - Low Sandstone Influence
- Cumberland Plain Woodland
    - Shale Hills Woodland
    - Shale Plains Woodland
- River-flat Eucalypt Forest
    - Alluvial Woodland
    - Riparian Forest
- Moist Shale Woodland

One other plant communities occur within the Study Area:

- Western Sandstone Gully Forest

A brief description of each community and its occurrence in the Study Area is provided below.

Land that has been cleared for agricultural practices has also been discussed below as Cleared Land/Agricultural Pasture.

The majority of the treed vegetation is confined to the Nepean River valley and associated tributaries, as steep sandstone benches and terraces have rendered it less useful for grazing and cropping than the flat to undulating land dominated by shale soils.

4.1.3 Shale Sandstone Transition Forest

Shale Sandstone Transition Forest is listed as an EEC on both the TSC and the EPBC Acts. Under the TSC Act, the KTP relating to subsidence due to longwall mining also list this community as an EEC that is likely to be altered by subsidence and mining associated activities.

In this report, as described by NPWS (2002b), Shale Sandstone Transition Forest is divided into two forms reflecting the variation in floristic composition associated with varying shale/sandstone influence. These are Shale Sandstone Transition Forest (Low Sandstone Influence) and Shale Sandstone Transition Forest (High Sandstone Influence), equivalent to Map Units 1 and 2 of NPWS (2002b) respectively. Both of these forms are consistent with the descriptions of Shale Sandstone Transition Forest in the TSC and EPBC Acts. These two forms of Shale Sandstone Transition Forest are described below.

Low Sandstone Influence

Shale Sandstone Transition Forest (Low Sandstone Influence) (Map Unit 1, NPWS 2002b) occurs around the margins of the Cumberland Plain on soils derived from Wianamatta Shale. This community is typically found on the middle or upper slopes of gently undulating land. As distance to the sandstone/shale boundary increases Map Unit 1 grades into Shale Plains Woodland (Map Unit 10, NPWS 2002b) or, less frequently, Shale Hills Woodland (Map Unit 9, NPWS 2002b). The boundary between these communities is indistinct by nature (NPWS 2002b).

Within the Study Area this community has been predominantly cleared and adjoins the banks of the Nepean River valley and associated drainage lines (Figure 4). In the Study Area, Shale Sandstone Transition Forest (Low Sandstone Influence) supported a canopy to approximately 20 m high of *Eucalyptus fibrosa, E. moluccana, E. tereticornis* and *E. crebra*, with the midstorey supporting juvenile eucalypts to 12 m high. The shrub layer supported native species such as *Westringia longifolia, Kunzea ambigua* and *Olearia viscdiula* and scattered patches of exotic species such as *Lantana camara* and *Olea europaea.* The understorey supported a dense coverage of grasses, herbs and sedges such as *Microlaena stipoides, Aristida vagans, Gahnia aspera* and *Calotis dentex.*

Existing patches of Shale Sandstone Transition Forest (Low Sandstone Influence) in the Study Area are considered to be in good to moderate condition even though they have been impacted by clearing for tracks and powerlines and also through weed invasion.

High Sandstone Influence

Shale Sandstone Transition Forest (High Sandstone Influence) (Map Unit 2, NPWS 2002b) occurs on the margins of the Cumberland Plain in close proximity to the sandstone/shale boundary (Figure 4) (NPWS 2002b). This community grades into Shale Sandstone Transition Forest (Low Sandstone Influence) (Map Unit 1, NPWS 2002b), with increasing distance from the sandstone/shale boundary. Sometimes this transition is abrupt, and Map Unit 2 grades directly into Shale Plains Woodland (Map Unit 10, NPWS 2002b).

Within the Study Area this community occurs immediately above the sandstone escarpments within the Nepean River valley and associated tributaries (Figure 4, Plate 1). In the Study Area, Shale Sandstone Transition Forest (High Sandstone Influence) supported a canopy of *Eucalyptus punctata* and *E. pilularis* to 25 m in height with a small tree layer of *Angophora bakeri, Allocasuarina littoralis, A. torulosa* and *Persoonia linearis* to a height of approximately 10 m. The shrub layer was relatively dense and supported native species such as *Leptospermum*

trinervium, Astrotricha latifolia, Bursaria spinosa, Kunzea ambigua, Correa reflexa, Indigophora australis and *Rapanea variabilis.* The exotic species *Lantana camara* was also recorded as scattered patches in the shrub layer. The understorey was dominated by *Gahnia aspera, Lomandra longifolia, L. fluviatilis, Entolasia stricta, Stypandra glauca, Cymbopogon refractus, Aristida vagans, Microlaena stipoides* and *Calotis dentex.*

Existing patches of Shale Sandstone Transition Forest (High Sandstone Influence) in the Study Area are considered to be in good to moderate condition even though they have been impacted by grazing, historical clearing, track creation and weed invasion. Grazing and trampling of regenerating vegetation by stock was observed as a major ongoing impact on this community as much of the Nepean River valley in which it occurs is open to stock access.

4.1.4 Cumberland Plain Woodland

Cumberland Plain Woodland, which is listed as an EEC on both the TSC and EPBC Acts, contains two forms: Shale Plains Woodland and Shale Hills Woodland. These are described below.

Shale Hills Woodland

Shale Hills Woodland occurs mainly on the elevated and sloping southern half of the Cumberland Plain (NPWS 2001b). Within the Study Area this community has been almost entirely cleared for agricultural pursuits and patches are typically very small and subject to ongoing disturbance, often through grazing (Figure 4). In the Study Area, Shale Hills Woodland supported a canopy of *Eucalyptus crebra, E. tereticornis* and *E. moluccana* to a height of approximately 20 m. Where present, the small tree layer supported juvenile eucalypts and the exotic *Schinus areira*. The shrub layer was relatively dense in some patches, supporting native species *Bursaria spinosa,* and the exotic species *Olea europaea, Schinus areira* and *Lycium ferocissimum.* The understorey supported species such as *Dichondra repens, Microlaena stipoides, Sporobolus crebra* and the exotic species *Senecio madagascariensis* and *Conyza albida.*

Patches of Shale Hills Woodland are considered to be in moderate to poor condition despite grazing pressure. Grazing within these patches has reduced the vegetation to canopy trees only in some patches, although some hardy ground cover and grazing resistant shrub species are present. Grazing and trampling is likely to lead to the long-term decline of this community within the Study Area as regenerating vegetation is either eaten by stock or trampled. Furthermore, invasion of the understorey and ground cover layers by pasture grasses and other agricultural plants reduces the integrity of this vegetation and the long-term regenerating prospects of the community.

Shale Plains Woodland

Shale Plains Woodland is the most widely distributed form of Cumberland Plain Woodland (NPWS 2001b). Within the Study Area this community has been almost entirely cleared (Figure 4) and patches occur as scattered degraded patches of woodland that are subject to ongoing disturbances such as grazing (Plate 2). In the Study Area, Shale Plains Woodland supports a canopy of *Eucalyptus tereticornis,* with *E. moluccana* occurring less frequently. The small tree layer supported juvenile Eucalyptus in some areas, with the exotic *Schinus areira* also occurring. The shrub layer was dominated by *Bursaria spinosa* and *Olea europaea.* The understorey supported a mixture of natives, such as *Microlaena stipoides, Themeda australis* and *Wahlenbergia stricta,* and exotic pasture grasses such as *Paspalum dilatatum.*

Patches of Shale Plains Woodland were considered to be in poor condition, due to grazing pressure and weed invasion. As with Shale Hills Woodland this community may occur as scattered remnant trees within improved pastures or grazed areas. Grazing within these patches has often reduced the vegetation to canopy trees with some hardy ground covers and grazing resistant shrubs surviving. Grazing and trampling within this community is likely to lead to its long-term decline in the local area as regenerating vegetation is either eaten by stock or trampled. Furthermore, invasion of the understorey and ground cover layers by pasture grasses and other agricultural plants reduces the integrity of this vegetation and also the long-term regenerating prospects for the community.

4.1.5 River-flat Eucalypt Forest

River-flat Eucalypt Forest (RFEF) on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner Bioregions was gazetted as an EEC on the TSC Act in December 2004. This listing included and replaced Sydney Coastal River Flat Forest EEC. RFEF includes the components of Alluvial Woodland (Map Unit 11) and Riparian Forest (Map Unit 12) of NPWS (2002a) that are dominated by Eucalypts (TSC Act Final Determination).

River-flat Eucalypt Forest vegetation was extensively cleared by early settlers to gain access to highly fertile alluvial soils (NPWS 2002b). The scattered patches of this community are currently under threat from invasion by woody weeds including Privet (*Ligustrum* spp.) as well as disturbance from grazing, clearing, sand/soil mining and physical disturbance associated with recreational access (NPWS 2002b).

Alluvial Woodland

Alluvial Woodland is one of the two main forms of vegetation described as River Flat Forest as described by Benson (Map Unit 9f, 1992a). This community occurs along minor watercourses and on terraces adjacent to Riparian Forest. In the Study Area, Alluvial Woodland has been largely cleared, with remnants restricted to thin strips of vegetation within riparian areas adjacent to creeks. In some cases the vegetation has been reduced to scattered trees over an exotic understorey.

In the Study Area, the species composition of Alluvial Woodland was largely similar to that of Cumberland Plain Woodland. This is due to the highly disturbed nature of the patches and the absence of a tree canopy in many areas (Plate 3). Dominant trees occurring in areas mapped as Alluvial Woodland included *Eucalyptus tereticornis, E. moluccana* and *E. crebra.* Where present, the small tree layer supported a scattered distribution of *Acacia* spp. and *Melaleuca styphelioides.* The shrub layer was also largely absent and supported a scattered distribution of *Bursaria spinosa, Indigophora australis, Olea europaea* and *Acacia* spp.. The ground layer was dominated by exotic grasses such as *Bromus catharticus, Chloris gayana, Setaria gracilis, Paspalum dilatatum,* with native grasses such as *Austrodanthonia tenuior* and *Chloris truncata* also occurring.

Alluvial Woodland was considered to be in poor condition in the Study Area given the highly modified structure, weed invasion and impacts from grazing.

Riparian Forest

Riparian Forest is described as a typically a tall open forest community on alluvial soils adjacent to main river channels, with emergent trees, such as *Angophora subvelutina, Eucalyptus amplifolia*, *E. botryoides* and *E. elata* (NPWS 2002b). The small tree layer often includes wattles, such as *Acacia floribunda* and *A. binervia*. Originally, the understorey would have had occasional dense pockets of low rainforest vegetation, such as *Backhousia myrtifolia* and a grassy shrub layer with *Bursaria spinosa* (NPWS 2002b).

Within the Study Area, areas mapped as supporting Riparian Forest are considered to be more closely aligned with Western Sandstone Gully Forest (described below). However, it should be noted that Riparian Forest could occur within the Study Area in sections not surveyed during the current assessment due to access restrictions. Riparian Forest was considered to be present along the Nepean River in the south of the Study Area in a previous survey (Biosis Research 2006). The Riparian Forest recorded in the previous survey of the area was considered to be in poor condition as stated below (Biosis Research 2006):

> "Within the Study Area *Ligustrum* spp., *Arundo donax* and various grass and climbing plants are major weeds within this community. Furthermore, along some sections of the river it appears that this community has been almost entirely replaced by *Ligustrum* spp and other woody weed species. This plant community is considered to be in poor condition."

A Vegetation Management Plan is in place to monitor and manage potential impacts of the mining of Longwalls 701 to 704 on River-flat Eucalypt Forest, occurring to the south of the Study Area (Biosis Research 2007a).

4.1.6 Moist Shale Woodland

Moist Shale Woodland in the Sydney Basin Bioregion is listed as an EEC under the TSC Act and occurs exclusively on soils derived from Wianamatta shale. It was mapped as Map Unit 14 by NPWS (2002b).

Moist Shale Woodland typically occurs on rugged hillsides and in the local region occurs on the Razorback Range and other prominent hills. It is highly restricted in distribution and existing remnants are threatened by clearing and weeds (NPWS 2002b). This community is the intermediate between Cumberland Plain Woodland on drier sites and Western Sydney Dry Rainforest on wetter sites. It is subject to periodic fires, and fire frequency and intensity have the potential to remove fire sensitive species from the understorey of this community (NPWS 2002b).

Within the Study Area, Moist Shale Woodland is restricted to rugged areas at higher elevations in the south-west section of the Study Area (Figure 4, Plate 4). Dominant canopy trees recorded in this community in the Study Area included *Eucalyptus tereticornis, E. moluccana* and *E. crebra*. The small tree layer was largely absent, however the shrub layer was relatively dense and supported species such as the native species *Bursaria spinosa* and *Sigesbeckia orientalis* and the exotic species *Olea europaea* and *Lycium ferocissimum*. The understorey was dominated by native grasses and herbs such as *Microlaena stipoides, Eragrostis leptostachya, Chloris tuncata, Dichondra repens, Clematis aristata* and *Solanum prinophyllum.*

Moist Shale Woodland within the Study Area is threatened by unrestricted grazing and was considered to be in a moderate to poor condition.

4.1.7 Western Sandstone Gully Forest

Western Sandstone Gully Forest (Map Unit 33, NPWS 2002b) occurs on the lower slopes of sandstone gullies on the western side of the Woronora Plateau

where annual rainfall falls below approximately 1050 mm. It is not listed as an EEC on either the TSC or EPBC Acts.

In the Study Area, Western Sandstone Gully Forest occupies the deeper valleys along sandstone creeklines, including areas mapped as supporting Riparian Forest below the Shale Sandstone Transition Forest (Low and High Sandstone Influence) along the Nepean River (Figure 4). Dominant canopy species recorded in Western Sandstone Gully Forest in the Study Area included *Eucalyptus punctata* and *E. pilularis,* with *E. piperita* and *Corymbia gummifera* occurring less frequently. The small tree layer was relatively dense and supported species such as *Angophora bakeri, Allocasuarina torulosa, Rapanea variabilis* and *Ceratopetalum gummifera.* More sheltered gullies supported dense small tree stratum of *Backhousia myrtifolia.* The shrub layer was relatively sparse and dominated by *Bursaria spinosa, Astrotricha latifolia, Clerodendrum tomentosum, Melaleuca styphelioides,* and *M. linearifolia,* with scattered patches of *Lantana camara* and *Ligustrum lucidum* also present. The understorey was dominated by native species such as *Adiantum aethiopicum, Microlaena stipoides, Dichondra repens, Doodia aspera, Lomandra longifolia, L. fluviatilis* and *Lepidosperma laterale.*

Western Sandstone Gully Forest was considered to be in good condition in the Study Area (Plates 5 and 6), despite impacts from weed invasion, given the intact structure and diverse native species composition.

In the Study Area, this closed forest community contains a number of species listed as occurring within the Western Sydney Dry Rainforest EEC. However, Western Sydney Dry Rainforest typically occurs on shale soils while the closed forest community within the Study Area occurs on sandstone soils that may be shale influenced.

4.1.8 Cleared Land/Agricultural Pasture

Within the Study Area Cleared Land/Agricultural Pasture occurs on most of the flat and undulating areas outside of the Nepean River gorge and its deeply incised tributaries (Figure 4, Plate 7). The relatively fertile soils of these areas and the proximity to large urban populations have led to the clearing of much of the native vegetation for agricultural practices. This landscape type is highly modified, has little or no flora habitat value and does not constitute a native plant community. Dominant species recorded within the cleared land included herbs such as *Cirsium vulgare, Senecio madagascariensis* and *Sida rhombifolia* and grasses such as *Paspalum dilatatum, Pennisetum clandestinum, Cynodon dactylon* and *Sporobolus* spp.

A tributary of Harris Creek in the south-western section of the Study Area was cleared of native vegetation and dominated by a dense layer of exotic trees and shrubs including *Schinus areira, Ligustrum lucidum, L. sinense* and *Olea europaea.* Rubbish dumping was prevalent along this creekline, with car bodies scattered throughout.

This landscape is dominated by improved pasture, which reflects the previous disturbances of vegetation clearing, over-grazing and the addition of fertilisers to the paddocks. Much of the area defined as Cleared Land/Agricultural Pasture is considered unlikely to retain a native plant seed bank (i.e. no resilience).

4.2 Flora

A total of 187 species were recorded in and surrounding the Study Area in the current survey, including 144 native and 43 exotic species. Five of the exotic species are listed as noxious weeds in Wollondilly LGA: *Lycium ferocissimum* (Class 4), *Xanthium* species (Class 4), *Rubus fruticosus* aggregate species (Class 4), *Lantana camara* (Class 5) and *Opuntia* spp, (Class 5). A list of flora species recorded from the Study Area during the field surveys is provided in Appendix 1.

4.2.1 Listed Threatened Flora Species

Database searches of the *Atlas of NSW Wildlife* and the *Protected Matters Search Tool* revealed that 21 threatened flora species have previously been recorded within a 10 km radius of the Study Area (Table 4). All 21 species are listed as either Vulnerable or Endangered on the TSC Act and 18 of these are listed on the EPBC Act. Eighteen of these threatened flora species have been previously recorded within a 10 kilometre radius of the Study Area (Figure 5). Table 4 lists the 21 threatened species potentially found in the Study Area and assesses whether the Study Area contains suitable habitat for them. It also indicates whether potential habitat is predicted to be affected by subsidence.

Seven threatened plant species with potential habitat in the Study Area are considered unlikely to be impacted by subsidence as a result of the proposed longwall mining (Table 4): *Epacris purpurascens* var. *purpurascens, Grevillea parviflora* ssp. *parviflora, Persoonia bargoensis, P. hirsuta, Pimelea spicata, Pultenaea pedunculata* and *Thesium australe.* Habitat for three threatened plant species has the potential to be impacted by subsidence as a result of the proposed longwall mining: *Eucalyptus benthamii, Pomaderris brunnea* and *Pterostylis saxicola.* The reasons for this are discussed in detail in Section 5.2.

Table 4: Threatened flora species listed on the TSC Act or the EPBC Act that have been recorded, or have the potential to occur, in the local area

Species		Status		Habitat	Potential Habitat?	Habitat potentially impacted by subsidence?
Scientific Name	**Common Name**	**EPBC Act**	**TSC Act**			
Acacia bynoeana	Bynoe's Wattle	V	E1	Bynoe's wattle is found in central eastern NSW, from the Hunter District (Morisset) south to the Southern Highlands and west to the Blue Mountains. It has recently been found in the Colymea and Parma Creek areas west of Nowra. Occurs in heath or dry sclerophyll forest on sandy soils. Seems to prefer open, sometimes slightly disturbed sites such as trail margins, edges of roadside spoil mounds and in recently burnt patches (DEC, 2005a). ROTAP	No	-

Species		Status		Habitat	Potential Habitat?	Habitat potentially impacted by subsidence?
Scientific Name	**Common Name**	**EPBC Act**	**TSC Act**			
				3V		
Amperea xiphoclada var. *pedicellata*	-	X	E4	Herb to 40 cm high. Occurs at altitudes 0-50 m with annual rainfall 1200 mm. Found in Swamp communities with sand and peaty sand substrate. Only known collection is from Double Bay (c. 1880) within the Sydney area (Royal Botanic Gardens 1995). ROTAP 1X	No	-
Caladenia tessellata	Tessellated Spider Orchid	V	E1	Low open forest with heath or sometimes grass understorey this species only grows in very dense shrubbery in coastal areas (Bishop 1996). Currently known from two disjunct areas: Braidwood on southern tablelands and three populations in Wyong area on the Central Coast (DEC, 2005b). ROTAP 3V.	No	-
Callistemon linearifolius	-	-	V	Occurs chiefly from Georges River to the Hawkesbury River where it grows in dry sclerophyll forest (Harden 2002), open forest, scrubland (Fairley and Moore 2000) or woodland on sandstone. Found in damp places, usually in gullies (Robinson 1994). Flowers in Spring. ROTAP 2Ri	No	-
Cryptostylis hunteriana	Leafless Tongue Orchid	V	V	This species typically grows in swamp-heath on sandy soils chiefly in coastal districts (Harden 1993) but has also been recorded on steep bare hillsides (Bishop 1996). This species does not appear to have well defined habitat preferences and is known from a range of communities, including swamp-heath and woodland. The larger populations typically occur in woodland dominated by *Eucalyptus sclerophylla*, *E. sieberi*, *Corymbia gummifera* and *Allocasuarina littoralis*; appears to prefer open areas in the understorey of this community and is often found in association with the *C. subulata* (DEC, 2005d). ROTAP 3V	No	-
Cynanchum elegans	White-flowered Wax Plant	E	E1	Rainforest gullies scrub and scree slopes in Gloucester and Wollongong districts (Harden 1992). Occurs mainly at the ecotone between dry subtropical rainforest and sclerophyll forest/woodland communities (DEC, 2005r). Has been recorded in dry subtropical rainforest, littoral rainforest, *Leptospermum laevigatum-Banksia integrifolia* Coastal scrub, *Eucalyptus tereticornis* forest and woodland, *Corymbia maculata* forest and woodland and *Melaleuca armillaris* scrub to open scrub (DEC, 2005r). ROTAP 3Ei	No	-
**Epacris purpurascens* var. *purpurascens*	-	-	V	Sclerophyll forest, scrub and swamps from Gosford and Sydney districts (Harden 1992) specifically this species is thought to require wet heath vegetation (T. James pers. comm.). Characteristically found in a range of habitat	Yes	No

Species		Status		Habitat	Potential Habitat?	Habitat potentially impacted by subsidence?
Scientific Name	**Common Name**	**EPBC Act**	**TSC Act**			
				types, most of which have a strong shale soil influence. These include ridgetop drainage depressions supporting wet heath within or adjoining shale cap communities (including Shale Sandstone Transition Forest). Also occurs in riparian zones draining into Sydney Sandstone Gully Forest, shale lenses within sandstone habitats and colluvial areas overlying or adjoining sandstone or tertiary alluvium. Has been recorded from Gosford, Narrabeen, Silverdale and Avon Dam vicinity (DEC, 2005f). ROTAP 2K		
Eucalyptus benthamii	Nepean River Gum	V	V	Known from two main locations: Bents Basin and Kedumba Valley. A few scattered individuals are recorded from other sites on the sandy alluvial flats of the Kedumba/Cox/Nepean River system. Occurs only in wet open forest on sandy alluvial soils along valley floors at an elevation of 140-750 m. The soils are shallow to moderately deep and are well drained alluvial sands and gravels along stream channels, small terraces and alluvial flats (NPWS 2000b). Restricted but locally abundant (Harden 1991). ROTAP 2Vi	Yes	Yes
Grevillea parviflora ssp. *parviflora*	Small flower Grevillea	V	V	Sporadically distributed throughout the Sydney Basin with the main occurrence centred around Picton, Appin and Bargo. Separate populations are also known further north from Putty to Wyong and Lake Macquarie on the Central Coast and Cessnock and Kurri Kurri in the Lower Hunter. Grows in sandy or light clay soils usually over thin shales. Occurs in a range of vegetation types from heath and shrubby woodland to open forest. Often occurs in open, slightly disturbed sites such as along tracks. Flowering has been recorded between July to December as well as April-May (DEC, 2005h).	Yes	No
**Leucopogon exolasius*	Woronora Beard-heath	V	V	Woodland on sandstone, restricted to the Woronora and Grose Rivers (Harden 1991). The plant occurs in woodland on sandstone and prefers rocky hillsides along creek banks (NPWS 1997). Flowering occurs in August and September. ROTAP 2V	No	-
**Melaleuca deanei*	Dean's Melaleuca	V	V	The species grows in heath on sandstone (DEC, 2005i). Occurs in two distinct areas of Sydney (Ku-Ring-Gai/Berowra and Holsworthy/Wedderburn) and has isolated occurrences in the Blue Mountains, Nowra and Central Coast areas (DEC, 2005i). Flowers appear in summer but seed production appears to be small and consequently the species exhibits a limited capacity to regenerate. ROTAP 3R	No	-

Species		Status		Habitat	Potential Habitat?	Habitat potentially impacted by subsidence?
Scientific Name	**Common Name**	**EPBC Act**	**TSC Act**			
Persoonia bargoensis	Bargo Geebung	V	E1	Restricted to a small area south-west of Sydney on the western edge of the Woronora Plateau. Its entire range falls between Picton, Douglas Park, Yanderra, Cataract River and Thirlmere. Occurs in woodland or dry sclerophyll forest on sandstone and on heavier, well drained, loamy, gravely soils typical of Shale Sandstone Transition Forest. Like most Geebungs this species seems to benefit from the reduced competition and increased light available on disturbance margins including roadsides (DEC, 2005j). ROTAP 2V	Yes	No
Persoonia hirsuta	Hairy Geebung	E	E1	Occurs from Gosford to Royal NP and in the Putty district from Hill Top to Glen Davis where it grows in woodland to dry sclerophyll forest on sandstone (Harden 2002) or rarely on shale (NSW Scientific Committee, 1998). Two subspecies are recognised, *P. hirsuta* ssp. *hirsuta* (Gosford to Berowra and Manly to Royal NP) and *P. hirsuta* ssp. *evoluta* (Blue Mountains, Woronora Plateau and Southern Highlands). Found in sandy soils in dry sclerophyll open forest, woodland and heath on sandstone and shale-sandstone transition areas (DEC, 2005k). ROTAP 3Ki	Yes	No
Persoonia nutans	Nodding Geebung	E	E1	Grows in Woodland to dry sclerophyll forest on clay soils and old alluviums on the Cumberland Plain (Robinson 1994) (Harden 2002). It is restricted to Castlereagh Scribbly Gum Woodlands, Agnes Banks Woodland, Shale Gravel Transition Forest and Cooks River Castlereagh Ironbark Forest (NPWS 2003). Peak flowering is from December to January with sporadic flowering all year round. ROTAP 2Ei	No	-
Pimelea spicata	Spiked Rice-flower	E	E1	In western Sydney, *P. spicata* is restricted to areas supporting, or that previously supported, Cumberland Plain Woodland. *Pimelea spicata* has been recorded from both shale hills and shale plains woodland. *Pimelea spicata* has also been recorded from highly degraded areas that no longer support native vegetation, but that would have supported CPW previously (DEC 2004). In the coastal Illawarra it occurs commonly in Coast Banksia open woodland with a more well developed shrub and grass understorey. ROTAP 3Ei	Yes	No
Pomaderris brunnea	Rufous Pomaderris	V	V	Confined to the Colo River & upper Nepean River (Harden 1990), on clay & alluvial soils (Fairley and Moore 1995) in moist forest or woodland of floodplains and creeklines (DEC, 2005l). ROTAP 2V	Yes	Yes

Species		Status		Habitat	Potential Habitat?	Habitat potentially impacted by subsidence?
Scientific Name	**Common Name**	**EPBC Act**	**TSC Act**			
Pterostylis saxicola	Sydney Plains Greenhood	E	E1	Most commonly found growing in small pockets of shallow soil in depressions on sandstone rock shelves above cliff lines (NSW Scientific Committee 1997). The plant communities that occur above the shelves are either shale/sandstone transition or shale communities. Often occurs near streams. Picnic Point to Picton (Harden 1993). Currently known from only 5 localities (NSW Scientific Committee 1997). ROTAP; 2E	Yes	Yes
**Pultenaea aristata*	Prickly Bush-pea	V	V	Restricted to the Woronora Plateau, a small area between Helensburgh, south of Sydney, and Mt Keira above Wollongong. The species occurs in either dry sclerophyll woodland or wet heath on sandstone. Flowering has been recorded in winter and spring (DEC, 2005m). ROTAP 2V	No	-
Pultenaea pedunculata	Matted Bush-pea	-	E1	Restricted to the Cumberland Plain and near Merimbula where it grows in dry sclerophyll forest and disturbed sites (Harden 2002). In western Sydney it occurs in three locations: within industrial and residential areas at Villawood and Prestons, and north-west of Appin between the Nepean River and Devines Tunnel No. 2 (DEC, 2005n). It occurs in clay or sandy clay soils (Blacktown soil landscape) on Wianamatta shale, close to localised patches of Tertiary alluvium (Liverpool) or the shale/sandstone influence (west of Appin) (DEC, 2005n). At all sites there is a lateritic influence in the soil with characteristic ironstone gravels present (DEC, 2005n). This species is known to occur in Patches of Cooks River Clay Plain Scrub Forest (James *et al.* 1999).	Yes	No
Syzygium paniculatum	Magenta Lilly Pilly	V	V	Subtropical and littoral rainforest on sandy soils or stabilised dunes near the sea (Harden 1991). Found only in NSW, in a narrow, linear coastal strip from Bulahdelah to Conjola State Forest. On the south coast the Magenta Lilly Pilly occurs on grey soils over sandstone, restricted mainly to remnant stands of littoral (coastal) rainforest. On the central coast Magenta Lilly Pilly occurs on gravels, sands, silts and clays in riverside gallery rainforests and remnant littoral rainforest communities (DEC, 2005p). ROTAP 3Ri	No	-
Thesium australe	Austral Toad-flax	V	V	Clay soils in grassy woodlands or coastal headlands (James *et al.* 1999). Found in very small populations scattered across eastern NSW, along the coast, and from the Northern to Southern Tablelands. Often found in damp sites in association with *Themeda australis*. A root parasite that takes water and some nutrient from other plants, especially *Themeda australis*	Yes	No

Species		Status		Habitat	Potential Habitat?	Habitat potentially impacted by subsidence?
Scientific Name	Common Name	EPBC Act	TSC Act			
				(DEC, 2005q). ROTAP 3Vi		

Key: Listed as E- Endangered or V- Vulnerable on the TSC Act and/or EPBC Act. For an explanation of ROTAP Codes see Appendix 3. * Listed on the Key Threatening Process - Alteration of Habitat following Subsidence due to Longwall Mining as a species with habitat likely to be altered by subsidence and mining associated activities.

4.2.2 Threatened Flora in the Study Area

No threatened plant species were recorded in the Study Area in the current surveys.

Pultenaea pedunculata has been previously recorded in the Study Area (DECC Atlas of NSW Wildlife Database, Figure 5). A population of an estimated 690 plants were recorded on the eastern side of the Nepean River in 2001 in three separate locations (DECC Atlas of NSW Wildlife Database). In 2006, an additional 51 plants were recorded at additional two locations in the same general area (DECC Atlas of NSW Wildlife Database). These records occur within and adjoining areas mapped as supporting Shale Sandstone Transition Forest (Low Sandstone Influence) (as mapped by NPWS 2002b).

4.2.3 Other Significant Flora

Other important flora species that may be encountered within the Study Area include those that are listed as Rare or Threatened Australian Plants (ROTAP, Briggs and Leigh 1996). One such species, *Lomandra fluviatilis*, was recorded along the banks of the Nepean River in the current and previous surveys. Typically, threatened species listed on the TSC and EPBC Acts may also be listed as ROTAPs. However, not all ROTAPs are listed as threatened species under these Acts and therefore may not be identified prior to fieldwork as occurring within the Study Area based on database searches. *Lomandra fluviatilis* is not listed on either the TSC Act or the EPBC Act, and as such Assessments of Significance have not been completed for this species.

Lomandra fluviatilis is listed on the TSC Act Key Threatening Process as a species that may become threatened as a result of habitat alteration following subsidence due to longwall mining. Three other species listed on the KTP have potential habitat in the Study Area: *Darwinia grandiflora*, *Epacris coriacea*, and *Pseudanthus pimeleoides*. These species are not listed as threatened species on the TSC or EPBC Acts and were not recorded in the Study Area in the current surveys.

4.3 Fauna Habitats

Suitability, size and configuration of vertebrate fauna habitats broadly correlate with the structure, connectivity and quality of local and regional vegetation types. Many local habitats are wholly, or in part, contiguous with much larger areas of bushland and therefore form part of a habitat corridor. Broadly, these habitats comprise mostly river and creek line, riparian forest, woodland and disturbed grassland. Finer scale habitat features include rock outcrops, caves, overhangs, tree hollows and hollow logs. These habitats and species associations are discussed in further detail below. It is important to note that the habitat features within the Study Area (as described for the plant communities) have been substantially altered since the introduction of agricultural practices.

4.3.1 General Habitat Descriptions

Nepean River and Tributaries with Sandstone Influence

The Nepean River and its tributaries provide habitat for a range of vertebrates and invertebrate species. Open water habitat (largely restricted to the Nepean River and isolated pools within the tributaries) provides shelter and foraging habitat for amphibians, reptiles and small ground-dwelling mammals. Fauna habitats along the Nepean River vary with changing fluvial geomorphology. In some areas there are steep rocky banks providing shelter and basking habitat for reptiles including the Eastern Water Dragon *Physignathus lesueurii*. Other sections of the bank are flat and heavily vegetated. In the open water habitat there are isolated sandbanks, dead trees and clumps of *Gahnia* and *Lomandra* species which provide shelter for amphibians and reptiles including the Blue Mountains Tree Frog *Litoria citropa* and Eastern Water Skink *Eulamprus quoyii*.

Within the tributaries there are isolated pools and small areas of riffle habitat scattered along creek lines. The riverbank is a mixture of rock and sandy soil with scattered vegetation. Open water habitat is generally restricted to small pools of periodically stagnant water that are generally subject to runoff from agricultural lands upstream. The tributaries would provide habitat for a range of animal species including amphibians (e.g. Striped Marsh-frog *Limnodynastes peronii*), reptiles (e.g. Red-bellied Black Snake *Pseudechis porphyriacus*), birds (e.g. Azure Kingfisher *Alcedo azurea*) and small mammals (e.g. Water Rat *Hydromys chrysogaster*).

This fauna habitat type is considered to be in moderate to good condition within the Study Area.

Creeklines With Shale Influence

Other smaller creeklines in the Study Area to the west of the Nepean River include Harris Creek, Navigation Creek and Foot Onslow Creek and smaller unnamed tributaries. These creeklines have been impacted by weed invasion, clearing of native vegetation and stock induced erosion (Plates 8-12). Some sections of these creeks have pools that provide opportunities for common native frog species such as the Common Eastern Froglet *Crinia signifera*. Native vegetation abutting these creeks is patchy, with some properties containing trees and others completely cleared up to the banks.

This fauna habitat type is considered to be in poor condition within the Study Area.

Riparian Forest and Woodland

Riparian forest and woodlands provide a wide range of foraging and sheltering habitat for vertebrate fauna. Myrtaceaeous trees, mostly eucalypt species, dominate the upper canopy in these areas and supply direct (foliage, nectar, exudates) and indirect food (arthropods) for a range of vertebrates, particularly birds and arboreal mammals. She-oaks, *Allocasuarina* spp. are abundant in the mid storey of many areas providing an important foraging resource for the threatened Glossy Black Cockatoo *Calyptorhynchus lathami*. Tree hollows (formed in stags, mature and/or senescent trees) provide nesting and roosting habitat for hollow-dwelling fauna (e.g. cockatoos, parrots, owls, gliders, possums and bats) and are important habitat components of native forests.

This fauna habitat type is considered to be in moderate to good condition within the Study Area as it provides good structural diversity of habitats despite being weedy.

Understorey Vegetation

Areas of dense understorey and shrub vegetation (principally within sheltered gullies and slopes with southern and south-eastern aspects) provide important potential habitat for a range of species. These include small birds (e.g. fairywrens and scrubwrens) and ground-dwelling mammals (e.g. Bush Rat *Rattus fuscipes* and *Antechinus* spp.).

This fauna habitat type is considered to be in poor to moderate condition within the Study Area due to the distribution of weeds.

Rock Outcrops, Caves and Overhangs

Rock outcrops, with exfoliating sandstone sheets and small crevices, occur throughout the Nepean River Gorge (Plate 13). These habitats provide refuge for

a range of reptile species including Blackish Blind Snake *Ramphotyphlops nigrescens*, Southern Leaf-tailed Gecko *Phyllurus platyurus*, Lesueur's Velvet Gecko *Oedura lesueurii* and possibly the threatened Broad-headed Snake *Hoplocephalus bungaroides*[1]. The latter species requires these habitats for over-wintering, thermoregulation and shelter as well as refuges of neonates, juveniles and prey species.

Overhangs generally occur along the river below escarpment areas (Plate 14). These areas can provide roosting and nursery habitat for cave-dwelling micro-bats, including the threatened Large-eared Pied Bat *Chalinolobus dwyeri*, Eastern Bent-wing Bat *Miniopterus schreibersii oceanensis*, and Eastern False Pipistrelle *Falsistrellus tasmaniensus*. Small caves and crevices may provide den habitat for the threatened Spotted-tailed Quoll *Dasyurus maculatus*.

This fauna habitat type is considered to be in good condition within the Study Area.

Tree Hollows

Tree hollows provide den and nesting habitat for a range of common birds and arboreal mammal species, including the Sulphur-crested Cockatoo *Cacatua galerita*, Sugar Glider *Petaurus breviceps*, Greater Glider *Petauroides volans* and forest dwelling micro-bats. Locally recorded threatened species requiring tree-hollows for mating and nesting include the Powerful Owl *Ninox strenua*, Barking Owl *Ninox connivens*, Glossy Black Cockatoo *Calyptorhynchus lathami*, Squirrel Glider *Petaurus norfolcensis* and Eastern Pygmy Possum *Cercartetus nanus*.

There are tree hollows of various sizes throughout the Study Area, with the majority occurring in the woodland habitat in the vicinity of the Nepean River. There are also hollow bearing trees in patches along creeklines and remnant patches of woodland.

This fauna habitat type is considered to be generally in good condition within the Study Area.

Fallen Timber and Bark

Fallen branches and bark (scattered throughout forested areas) provide refuge and nesting habitat for a range of terrestrial animals. Many invertebrates and

[1] Note this species has not been recorded within the Nepean Gorge (within 10 km of the Study Area) but suitable habitat for this species is considered to occur in sheltered gullies with high sandstone influence and woodland-forest habitat.

amphibians rely on these 'moisture-retaining' microhabitats to over-winter or as refuge during periods of drought. Similarly, many reptiles rely on ground litter and debris for shelter and foraging. Larger hollow logs provide potential denning and nesting habitat for small to medium sized mammals including the Spotted-tailed Quoll.

This fauna habitat type is considered to be in moderate to good condition within the Study Area.

Cleared Areas

Large sections of the Study Area have been cleared for agriculture for many years (Plate 7). Despite these activities some native species may occur within disturbed vegetation and microhabitat components of these areas, but generally these areas would provide few habitat opportunities for native fauna. Species more likely to inhabit these areas include introduced and domestic animals, birds of prey such as the Black-shouldered Kite *Elanus axillaris*, and native species tolerant of disturbance or favouring edge/ecotone habitat.

This fauna habitat type is considered to be in poor condition within the Study Area because of the distribution and abundance of weed species and the impact of grazing.

Farm Dams

There are a number of man made farm dams in the Study Area. Many of which are used by stock and are heavily eroded (Plate 15). There are a few dams in the Study Area that have stock excluded and have fringing native vegetation, these would provide more opportunities for native fauna, such as Verreaux's Frog, *Litoria verreauxii* and Australian Wood Ducks, *Chenonetta jubata*.

4.4 Animal Species

Fauna surveys undertaken for this study consists of a habitat-based assessment. Incidental observations of fauna species in the Study Area are listed in Appendix 2 and include 69 species of bird (four introduced), four reptiles, two amphibians, three native mammals, four introduced mammals and one threatened terrestrial invertebrate. These results are combined with records from previous assessments within or adjacent to the Study Area in Appendix 2 (Biosis Research 2004; Biosis Research 2006).

4.4.1 Listed Threatened Fauna Species

A total of 51 threatened or migratory animal species or their habitat have been previously recorded within the local area (DECC Atlas of NSW Wildlife and DEWHA Online EPBC Database) (Table 5). Of these, 41 are listed under the TSC Act and 25 are listed under the EPBC Act.

Where a threatened species is recorded or where there is potential habitat (foraging or breeding resources) for threatened species in the Study Area, further consideration must be given to the potential impact of the proposal on these species. The proposed development may impact threatened species by causing any of the following situations to arise:

- death or injury of individuals
- loss or disturbance of limiting foraging resources or
- loss or disturbance of limiting breeding resources

Only those species for which the proposed development is considered likely to have an impact in one or more of the above ways will be considered further in the impact assessment. As the possible impacts from subsidence relate to fracturing of rock, rock falls, flow diversion and water quality changes and these are restricted to the Nepean River gorge and other creeks, only animal species with potential habitat in these areas are considered further.

Table 5: Threatened animal species listed on the TSC Act or the EPBC Act that have been recorded, or have the potential to occur, in the local area.

Scientific Name	Common Name	EPBC Act	TSC Act (NSW)	Habitat	Potential Habitat	Habitat potentially impacted by subsidence?
Amphibians						
Litoria aurea	Green and Golden Bell Frog	V	E1	Found in marshes, dams and stream sides, particularly those containing bullrushes or spikerushes (NPWS, 1999b). Preferred habitat contains water bodies that are unshaded, are free of predatory fish, have a grassy area nearby and have diurnal sheltering sites nearby such as vegetation or rocks (NPWS, 1999b; White and Pyke 1996).	Unlikely. Not previously recorded withkin a 10 km radius of Study Area.	-
Litoria littlejohni	Littlejohn's Tree Frog	V	V	Occurs in wet and dry sclerophyll forests associated with sandstone outcrops between 280 and 1000 m on the eastern slopes of the Great Dividing Range (Barker *et al.* 1995). Prefers rock flowing streams, but individuals have also been collected from semi-permanent dams with some emergent vegetation (Barker *et al.* 1995). Forages both in the tree canopy and on the ground, and has been observed sheltering under rocks on high exposed ridges during summer. It is not known from coastal habitats.	Yes	Yes
Heleioporus australiacus	Giant Burrowing Frog	V	V	Prefers hanging swamps on sandstone shelves adjacent to perennial non-flooding creeks (Daly 1996; Recsei 1996). Can also occur within shale outcrops within sandstone formations. In the southern part of its range can occur in wet and dry forests, montane sclerophyll woodland and montane riparian woodland (Daly 1996). Individuals can be found around sandy creek banks or foraging along ridge-tops during or directly after heavy rain. Males often call from burrows located in sandy banks next to water (Barker *et al.* 1995).	Yes	Yes
Mixophyes balbus	Stuttering Frog	V	E1	This species is usually associated with mountain streams, wet mountain forests and rainforests (Barker *et al.* 1995). It rarely wanders very far from the banks of permanent forest streams, although it will forage on nearby forest floors. Eggs are deposited in leaf litter on the banks of streams and are washed into the water during heavy rains (Barker *et al.* 1995).	No	-
Pseudophryne australis	Red-crowned Toadlet		V	Occurs on wetter ridge tops and upper slopes of sandstone formations on which the predominant vegetation is dry open forests and heaths. This species typically breeds within small ephemeral creeks that feed into larger semi-perennial streams. After rain these creeks are characterised by a series of shallow pools lined by dense grasses, ferns and low shrubs (Thumm and Mahony 1997).	Yes	Yes

Scientific Name	Common Name	EPBC Act	TSC Act (NSW)	Habitat	Potential Habitat	Habitat potentially impacted by subsidence?
Birds						
Haliaeetus leucogaster	White-bellied Sea-eagle	M		A migratory species that is resident to Australia. Found in terrestrial and coastal wetlands; favoring deep freshwater swamps, lakes and reservoirs; shallow coastal lagoons and saltmarshes (English and Predavec 2001).	Yes	No
Stictonetta naevosa	Freckled Duck		V	The freckled duck breeds in permanent fresh swamps that are heavily vegetated. Found in fresh or salty permanent open lakes, especially during drought. Often seen in groups on fallen trees and sand spits (Simpson and Day 1996).	No	-
Apus pacificus	Fork-tailed Swift	M		Almost exclusively aerial (Higgins 1999), over open country, from semi-deserts to coasts, islands; sometimes over forests, cities (Pizzey and Knight 2007). Reported to roost on cliffs, in large trees, but may spend nights on wing (Pizzey and Knight 2007).	Yes	No
Hirundapus caudacutus	White-throated Needletail	M		An aerial species found in feeding concentrations over cities, hilltops and timbered ranges (Pizzey and Knight 1997).	Yes	No
Ardea alba	Great Egret	M		Terrestrial wetlands, estuarine and littoral habitats and moist grasslands. Inland, prefer permanent waterbodies on floodplains; shallows of deep permanent lakes (either open or vegetated), semi-permanent swamps with tall emergent vegetation and herb dominated seasonal swamps with abundant aquatic flora. Also regularly use saline habitats including mangrove forests, estuarine mudflats, saltmarshes, bare saltpans, shallows of salt lakes, salt fields and offshore reefs. Breeding requires wetlands with fringing trees in which to build nests including mangrove forest, freshwater lakes or swamps and rivers (Marchant and Higgins 1990).	No	-
Ardea ibis	Cattle Egret	M		Occurs in tropical and temperate grasslands, wooded lands and terrestrial wetlands (Marchant and Higgins 1990).	No	-
Burhinus grallarius	Bush Stone-curlew		E1	Lightly timbered open forest and woodland, or partly cleared farmland with remnants of woodland, with a ground cover of short sparse grass and few or no shrubs where fallen branches and leaf litter are present (Marchant and Higgins 1993).	Yes	-
Callocephalon fimbriatum	Gang-gang Cockatoo		V	In summer, occupies tall montane forests and woodlands, particularly in heavily timbered and mature wet sclerophyll forests (Higgins 1999). Also occur in subalpine Snow Gum woodland and occasionally in temperate or regenerating forest (Forshaw and Cooper 1981). In winter, occurs at lower altitudes in drier, more open eucalypt forests and woodlands, particularly in box-ironbark assemblages, or in dry forest in coastal areas (Shields and Crome 1992). It requires tree hollows in which to breed (Gibbons and Lindenmayer 1997).	Yes	No

Scientific Name	Common Name	EPBC Act	TSC Act (NSW)	Habitat	Potential Habitat	Habitat potentially impacted by subsidence?
Calyptorhynchus lathami	Glossy Black-cockatoo		V	Inhabits forest with low nutrients, characteristically with key *Allocasuarina* spp. Tends to prefer drier forest types (NPWS, 1999a) with a middle stratum of Allocasuarina below *Eucalyptus* or *Angophora*. Often confined to remnant patches in hills and gullies (Higgins 1999). Breed in hollows stumps or limbs, either living or dead (Higgins 1999).	Yes	No
Ephippiorhynchus asiaticus	Black-necked Stork		E1	Found in swamps, mangroves and mudflats. Can also occur in dry floodplains and irrigated lands and occasionally forages in open grassy woodland. Nests in live or dead trees usually near water (Pizzey and Knight 1997).	No	No
Climacteris picumnus victoriae	Brown Treecreeper (eastern subspecies)		V	Live in eucalypt woodlands, especially areas of relatively flat open woodland typically lacking a dense shrub layer, with short grass or bare ground and with fallen logs or dead trees present (Traill and Duncan 2000).	Yes	No
Monarcha melanopsis	Black-faced Monarch	M		A migratory species found during the breeding season in damp gullies in temperate rainforests. Disperses after breeding into more open woodland (Pizzey and Knight 1997).	Yes	No
Myiagra cyanoleuca	Satin Flycatcher	M		Migratory species that occurs in coastal forests, woodlands and scrubs during migration. Breeds in heavily vegetated gullies (Pizzey and Knight 1997).	No	No
Rhipidura rufifrons	Rufous Fantail	M		Migratory species that prefers dense, moist undergrowth of tropical rainforests and scrubs. During migration it can stray into gardens and more open areas (Pizzey and Knight 1997).	Yes	No
Grantiella picta	Painted Honeyeater		V	Found mainly in dry open woodlands and forests, where it is strongly associated with mistletoe (Higgins *et al.* 2001). Often found on plains with scattered eucalypts and remnant trees on farmlands.	Yes	No
Melithreptus gularis gularis	Black-chinned Honeyeater (eastern subspecies)	M	V	Found mostly in open forests and woodlands dominated by box and ironbark eucalypts (Higgins *et al.* 2001). It is rarely recorded east of the Great Dividing Range (Higgins *et al.* 2001).	Yes	No
Xanthomyza phrygia	Regent Honeyeater	E	E1	A semi-nomadic species occurring in temperate eucalypt woodlands and open forests. Most records are from box-ironbark eucalypt forest associations and wet lowland coastal forests (NPWS, 1999c; Pizzey and Knight 1997).	Yes	No
Merops ornatus	Rainbow Bee-eater	M		Usually occurs in open or lightly timbered areas, often near water (Higgins 1999).	Yes	No

Scientific Name	Common Name	EPBC Act	TSC Act (NSW)	Habitat	Potential Habitat	Habitat potentially impacted by subsidence?
Pyrrholaemus sagittatus	Speckled Warbler		V	This species occurs in eucalypt and cypress woodlands on the hills and tablelands of the Great Dividing Range. They prefer woodlands with a grassy understorey, often on ridges or gullies (Blakers *et al.* 1984; NSW Scientific Committee 2001). The species is sedentary, living in pairs or trios and nests on the ground in grass tussocks, dense litter and fallen branches. They forage on the ground and in the understorey for arthropods and seeds (Blakers *et al.* 1984; NSW Scientific Committee 2001). Home ranges vary from 6-12 hectares (NSW Scientific Committee 2001).	Yes	No
Stagonopleura guttata	Diamond Firetail		V	Found in a range of habitat types including open eucalypt forest, mallee and acacia scrubs (Pizzey and Knight 1997).	Yes	No
Melanodryas cucullata cucullata	Hooded Robin (south-eastern form)		V	This species lives in a wide range of temperate woodland habitats, and a range of woodlands and shrublands in semi-arid areas (Traill and Duncan 2000).	Yes	No
Lathamus discolor	Swift Parrot	E	E1	The Swift Parrot occurs in woodlands and forests of NSW from May to August, where it feeds on eucalypt nectar, pollen and associated insects (Forshaw and Cooper 1981). The Swift Parrot is dependent on flowering resources across a wide range of habitats in its wintering grounds in NSW (Shields and Crome 1992). This species is migratory, breeding in Tasmania and also nomadic, moving about in response to changing food availability (Pizzey and Knight 1997).	Yes	No
Neophema pulchella	Turquoise Parrot		V	Occurs in open woodlands and eucalypt forests with a ground cover of grasses and understorey of low shrubs (Morris 1980). Generally found in the foothills of the Great Divide, including steep rocky ridges and gullies (Higgins 1999). Nest in hollow-bearing trees, either dead or alive; also in hollows in tree stumps. Prefer to breed in open grassy forests and woodlands, and gullies that are moist (Higgins 1999).	Yes	No
Rostratula australis	Australian Painted Snipe	VM	E1	Usually found in shallow inland wetlands including farm dams, lakes, rice crops, swamps and waterlogged grassland. They prefer freshwater wetlands, ephemeral or permanent, although they have been recorded in brackish waters (Marchant and Higgins 1993).	No	-
Gallinago hardwickii	Latham's Snipe	M		Typically found on wet soft ground or shallow water with good cover of tussocks. Often found in wet paddocks, seepage areas below dams (Pizzey and Knight 1997).	No	-
Ninox connivens	Barking Owl		V	Generally found in open forests, woodlands, swamp woodlands and dense scrub. Can also be found in the foothills and timber along watercourses in otherwise open country (Pizzey and Knight 1997).	Yes	No

Scientific Name	Common Name	EPBC Act	TSC Act (NSW)	Habitat	Potential Habitat	Habitat potentially impacted by subsidence?
Ninox strenua	Powerful Owl		V	Occupies wet and dry eucalypt forests and rainforests. Can occupy both un-logged and lightly logged forests as well as undisturbed forests where it usually roosts on the limbs of dense trees in gully areas. It is most commonly recorded within Red Turpentine in tall open forests and Black She-oak within open forests (Debus and Chafer 1994b; Debus and Chafer 1994a). Large mature trees with hollows at least 0.5 m deep are required for nesting (Garnett 1992). Tree hollows are particularly important for the Powerful Owl because a large proportion of the diet is made up of hollow-dependent arboreal marsupials (Gibbons and Lindenmayer 1997). Nest trees for this species are usually emergent with a diameter at breast height of at least 100 cm (Gibbons and Lindenmayer 1997).	Yes	No
Mammals						
Cercartetus nanus	Eastern Pygmy-possum		V	Inhabits rainforest through to sclerophyll forest and tree heath. Banksias and myrtaceous shrubs and trees are a favoured food source. Will often nest in tree hollows, but can also construct its own nest (Turner and Ward 1995). Because of its small size it is able to utilise a range of hollow sizes including very small hollows (Gibbons and Lindenmayer 1997). Individuals will use a number of different hollows and an individual has been recorded using up to 9 nest sites within a 0.5 ha area over a 5 month period (Ward 1990).	Yes	No
Dasyurus maculatus maculatus	Spotted-tailed Quoll (south-eastern mainland)	E	V	Uses a range of habitats including sclerophyll forests and woodlands, coastal heathlands and rainforests (Dickman and Read 1992). Habitat requirements include suitable den sites, including hollow logs, rock crevices and caves, an abundance of food and an area of intact vegetation in which to forage (Edgar and Belcher 1995).	Yes	Impacts unlikely see section 5
Saccolaimus flaviventris	Yellow-bellied Sheathtail Bat		V	Reported from a wide range of habitats throughout eastern and northern Australia, including wet and dry sclerophyll forest, open woodland, acacia shrubland, mallee, grasslands and desert (Churchill 1998). They roost in tree hollows and have also been observed roosting in animal burrows, abandoned Sugar Glider nests, cracks in dry clay, hanging from buildings and under slabs of rock (Churchill 1998). The species flies high and fast and forages above the canopy (Churchill 1998).	Yes	Impacts unlikely see section 5
Petrogale penicillata	Brush-tailed Rock-wallaby	V	E1	Found in rocky areas in a wide variety of habitats including rainforest gullies, wet and dry sclerophyll forest, open woodland and rocky outcrops in semi-arid country. Commonly sites have a northerly aspect with numerous ledges, caves and crevices (Eldridge and Close 1995).	Yes	Impacts unlikely see section 5

Scientific Name	Common Name	EPBC Act	TSC Act (NSW)	Habitat	Potential Habitat	Habitat potentially impacted by subsidence?
Mormopterus norfolkensis	Eastern Freetail Bat		V	Most records are from dry eucalypt forests and woodlands to the east of the Great Dividing Range. Appears to roost in trees, but little is known of this species' habits (Allison and Hoye 1995; Churchill 1998).	Yes	No
Isoodon obesulus	Southern Brown Bandicoot	E	E1	Prefers sandy soils with scrubby vegetation and/or areas with low ground cover that are burn from time to time (Braithwaite 1995). A mosaic of post fire vegetation is important for this species (Maxwell *et al.* 1996).	Yes	No
Petaurus australis	Yellow-bellied Glider		V	Restricted to tall native forests in regions of high rainfall. Preferred habitats are productive, tall open sclerophyll forests where mature trees provide shelter and nesting hollows. Critical elements of habitat include sap-site trees, winter flowering eucalypts, mature trees suitable for den sites and a mosaic of different forest types (NPWS, 1999d).	Yes	No
Petaurus norfolcensis	Squirrel Glider		V	Generally occurs in dry sclerophyll forests and woodlands but is absent from dense coastal ranges in the southern part of its range (Suckling 1995). Requires abundant hollow bearing trees and a mix of eucalypts, banksias and acacias (Quin 1995). There is only limited information available on den tree use by Squirrel gliders, but it has been observed using both living and dead trees as well as hollow stumps (Gibbons and Lindenmayer 1997). Within a suitable plant community at least one species should flower heavily in winter and one species of eucalypt should be smooth barked (Menkhorst *et al.* 1988).	Yes	No
Phascolarctos cinereus	Koala		V	Inhabits eucalypt forests and woodlands. The suitability of these forests for habitation depends on the size and species of trees present, soil nutrients, climate and rainfall (Reed and Lunney 1990; Reed *et al.* 1990).	Yes	No
Potorous tridactylus	Long-nosed Potoroo	V	V	Inhabits coastal heath and wet and dry sclerophyll forests. Generally found in areas with rainfall greater than 760 mm. Requires relatively thick ground cover where the soil is light and sandy (Johnston 1995).	Yes	No
Pteropus poliocephalus	Grey-headed Flying-fox	V	V	This species is a canopy-feeding frugivore and nectarivore of rainforests, open forests, woodlands, melaleuca swamps and banksia woodlands. Bats commute daily to foraging areas, usually within 15 km of the day roost (Tidemann 1995) although some individuals may travel up to 70 km (Augee and Ford 1999).	Yes	No
Chalinolobus dwyeri	Large-eared Pied Bat	V	V	Located in a variety of drier habitats, including the dry sclerophyll forests and woodlands to the east and west of the Great Dividing Range (Hoye and Dwyer 1995). Can also be found on the edges of rainforests and in wet sclerophyll forests (Churchill 1998). This species roosts in caves and mines in groups of between 3 and 37 individuals (Churchill 1998).	Yes	Impacts unlikely see section 5

Scientific Name	Common Name	EPBC Act	TSC Act (NSW)	Habitat	Potential Habitat	Habitat potentially impacted by subsidence?
Falsistrellus tasmaniensis	Eastern False Pipistrelle		V	Inhabit sclerophyll forests, preferring wet habitats where trees are more than 20 m high (Churchill 1998). Two observations have been made of roosts in stem holes of living eucalypts (Phillips 1995). There is debate about whether or not this species moves to lower altitudes during winter, or whether they remain sedentary but enter torpor (Menkhorst and Lumsden 1995). This species also appears to be highly mobile and records showing movements of up to 12 km between roosting and foraging sites (Menkhorst and Lumsden 1995).	Yes	No
Miniopterus schreibersii oceanensis	Eastern Bentwing Bat		V	Broad range of habitats including rainforest, wet and dry sclerophyll forest, paperbark forest and open grasslands. Roost in caves and man made habitats and under road culverts (Strahan 1995).	Yes	Impacts unlikely see section 5
Myotis macropus (adversus)	Large-footed Myotis		V	Occurs in most habitat types as long as they are near permanent water bodies, including streams, lakes and reservoirs. Commonly roost in caves, but can also roost in tree hollows, under bridges and in mines (Richards 1995; Churchill 1998).	Yes	Yes
Scoteanax rueppellii	Greater Broad-nosed Bat		V	Prefer moist gullies in mature coastal forests and rainforests, between the Great Dividing Range and the coast. They are only found at low altitudes below 500 m (Churchill 1998). In dense environments they utilise natural and human-made opening in the forest for flight paths. Creeks and small rivers are favoured foraging habitat (Hoye and Richards 1995). This species roosts in hollow tree trunks and branches (Churchill 1998).	Yes	No
Reptiles						
Hoplocephalus bungaroides	Broad-headed Snake	V	E1	Mainly occurs in association with communities occurring on Triassic sandstone within the Sydney Basin. Typically found among exposed sandstone outcrops with vegetation types ranging from woodland to heath. Within these habitats they generally use rock crevices and exfoliating rock during the cooler months and tree hollows during summer (Webb 1996; Webb and Shine 1998).	Yes	Impacts unlikely see section 5
Varanus rosenbergi	Rosenberg's Goanna		V	This species is a Hawkesbury/Narrabeen sandstone outcrop specialist (Wellington and Wells 1985). Occurs in coastal heaths, humid woodlands and both wet and dry sclerophyll forests (Cogger 1992).	Yes	Impacts unlikely see section 5
Invertebrates						
Meridolum corneovirens	Cumberland Plain Land Snail		E1	Most likely restricted to Cumberland Plain, Castlereagh Woodlands and boundaries between River-flat Forest and Cumberland Plain Woodland. It is normally found beneath logs, debris and amongst accumulated leaf and bark particularly at the base of trees. May also use soil cracks for refuge (NPWS 1999).	Yes	No

1) Listed on the EPBC Act as Endangered (E), Critically Endangered (Z), Vulnerable (V) or

covered under migratory provisions (M) on the EPBC Act.
2) Listed on the TSC Act as Endangered (E1), Critically Endangered (C1) or Vulnerable (V).

5.0 IMPACT ASSESSMENT

Several threatened species and habitat for a range of other threatened species have been recorded within the Study Area. The effects of subsidence associated with the extraction of Longwalls 705-710 on threatened species and their habitats have been described in Section 2.5. Hence, the impact assessment of the proposed extraction of Longwalls 705 to 710 on threatened terrestrial species only considers those species which may be impacted either directly or indirectly through habitat disturbance by subsidence (defined in Section 2.5).

5.1 Endangered Ecological Communities

Five broad plant communities are recognised as occurring within the Study Area (Figure 4). Four of these communities are listed as Endangered Ecological Communities on the TSC Act and/or the EPBC Act: Cumberland Plain Woodland, Shale Sandstone Transition Forest, Moist Shale Woodland and River-flat Eucalypt Forest.

Cumberland Plain Woodland, Moist Shale Woodland and Shale Sandstone Transition Forest occur on the undulating topography on shale derived and shale influenced sandy soils. While creeks and or drainage lines may cut through these plant communities, they are entirely terrestrial in nature. Unlike wetlands or other flow-dependent plant communities, they are not dependent on the flow of water from creeks or streams.

River-flat Eucalypt Forest (Alluvial Woodland) occurs along the shallow creeklines and drainage lines within the Study Area. River-flat Eucalypt Forest (Riparian Forest) is also mapped as occurring adjacent to the Nepean River; however, as discussed in Section 4.1.2, vegetation in this area was found to be more closely aligned with Western Sandstone Gully Forest. However, Riparian Forest is likely to be present in the southern sections of the Study Area along the Nepean River, as recorded in previous surveys (Biosis Research, 2006).

Predicted impacts to the Nepean River include minor desiccation of small areas where the banks are shallow, less frequent inundation of higher elevations of the bank and minor fracturing as a result of the proposed longwalls mining. Predicted impacts to drainage lines and creeks in the Study Area include minor increase in ponding and flooding and the possibility of some cracking which is not likely to result in a loss of water from the catchment. Given the minor nature of the impacts to the Nepean River and other drainage lines within the Study Area, the proposed longwall mining is not likely to impact the plant communities occurring in these areas. This is because these plant communities are not reliant on surface water flows.

The possibility of minor rockfalls, surface cracking and erosion events are predicted in the MSEC report. These impacts are likely to be minor and temporary in nature and are unlikely to alter the species composition or distribution of plant communities in the Study Area.

Gas emissions may result from sandstone fracturing above areas where coal is being extracted from longwalls. The liberation of gas emissions has been observed within the Cataract River above the workings of Tower Colliery and a discussion of the minimal impact of these emissions on riparian vegetation is provided in Section 2.5.8. The MSEC report states that gas emissions occurring in the Nepean River gorge are likely to be minor in nature given the distance of the gorge from the proposed longwalls. Furthermore, in the event that gas is liberated from above these workings it is likely to only occur within a limited area and would be unlikely to result in permanent vegetation die-off over a wide area. Gas emissions are unlikely to result in the alteration of species distribution or composition within the plant communities in the Study Area. Further, recent extraction of coal from Longwall 701 has resulted in only minor gas emissions which have not affected riparian vegetation.

For these reasons listed above, it is considered unlikely that subsidence impacts would have a significant impact on the four EECs within the Study Area. However, as Shale Sandstone Transition Forest is listed on the KTP regarding subsidence due to longwall mining, an Assessment of Significance under the TSC Act (Appendix 4) and Assessment of Significance under the EPBC Act (Appendix 5) have been completed for this community. Although River-flat Eucalypt Forest is not listed on the KTP, it is more likely to be affected by subsidence than Shale Sandstone Transition Forest due to its proximity to the Nepean River, thus Assessments of Significance (Appendix 4 and Appendix 5) have been carried out for this community also.

5.2 Threatened Flora

No threatened plant species were recorded in the Study Area during the current surveys. It is considered unlikely that the population of *Pultenaea pedunculata* previously recorded in the Study Area will be impacted by subsidence given that the habitat it has been recorded in is entirely terrestrial in nature and, unlike wetlands or other flow-dependent plant communities; it is not dependent on the flow of water from creeks or streams.

There are six other threatened plant species with potential habitat in the Study Area, whose habitats are not likely to be impacted by subsidence. These are *Epacris purpurascens* var. *purpurascens, Grevillea parviflora ssp. parviflora, Persoonia bargoensis, P. hirsuta, Pimelea spicata* and *Thesium australe* (see Table 4). These species potentially occur within habitats on gently sloping hills,

plains or ridges and are not likely to be dependant on water flows within creeklines or groundwater for survival. Nor are they likely to be impacted by gas emissions given that they do not occur along creeklines. Further, they are not likely to occur on cliff lines or on steep slopes that may be subject to erosion or cracking. There are no known mechanisms for subsidence that are likely to result in impacts to these species habitats. As such, these species have not been considered further in this assessment.

Potential habitat within the Study Area that could potentially be affected by the mechanisms of subsidence exists for three threatened species (see Table 4): *Eucalyptus benthamii, Pomaderris brunnea* and *Pterostylis saxicola.* Assessments of Significance under the TSC and EPBC Acts have been conducted for these species in Appendix 4 and Appendix 5 respectively.

The volume of water available for plant use within the Study Area is unlikely to be significantly impacted by subsidence from the proposed longwalls. Further, potential impacts from rock falls, erosion events and gas emission are likely to be minor and temporary in nature. It is therefore considered unlikely that subsidence impacts would result in impacts to the floristic composition of the Study Area. However, subsidence may affect the way in which water is made available to plants within the area, leading to small, localised changes in riparian vegetation. Potential changes in the riparian vegetation may include:

- loss of aquatic plants; and
- loss of individuals, changes in species distribution and abundance for those species requiring moist conditions (e.g. *Drosera* spp.).

It is unlikely that any of the threatened flora species listed on the TSC Act or EPBC Act or any other significant flora species that have been recorded or have potential habitat within the Study Area would be significantly impacted by subsidence resulting from the proposal.

5.2.1 Impacts To Other Significant Flora

There is no legislative mechanism to consider the impacts of the proposal on the ROTAP species *Lomandra fluviatilis, Darwinia grandiflora, Epacris coriacea* and *Pseudanthus pimeleoides*. However, it is considered highly unlikely that the proposal would have a significant impact on these species for the following reasons:

- Habitat for *Lomandra fluviatilis* and *Pseudanthus pimeleoides* within the Study Area occurs within the riparian zone. Habitat for *Epacris coriacea* occurs in sandstone cliffs and rock crevices. If present within the Study Area, the habitat for these species is unlikely to be significantly impacted.

Potential impacts to the riparian zone include minor desiccation of the river bank over a very small area which may result from a maximum predicted uplift of 345 mm. Gas emissions within the riparian zone are predicted to be minor and insignificant. These emissions have been demonstrated to have only a very localised and short term impact on similar riparian vegetation.

- Habitat for *Darwinia grandiflora* occurs in dry sclerophyll forest, which is unlikely to be significantly impacted by any potential impacts of subsidence.

5.3 Fauna

5.3.1 Potential Impacts on Fauna Habitats

Potential impacts on fauna and their habitats will occur where the disturbance to the soils and near surface strata are the greatest, resulting in changes to surface water conditions. Where fauna and their habitats are reliant on these surface waters, some impacts are possible. It is possible that fracturing of the Nepean River bed will occur, however it is unlikely to result in any noticeable loss of surface water flows or quality.

Any fractures in feeder creeks may result in surface flows being redirected into the dilated strata below to re-surface downstream and/or reduced overflow and increased leakage at rock bars. MSEC (2008) indicate that surface flow diversions are generally limited to sections of river located directly above the longwalls, which is not the case in the Study Area as the longwalls will be offset from the Nepean River by at least 180 m. It is therefore unlikely that native fauna which rely on these areas will be significantly impacted by the proposed longwall extraction. Creeks that will be directly mined beneath such as Foot Onslow Creek and small unnamed drainages are highly degraded and do not contain any significant fauna habitat that will be impacted.

Where the creeks have an alluvial bed above the strata, it is unlikely that cracking in the strata will continue up to the surface (MSEC 2008). In the unlikely event that it does, the cracks are likely to be filled with alluvial material during subsequent flow events. Where the creek beds are exposed rock, there may be some redirection of water from the creek beds into the dilated strata beneath them and the draining of some of the pools that exist within the creek alignments (MSEC 2008). However, the creek lines generally occur on gentle, undulating land and are unlikely to be significantly altered by mining induced subsidence. Furthermore, the creek lines and most associated pools are ephemeral and it is likely that fauna reliant on them would be adapted to using non-perennial water sources. It is therefore unlikely that native fauna which rely on these areas will be significantly impacted by the proposed longwall extraction.

As no cliffs or steep and rocky slopes along creeks will be directly mined beneath, MSEC (2008) predicts instabilities due to subsidence are unlikely. Consequently, it is unlikely that native fauna that live in such areas will be significantly impacted by the proposed longwall extraction.

Gas emission through alluvial or rocky substrate within a watercourse may affect water quality at low river flows and hence fauna habitat. However, these gas emissions are expected to be temporary and it is unlikely that any significant impacts on fauna or their habitats will occur.

Given the nature of the likely subsidence impacts and that significant fauna habitats will not be directly mined beneath by the proposal, it is considered that the proposed longwall extraction would be unlikely to have a significant impact on any important fauna habitats.

5.3.2 Potential Impacts on Threatened Animal Species

The Study Area provides potential habitat for 42 threatened or migratory animal species that may occur in the locality (Table 5). Four of these species, if present, are likely to be dependent on the Nepean River and tributaries for breeding or foraging. A detailed assessment of the potential impacts on these species is provided in Appendix 4 and Appendix 5. General comments on the likely impacts are provided below.

The Nepean River and pools associated with its tributaries may provide breeding or foraging habitat for frog species. A reduction in the amount of water present in some pools may reduce the available breeding habitat for frog species and possibly disrupt their life cycle. Frog species considered further in the impact assessment include the Giant Burrowing Frog, *Helioporus australiacus*, Littlejohn's Tree Frog, *Litoria littlejohni* and the Red-crowned Toadlet, *Psuedophryne australis*. The impact assessment (Appendix 4) indicates that subsidence is unlikely to have a significant impact on these species as the Study Area only provides marginal habitat and the impacts to potential habitat would be insignificant.

The Large-footed Myotis, *Myotis macropus* has previously been recorded within the Study Area on the Eastern side of the Nepean River. This species forages along the creek lines and pools where it feeds on small fish and insects. The potential short-term loss of pools in tributaries to the Nepean River as a result of subsidence may reduce the foraging area available to individuals. The impact assessment (Appendix 4) indicates that subsidence is unlikely to have a significant impact on this species given the minimal potential subsidence impacts to the Nepean River the large areas of potential foraging habitat for this species in the vicinity of the Study Area and the region.

Species which are dependant on caves, overhangs, rock crevices and steep slopes such as cave dwelling bat species, the Spotted-tailed Quoll, *Dasyurus maculates*, Rosenberg's Goanna *Varanus Rosenberg,* the Broad-headed Snake *Hoplocephalus bungaroide*s and the Brush-tailed Rock Wallaby, *Petrogale penicillata*, have been considered as there is possibility for impacts to this habitat. MSEC (2008) states that cliff failures in the Nepean gorge are considered unlikely in relation to the mining of Longwall 705-710 and that rockfalls are unlikely to occur and if they do are likely to be isolated and minor in nature. As such assessments of significance were not prepared for these species.

There is a large camp of Grey-headed Flying Fox (GHFF), *Pteropus poliocephalus*, in the Study Area on the western side of the Nepean River (DECC 2007b; Biosis Research 2006)(Figure 7). Camps are important for GHFFs and disturbance to camps is a threat to this species survival (DECC 2007a). It is highly unlikely subsidence will cause any impacts to the habitat where this camp is located. There is a possibility of localised rock falls in some areas (MSEC 2008) but these are expected to be minor and would be unlikely to affect the trees that this species roosts in and as such an assessment of significance was not prepared for this species.

The Cumberland Plain Land Snail was recorded during the current assessment in the north west of the Study Area in a patch of Cumberland plain Woodland adjacent to a tributary of Navigation Creek (Figure 7). This species has also previously been recorded East of the Nepean River in the Study Area (Figure 6). This species primarily inhabits Cumberland Plain Woodland and is found under logs, bark and leaf litter (DEC, 2005e). Impacts to this habitat type are considered highly unlikely and as such an assessment of significance was not prepared for this species.

The remaining threatened fauna species known to occur or with potential habitat within the Study Area are unlikely to be significantly impacted by subsidence as habitat for these species occurs within woodland, or other habitats that are unlikely to be impacted by subsidence. Hence, Assessments of Significance under the TSC and EPBC Acts were not completed for these species.

6.0 RECOMMENDATIONS

This study provides a qualitative assessment of the potential impacts of mining related subsidence effects on threatened species, populations and ecological communities. The assessment also provides qualitative base-line data on the plant communities, fauna habitats and species presence within the Study Area, as recorded during two survey periods prior to mining. From this assessment the following management actions should be incorporated into the project:

- In the unlikely event that gas release related die-off is observed, actions should be taken to monitor the extent of and recovery of any such vegetation impacts. Locally indigenous plant species should be utilised for any rehabilitation that may be required.
- The current Appin Area 7 River-flat Eucalypt Forest Management Plan (Biosis Research 2007a) should be extended to the length of the Nepean River adjacent to Longwalls 705-710.
- Species Impact Statements and/or Referrals to the Environment Minister are not recommended for any plant communities or plant or animal species.

7.0 CONCLUSION

This report assesses the terrestrial flora and fauna of the areas that may be impacted by subsidence associated with the mining of Longwalls 705 to 710. Field surveys for this flora and fauna assessment have been conducted over several years and will provide baseline data to which the post-mining habitat type and condition may be compared.

Subsidence impacts within the Study Area may potentially result in; minor impacts to water quality in the Nepean River, the localised emission of gas, minor bank desiccation and scouring, and cracking in soils and fracturing of bedrock on the surface and possibly minor rockfalls and erosion events. However, these effects are not expected to represent a significant impact to the terrestrial flora and fauna values of the area.

Plant Communities

The Study Area contains five broad plant communities, four of which are EECs listed on the TSC and/or EPBC Act: Cumberland Plain Woodland, Shale Sandstone Transition Forest, Moist Shale Forest and River-flat Eucalypt Forest.

Potential surface fracturing, gas emissions or erosion events are considered unlikely to result in the broad scale alteration of species composition or distribution within the Study Area. For these reasons, it is considered unlikely that the proposed longwall mining activities and the associated subsidence impacts would have a significant impact on any plant community within the Study Area.

Flora

Potential habitat for three threatened plant species that could potentially be affected by the mechanisms of subsidence occurs within the Study Area. Impact assessments (Appendix 4 and Appendix 5) conclude that habitat for these species is unlikely to be significantly impacted by the proposed mining activities. It is therefore considered unlikely that the proposed longwall mining activities would have a significant impact on any threatened flora species within the Study Area.

Fauna

Actual or potential habitat for several threatened fauna species was recorded from the Study Area. Four species were considered likely to be dependent on habitat resources that may be impacted by subsidence. Based on the likely subsidence impacts to the Study Area and the extent of similar habitat in the region, it is considered unlikely that the proposed longwall mining activities

would have a significant impact on any threatened fauna species within the Study Area.

PLATES

Plate 1: Shale Sandstone Transition Forest along Leafs Gully

Plate 2: Cumberland Plain Woodland along Foot Onslow Creek

Plate 3: Alluvial Woodland along tributary of Navigation Creek

Plate 4: Moist Shale Woodland

Plate 5: Western Sandstone Gully Forest along Nepean River

Plate 6: Western Sandstone Gully Forest along tributary of Nepean River

Plate 7: Cleared areas throughout the Study Area

Plate 8: Foot Onslow Creek

Plate 9: Foot Onslow Creek

Plate 10: Tributary of Navigation Creek

Plate 11: Navigation Creek

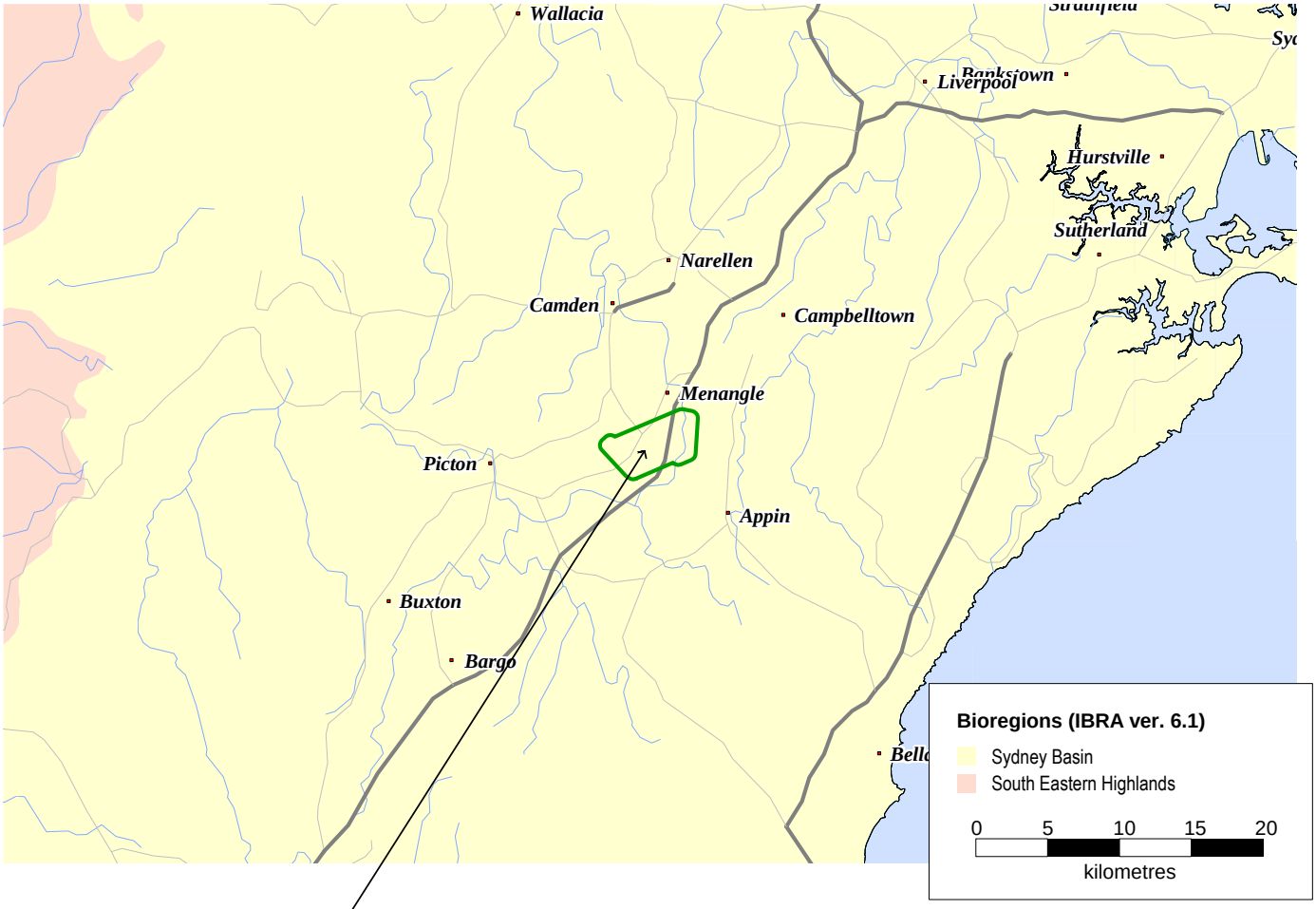
Plate 12: Tributary of Harris Creek

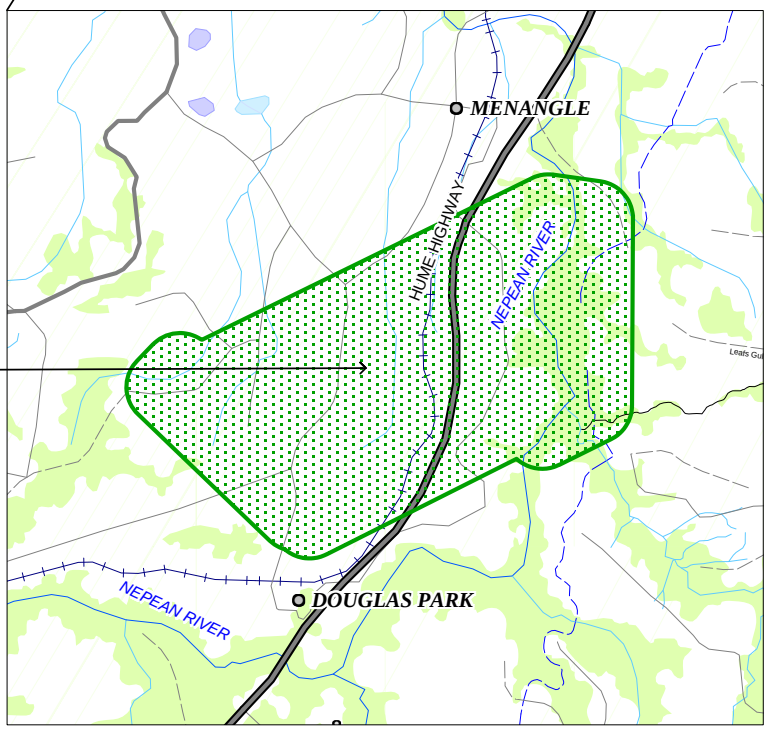
Plate 13: Rock outcrop with crevices in the Nepean River gorge.

Plate 14: Overhang in Nepean River Gorge

Plate 15: Farm dam within cleared areas

FIGURES





Study area

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8 Tate St
WOLLONGONG
NEW SOUTH WALES 2500

Figure 1: Location of the Study Area in a regional context.

Date: 10 June 2008
Checked by: MR
File number: S4971
Location:-...\4000\4900\4971\S4971 F1 Study area.WOR

Scale: 0 1 2 3 4 kilometres

N W E S

Legend

- Proposed Mine Layout
- SMP Area
- Study Area

Acknowledgements: Illawarra Coal/BHP Billiton

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Figure 2 : The proposed works and the study area

DATE: 10 June 2008

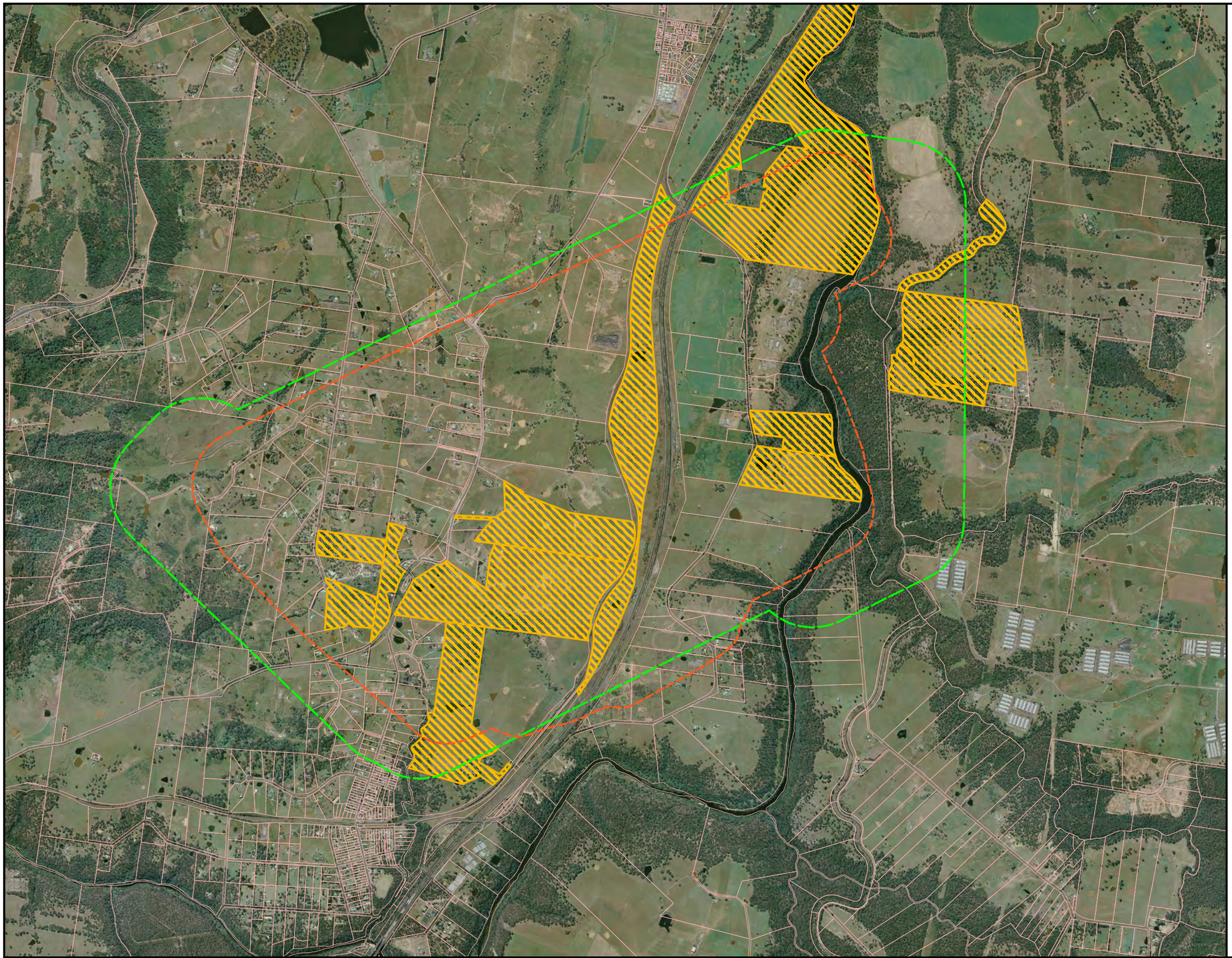
Checked by: MHS | File number: S4971

Location:-..\4000\4900s\4971\Mapping\S4971 F2 Proposed works and study area.WOR

Scale: 0 0.25 0.5 0.75 1.0 1.25 kilometres

N W E S

Figure 2 : The proposed works and the study area



Acknowledgements: Illawarra Coal/BHP Billiton
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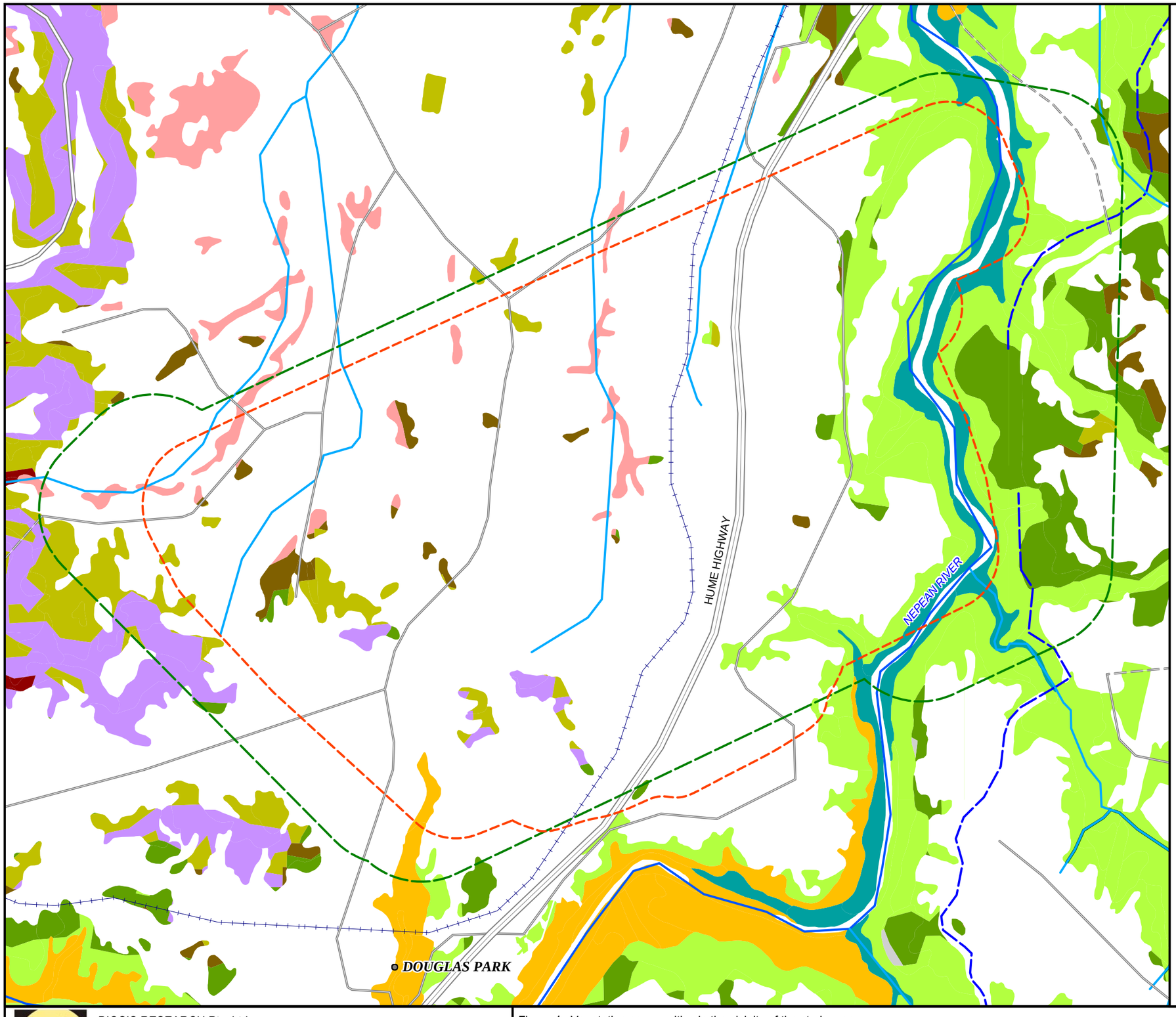
Figure 3 : Aerial photography showing the Study Area and property access

Date: 10 June 2008
Checked by: MT
File number: S4970
Location:-..4000\4900s\4971\Mapping\S4971 F3 Ortho with study area and access.WOR

Scale: 0 0.3 0.6 0.9 1.2 1.5 kilometres

N W E S

Figure 3 : Aerial photography showing the Study Area and property access



Legend

Vegetation communities in study area

- Alluvial Woodland
- Cleared
- Moist Shale Woodland
- Riparian Forest
- Riparian Vegetation
- Shale Hills Woodland
- Shale Plains Woodland
- Shale Sandstone Transition Forest (High Sandstone Influence)
- Shale Sandstone Transition Forest (Low Sandstone Influence)
- Western Sandstone Gully Forest
- Western Sydney Dry Rainforest

Survey Areas

- SMP Area
- Study Area

Topography

- Township
- Dual carriageway
- Major road
- Railway
- River/creek - ephemeral
- River/creek - perennial
- Secondary/minor road
- Track
- Canal

Acknowledgements: Illawarra Coal/BHP Billiton and DECC

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Figure 4 : Vegetation communities in the vicinity of the study area

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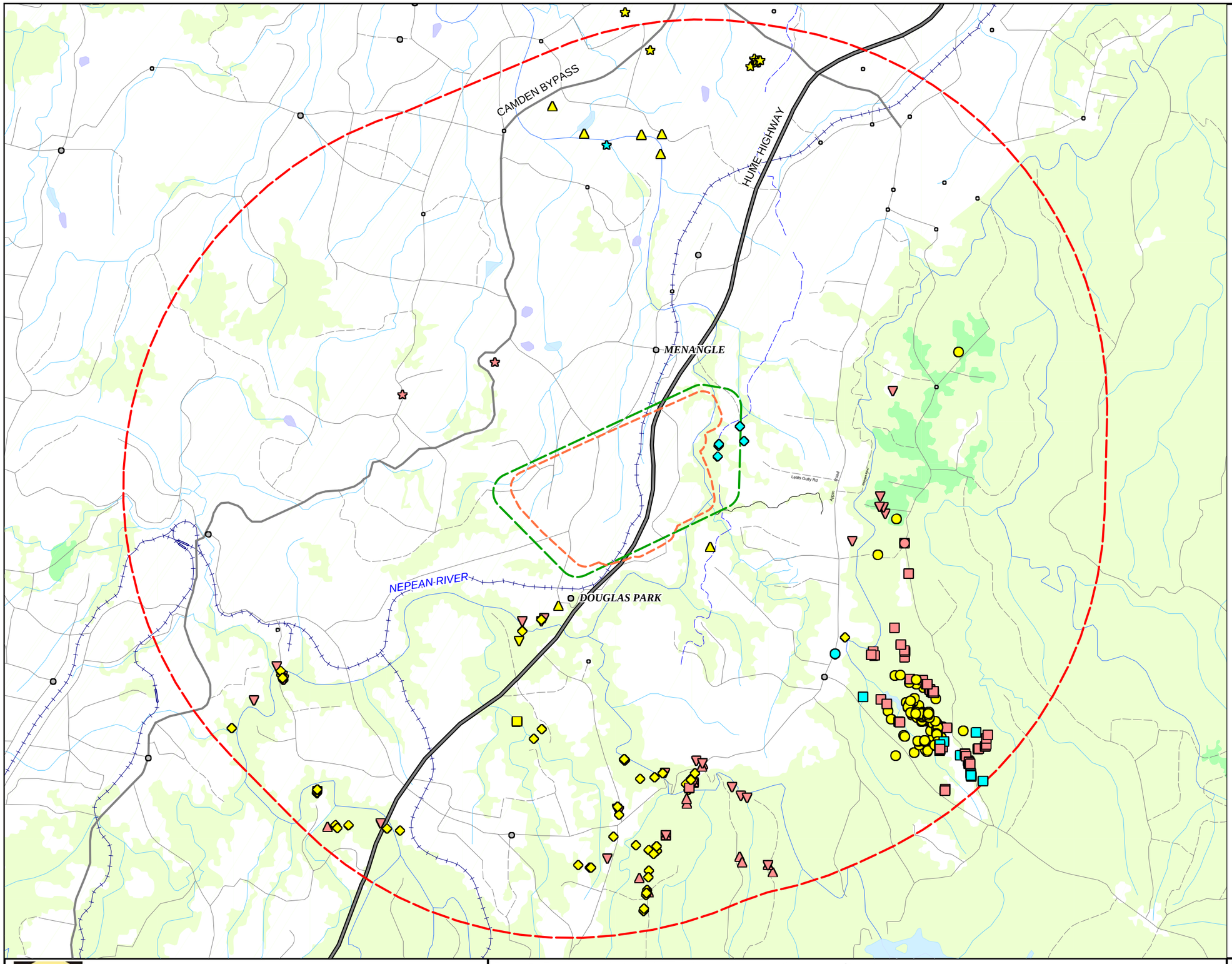
Location:-..\4000\4900s\4971\Mapping\S4971 F4 Vegetation Communities.WOR

Scale: 0 0.25 0.5 0.75 1.0 1.25 kilometres

N W E S

Figure 4 : Vegetation communities in the vicinity of the study area



Legend

Threatened plant species

- *Acacia bynoeana*
- *Amperea xiphoclada var. pedicellata*
- *Callistemon linearifolius*
- *Cynanchum elegans*
- *Epacris purpurascens var. purpurascens*
- *Grevillea parviflora ssp. parviflora*
- *Melaleuca deanei*
- *Persoonia bargoensis*
- *Persoonia hirsuta subsp. hirsuta*
- *Pimelea spicata*
- *Pomaderris brunnea*
- *Pterostylis saxicola*
- *Pultenaea aristata*
- *Pultenaea pedunculata*
- *Syzygium paniculatum*
- *Thesium australe*

Survey Areas

- SMP Area
- Study Area
- 10km search area

Topography

- City/Town
- Locality
- Dual Carriageway
- Major road
- Secondary/minor road
- Track
- Railway
- River/creek - ephemeral
- River/creek - perennial
- Canal
- Lake
- Reservoir
- Forest
- Orchard

Acknowledgements:
Species records from DECC/NPWS and Biosis
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Figure 5 : Threatened plant species previously recorded in the vicinity of the study area as dreived from DECC Atlas of NSW Wildlife

DATE: 10 June 2008

Checked by: MHS | File number: S4971

Location:-..\4000\4900s\4971\Mapping\S4971 F5 Threatened Plants.WOR

Scale: 0 1 2 3 4 5 kilometres

N W E S

Figure 5 : Threatened plant species previously recorded in the vicinity of the study area as derived from DECC Atlas of NSW Wildlife

CAMDEN BYPASS

HUME HIGHWAY

MENANGLE

NEPEAN RIVER

DOUGLAS PARK

Leafs Gully Rd

Appin Road

Appin Road

Legend

Threatened animal species

- Barking Owl
- Black-chinned Honeyeater (eastern subspecies)
- Black-necked Stork
- Broad-headed Snake
- Brown Treecreeper
- Bush Stone-curlew
- Common Bent-wing Bat
- Cumberland Plain Land Snail
- Diamond Firetail
- Eastern Bentwing-bat
- Eastern False Pipistrelle
- Eastern Freetail-bat
- Eastern Pygmy-possum
- Freckled Duck
- Gang-gang Cockatoo
- Giant Burrowing Frog
- Glossy Black-Cockatoo
- Greater Broad-nosed Bat
- Grey-headed Flying-fox
- Hooded Robin
- Koala
- Large-eared Pied Bat
- Large-footed Myotis
- Painted Honeyeater
- Powerful Owl
- Red-crowned Toadlet
- Regent Honeyeater
- Rosenberg's Goanna
- Speckled Warbler
- Spotted-tailed Quoll
- Squirrel Glider
- Swift Parrot
- Turquoise Parrot
- Yellow-bellied Glider
- Yellow-bellied Sheathtail-bat

Survey Areas

- SMP Area
- Study Area
- 10km search area

Acknowledgements:
Species data from DECC/NPWS and Biosis
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Figure 6 : Threatened animal species previously recorded in the vicinity of the study area as dreived from DECC Atlas of NSW Wildlife

DATE: 10 June 2008

Checked by: MHS | File number: S4971

Location:-..\4000\4900s\4971\Mapping\S4971 F6 Threatened Animals.WOR

Scale: 0 1 2 3 4 5 kilometres

N W E S

Figure 6 : Threatened animal species previously recorded in the vicinity of the study area as derived from DECC Atlas of NSW Wildlife

Legend

- Cumberland Land Snail Sighting
- Grey-Headed Flying Fox Colony
- SMP Area
- Proposed Mine Layout
- Study Area

Acknowledgements: Illawarra Coal/BHP Billiton
Grey-headed Flying-fox record from DECC/NPWS

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Figure 7 : Location of Cumberland Plain Land Snail recorded in recent surveys and the location of the Grey-Headed Flying Fox colony

DATE: 10 June 2008
Checked by: MHS | File number: S4971
Location:-..\4000\4900s\4971\Mapping\S4971 F7 Land Snail & Flying Fox.WOR

Scale: 0 0.25 0.5 0.75 1.0 1.25 kilometres

N W E S

Figure 7 : Location of Cumberland Plain Land Snail recorded in recent surveys and the location of the Grey-Headed Flying Fox colony

APPENDICES

Appendix 1
FLORA RESULTS

Dominant flora recorded in the Study Area in the current survey and previous surveys (Biosis Research 2006; Biosis Research 2004)

Family	Species Name	Common Name	Exotic *	Present Survey	Previous Surveys
Ferns and Fern-like Plants					
Adiantaceae					
	Adiantum aethiopicum	Common Maidenhair		X	X
	Adiantum formosum	Giant Maidenhair		X	X
	Cheilanthes sieberi ssp. *sieberi*	Narrow Rock-fern		X	X
	Pellaea falcata	Sickle Fern			X
Aspleniaceae					
	Asplenium flabellifolium	Necklace Fern		X	X
Blechnaceae					
	Blechnum ambiguum			X	
	Blechnum spp.				X
	Doodia aspera	Prickly Rasp Fern		X	X
Dennstaedtiaceae					
	Pteridium esculentum	Bracken			X
Dicksoniaceae					
	Calochlaena dubia	Common Ground Fern			X
Gleicheniaceae					
	Gleichenia dicarpa	Pouched Coral-fern			X
	Gleichenia spp.	Gleichenia			X
Osmundaceae					
	Todea Barbara	King Fern			X
Polypodiaceae					
	Platycerium bifurcatum	Elkhorn		X	
	Pyrrosia rupestris	Rock Felt Fern		X	
Conifers					
Pinaceae	*Pinus radiata*	Radiata Pine	*	X	
Monocotyledons					
Anthericaceae	Arthropodium milleflorum	Vanilla Lily		X	
Alismataceae					
	Alisma plantago-aquatica	Water Plantain	*		X
Anthericaceae					
	Laxmannia gracilis	Slender Wire-lily			X
Asparagaceae					
	Myrsiphyllum asparagoides	Florist's Smilax	*		X
Commelinaceae					
	Commelina cyanea	Native Wandering Jew			X
	Tradescantia albiflora	Wandering Jew	*		X
Cyperaceae					
	Cladium procerum	Leafy Twig-sedge			X
	Cyperus congestus	Dense Flat-sedge	*		X
	Cyperus eragrostis	Umbrella Sedge	*	X	
	Cyperus gracilis	Slender Flat-sedge			X
	Cyperus polystachyos	Bunchy flat-sedge		X	
	Cyperus sp.		*	X	
	Eleocharis sphacelata	Tall Spike Rush			X
	Gahnia aspera			X	X
	Gahnia spp.				X
	Lepidosperma laterale	Variable Sword-sedge		X	
	Lepidosperma spp.				X
	Lepidosperma urophorum	Tailed Rapier-sedge		X	
	Schoenoplectus validus				X
Hydrocharitaceae					
	Vallisneria gigantean	Eelweed			X
Juncaceae					
	Juncus usitatus	Billabong Rush		X	X
Juncaginaceae					

Family	Species Name	Common Name	Exotic *	Present Survey	Previous Surveys
	Triglochin procerum	Water Ribbons			X
Lomandraceae					
	Lomandra cylindrica	Needle Mat-rush			X
	Lomandra filiformis ssp. *coriacea*	Wattle Mat-rush		X	X
	Lomandra filiformis ssp. *filiformis*	Wattle Mat-rush			X
	Lomandra fluviatilis			X	X
	Lomandra glauca	Pale Mat-rush		X	X
	Lomandra gracilis				X
	Lomandra longifolia	Spiny-headed Mat-rush		X	X
	Lomandra multiflora subsp. *multiflora*	Many-flowered Mat-rush		X	
	Lomandra obliqua			X	X
	Lomandra spp.				X
Luzuriagaceae					
	Eustrephus latifolius	Wombat Berry		X	
	Geitonoplesium cymosum	Scrambling Lily		X	X
Orchidaceae					
	Chiloglottis sp.			X	
	Corybas sp.			X	
	Dendrobium linguiforme	Tongue Orchid		X	
	Dendrobium speciosum	Rock Lily		X	
Phormiaceae					
	Dianella Caerulea var. *producta*	Blue Flax-lily		X	
	Stypandra glauca	Nodding Blue Lily		X	X
Poaceae					
	Andropogon virginicus	Whisky Grass	*		X
	Aristida ramosa var. *ramosa*			X	
	Aristida spp.				X
	Aristida vagans	Three-awn Speargrass		X	
	Arundo donax	Giant Reed	*		X
	Austrodanthonia spp.				X
	Austrodanthonia tenuior	Purplish Wallaby-grass		X	
	Austrostipa pubescens			X	X
	Austrostipa ramosissima	Stout Bamboo Grass			X
	Austrostipa rudis ssp. *rudis*	Veined Spear-grass			X
	Bothriochloa spp.			X	
	Bromus catharticus	Prairie Grass	*	X	
	Chloris gayana	Rhodes Grass	*	X	
	Chloris truncata	Windmill Grass		X	
	Cortaderia selloana	Pampas Grass	*		X
	Cymbopogon refractus	Barbed Wire Grass		X	X
	Cynodon dactylon	Common Couch	*	X	X
	Dichelachne micrantha	Shorthair Plumegrass		X	
	Digitaria spp.			X	
	Echinopogon caespitosus var. *caespitosus*	Tufted Hedgehog Grass			X
	Echinopogon ovatus	Forest Hedgehog Grass		X	X
	Ehrharta longifolia	Annual Veldtgrass	*	X	
	Elusine indica	Crowsfoot Grass	*	X	
	Entolasia marginate	Bordered Panic		X	X
	Entolasia stricta	Wiry Panic		X	X
	Eragrostis brownie	Brown's Lovegrass			X
	Eragrostis leptostachya	Paddock Lovegrass		X	X
	Microlaena stipoides var. *stipoides*	Weeping Grass		X	X
	Oplismenus aemulus			X	X
	Panicum simile	Two-colour Panic		X	X
	Paspalum dilatatum	Paspalum	*	X	
	Paspalum distichum	Water Couch			X
	Pennisetum clandestinum	Kikuyu	*	X	
	Phragmites australis	Common Reed			X
	Poa affinis	Poa 6986			X
	Poa labillardierei var. *labillardierei*	Tussock			X

Family	Species Name	Common Name	Exotic *	Present Survey	Previous Surveys
	Setaria gracilis	Slender Pigeon Grass	*	X	X
	Sporobolus creber	Slender Rat's Tail Grass	*	X	
	Sporobolus indecus var. *capensis*	Parramatta Grass	*	X	
	Themeda australis	Kangaroo Grass		X	X
Typhaceae					
	Typha orientalis	Broad-leaved Cumbungi			X
Xanthorrhoeaceae	*Xanthorrhoea media*	Forest Grass Tree		X	
Dicotyledons					
Acanthaceae					
	Brunoniella australis	Blue Trumpet		X	
	Pseuderanthemum variabile	Pastel flower		X	
Aizoaceae					
	Tetragonia tetragonioides	New Zealand Spinach			X
Amaranthaceae					
	Alternanthera denticulata	Lesser Joyweed			X
Anacardiaceae					
	Schinus areira	Pepper Tree	*	X	
Apiaceae					
	Actinotus helianthi	Flannel Flower		X	
	Centella asiatica	Pennywort			X
	Platysace lanceolata	Shrubby Platysace			X
Apocynaceae					
	Parsonsia straminea	Common Silkpod		X	
Araliaceae					
	Astrotricha latifolia			X	
Asclepiadaceae					
	Araujia hortorum	Araujia	*	X	X
	Gomphocarpus fruticosus	Narrow-leaved Cotton bush	*	X	
	Marsdenia rostrata	Common Milk Vine		X	
	Tylophora barbata	Bearded Tylophora		X	X
Asteraceae					
	Ageratina adenophora	Crofton Weed	*	X	
	Ageratina riparia	Mistflower	*		X
	Bidens pilosa	Cobbler's Pegs	*	X	X
	Bidens spp.				X
	Brachyscome angustifolia var. *angustifolia*				X
	Calotis cuneata var. cuneata				X
	Calotis dentex			X	X
	Calotus lappulaceae	Yellow burr-daisy		X	
	Cirsium vulgare	Spear Thistle	*	X	X
	Conyza albida	Tall Fleabane	*	X	X
	Euchiton sphaericus	Annual Cudweed	*	X	
	Helichrysum scorpioides	Button Everlasting			X
	Hypochoeris radicata	Catsear	*		X
	Olearia viscidula	Wallaby Weed		X	X
	Senecio linearifolius	Fireweed Groundsel			X
	Senecio madagascariensis	Fireweed	*	X	X
	Senecio mikanioides		*		X
	Senecio tamoides		*		X
	Senecio vagus ssp. *eglandulosus*				X
	Sigesbeckia orientalis ssp. *orientalis*	Indian Weed		X	X
	Tagetes minuta	Stinking Roger	*	X	
	Taraxicum officinale	Dandelion	*	X	
	Xanthium spinosum	Bathurst Burr	*	X	
Bignoniaceae					
	Pandorea pandorana ssp. *pandorana*			X	X
Brassicaceae					
	Brassica sp.		*	X	
	Lepidium sp.		*	X	
Cactaceae					

Family	Species Name	Common Name	Exotic *	Present Survey	Previous Surveys
	Opuntia sp.	Prickly Pear	*	X	
Campanulaceae					
	Wahlenbergia gracilis			X	
	Wahlenbergia spp.				X
	Wahlenbergia stricta	Australian Bluebell		X	
Caprifoliaceae					
	Lonicera japonica	Japanese Honeysuckle	*		X
Caryophyllaceae					
	Cerastium glomeratum	Mouse-ear Chickweed	*		X
Casuarinaceae					
	Allocasuarina littoralis	Black Sheoak		X	
	Allocasuarina torulosa	Forest Oak		X	
	Casuarina cunninghamiana ssp. *cunninghamiana*				X
	Casuarina glauca	Swamp Oak			X
Chenopodiaceae					
	Einadia hastate	Berry Saltbush		X	X
	Einadia trigonos ssp. *trigonos*	Lax Goosefoot		X	X
Convolvulaceae					
	Convolvulus erubescens			X	
	Dichondra repens	Kidney Weed		X	X
	Ipomoea indica	Blue Morning Glory	*		X
Cunoniaceae					
	Ceratopetalum gummiferum	Christmas Bush		X	
Dilleniaceae					
	Hibbertia diffusa	Wedge Guinea-flower			X
	Hibbertia empetrifolia ssp. *empetrifolia*	Tangled Guinea-flower		X	
Epacridaceae					
	Leucopogon juniperinus	Long-flower Beard-heath		X	X
	Lissanthe strigosa ssp. *strigosa*				X
Euphorbiaceae					
	Breynia oblongifolia	Coffee Bush		X	X
	Euphorbia peplus	Petty Spurge	*		X
	Phyllanthus gunnii	Shrubby Spurge			X
	Phyllanthus hirtellus	Thyme Spurge		X	X
	Poranthera corymbosa	Clustered Poranthera			
	Poranthera microphylla	Small Poranthera		X	
Fabaceae (Caesalpinioideae)					
	Gleditsia triacanthos	Honey Locust	*		X
Fabaceae (Faboideae)					
	Daviesia ulicifolia ssp. *stenophylla*			X	
	Desmodium rhytidophyllum			X	
	Desmodium varians	Slender Tick-trefoil		X	X
	Glycine clandestina	Twining Glycine		X	
	Glycine microphylla	Small-leaf Glycine			X
	Glycine tabacina	Variable Glycine		X	
	Goodia lotifolia var. *lotifolia*	Common Golden-tip			X
	Hardenbergia violacea	False Sarsaparilla		X	X
	Indigofera australis	Austral Indigo		X	
	Jacksonia scoparia	Dogwood			X
	Jacksonia spp.	Jacksonia			X
	Kennedia rubicunda	Red Kennedy Pea			X
	Podolobium ilicifolium	Prickly Shaggy Pea		X	X
	Trifolium repens	White Clover	*	X	
Fabaceae (Mimosoideae)					
	Acacia binervata	Two-veined Hickory			X
	Acacia binervia	Coast Myall			X
	Acacia decurrens	Black Wattle		X	X
	Acacia echinula	Hedgehog Wattle			X

Family	Species Name	Common Name	Exotic *	Present Survey	Previous Surveys
	Acacia elongata	Swamp Wattle			X
	Acacia floribunda	White Sally		X	X
	Acacia implexa	Hickory Wattle		X	X
	Acacia irrorata	Green Wattle			X
	Acacia linearifolia	Narrow-leaved Wattle			X
	Acacia longifolia	Coast/Sallow Wattle			X
	Acacia obtusifolia	Blunt-leaf Wattle			X
	Acacia parramattensis	Parramatta Wattle		X	X
	Acacia parvipinnula	Silver-stemmed Wattle			X
	Acacia terminalis	Sunshine Wattle		X	
	Acacia ulicifolia	Prickly Moses		X	X
Fumariaceae					
	Fumaria spp.				X
Geraniaceae					
	Geranium homeanum	Northern Cranesbill			X
	Geranium solanderi var. *solanderi*			X	
Goodeniaceae					
	Goodenia hederacea ssp. *hederacea*	Ivy Goodenia		X	X
	Goodenia ovata	Hop Goodenia		X	
	Scaevola albida var. *albida*			X	
	Scaevola ramosissima	Hairy Fan-flower		X	
Haloragaceae					
	Gonocarpus longifolius				X
Lamiaceae					
	Plectranthus parviflorus	Cockspur Flower		X	
	Prostanthera incana	Velvet Mint-bush		X	
	Westringia longifolia			X	
Lauraceae					
	Cassytha glabella f. *glabella*	Slender Dodder-laurel			X
	Cassytha pubescens	Cassytha		X	X
	Cassytha spp.				X
Lobeliaceae					
	Lobelia alata Labill. Complex				X
	Pratia purpurascens	Whiteroot			X
Loranthaceae				X	
	Amyema spp.	Amyema			X
Malvaceae					
	Modiola caroliniana	Red-flowered Mallow	*	X	
	Sida rhombifolia	Paddy's Lucerne	*	X	X
Menispermaceae					
	Stephania japonica var. *discolor*	Snake Vine		X	X
Monimiaceae					
	Palmeria scandens	Anchor Vine		X	
Moraceae					
	Ficus coronata	Creek Sandpaper Fig			X
	Ficus rubiginosa	Ficus		X	X
Myrsinaceae					
	Rapanea variabilis	Muttonwood		X	X
Myrtaceae					
	Angophora bakeri	Narrow-leaved Apple		X	X
	Angophora crassifolia				X
	Angophora floribunda	Rough-barked Apple			X
	Backhousia myrtifolia	Grey Myrtle		X	X
	Callistemon salignus	Willow Bottlebrush		X	X
	Corymbia gummifera	Red Bloodwood		X	
	Eucalyptus botryoides	Bangalay			X
	Eucalyptus crebra	Narrow-leaved Ironbark		X	X
	Eucalyptus elata	River Peppermint			X
	Eucalyptus fibrosa	Red Ironbark		X	
	Eucalyptus globoidea	White Stringybark			X
	Eucalyptus moluccana	Grey Box		X	
	Eucalyptus pilularis	Blackbutt		X	

Family	Species Name	Common Name	Exotic *	Present Survey	Previous Surveys
	Eucalyptus piperita	Sydney Peppermint		X	X
	Eucalyptus punctata	Grey Gum		X	X
	Eucalyptus racemosa	Narrow-leaved Scribbly Gum			
	Eucalyptus saligna	Sydney Blue Gum			X
	Eucalyptus tereticornis	Forest Red Gum		X	X
	Kunzea ambigua	Tick Bush		X	X
	Leptospermum polygalifolium ssp. *polygalifolium*			X	
	Leptospermum trinervium	Paperbark Tea-tree		X	X
	Melaleuca decora	Melaleuca			X
	Melaleuca linariifolia			X	X
	Melaleuca nodosa	Prickly-leaved Tea Tree		X	
	Tristania neriifolia	Water Gum			X
	Tristaniopsis laurina	Kanuka		X	X
Oleaceae					
	Ligustrum lucidum	Large-leaved Privet	*	X	X
	Ligustrum sinense	Small-leaved Privet	*		X
	Notelaea longifolia f. *longifolia*			X	
	Olea europaea	Common Olive	*	X	
Onagraceae					
	Ludwigia peploides ssp. *montevidensis*	Water Primrose		X	
Oxalidaceae					
	Oxalis spp.	Oxalis		X	X
Passifloraceae					
	Passiflora herbertiana ssp. *herbertiana*	Native Passionfruit		X	X
	Passiflora spp.	Passiflora			X
Phytolaccaceae					
	Phytolaca octandra	Inkweed	*	X	
Pittosporaceae					
	Billardiera scandens var. *scandens*	Common Apple-berry		X	
	Bursaria spinosa ssp. *spinosa*	Sweet Bursaria		X	X
	Pittosporum revolutum	Rough Fruit Pittosporum		X	X
	Pittosporum undulatum	Sweet Pittosporum			X
Plantaginaceae					
	Plantago lanceolata	Lamb's Tongues	*	X	X
Polygonaceae					
	Acetosa sagittata	Rambling Dock	*		X
	Persicaria spp.				X
	Rumex crispus	Curled Dock	*		X
Primulaceae					
	Anagallis arvensis	Blue Pimpernel	*	X	
Proteaceae					
	Banksia spinulosa	Hairpin Banksia		X	
	Grevillea oleoides	Grevillea			X
	Persoonia linearis	Narrow-leaved Geebung		X	X
Ranunculaceae					
	Clematis aristata	Mountain Clematis		X	X
Rhamnaceae					
	Cryptandra spinescens			X	X
	Pomaderris ligustrina ssp. *ligustrina*	Privet Pomaderris			X
Rosaceae					
	Rubus fruiticosus	Blackberry complex	*	X	X
	Rubus parvifolius	Native Raspberry		X	X
	Rubus ulmifolius	Blackberry	*		X
Rubiaceae					
	Asperula conferta	Common Woodruff		X	
	Coprosma quadrifida	Prickly Currant Bush		X	
	Galium aparine	Goosegrass	*		X
	Morinda jasminoides	Jasmine Morinda		X	X
	Opercularia aspera	Coarse Stinkweed			X

Family	Species Name	Common Name	Exotic *	Present Survey	Previous Surveys
	Opercularia diphylla	Stinkweed		X	
	Pomax umbellata	Pomax		X	X
Rutaceae					
	Boronia ledifolia	Sydney Boronia		X	
	Correa reflexa var. *reflexa*	Native Fuschia		X	X
	Zieria smithii	Sandfly Zieria		X	X
Salicaceae					
	Salix spp.	Salix			X
Sambucaceae					
	Sambucus gaudichaudiana	White Elderberry			X
Santalaceae					
	Exocarpus cupressiformis	Native cherry		X	
Sapindaceae					
	Cardiospermum grandiflorum	Balloon Vine	*		X
	Dodonaea multijuga				X
	Dodonaea triquetra	Large-leaf Hop-bush		X	X
Scrophulariaceae					
	Veronica plebeian	Trailing Speedwell			X
Solanaceae					
	Duboisia myoporoides	Corkwood			X
	Lycium ferocissimum	African Boxthorn	*	X	X
	Solanum mauritianum	Wild Tobacco Bush	*		X
	Solanum nigrum	Black-berry Nightshade	*	X	X
	Solanum prinophyllum	Forest Nightshade		X	X
Sterculiaceae					
	Brachychiton populneus ssp. *populneus*	Kurrajong		X	
	Commersonia fraseri	Brush Kurrajong			X
Stylidiaceae					
	Stylidium laricifolium	Tree Triggerplant		X	
Tropaeolaceae					
	Tropaeolum majus	Nasturtium	*		X
Ulmaceae					
	Trema tomentosa var. *viridis*	Native Peach			X
Urticaceae					
	Urtica incise	Stinging Nettle			X
Verbenaceae					
	Clerodendrum tomentosum			X	X
	Lantana camara	Lantana	*	X	X
	Verbena bonariensis	Purpletop	*	X	
	Verbena officinalis	Common Verbena	*		X
	Verbena rigida	Veined Verbena	*	X	
Violaceae					
	Hybanthus monpetalus	Slender Violet-bush		X	
	Hymenanthera dentata	Tree Violet			X
	Viola hederacea	Ivy-leaved Violet			X
Vitaceae					
	Cayratia clematidea	Slender Grape			X
	Cissus hypoglauca	Giant Water Vine		X	X

Appendix 2
FAUNA RESULTS

Terrestrial fauna species recorded within the Study Area during the current survey and previous surveys (Biosis Research 2006; Biosis Research 2004)

Family Name	Latin Name	Common Name	EPBC Act	TSC Act	Present Survey	Previous Surveys
Amphibians						
Hylidae						
	Litoria verreauxii	Verreaux's Tree Frog			X	
Myobatrachidae						
	Crinia signifera	Common Eastern Froglet			X	X
	Limnodynastes peronii	Striped Marsh-Frog				X
Birds - Introduced						
Columbidae	*Streptopelia chinensis*	Spotted Turtle-Dove		U	X	X
Pycnonotidae	*Pycnonotus jocosus*	Red-whiskered Bulbul		U	X	X
Sturnidae	*Acridotheres tristis*	Common Myna		U	X	X
Sturnidae	*Sturnus vulgaris*	Common Starling		U	X	X
Birds - Native						X
Accipitridae						
	Accipiter cirrhocephalus	Collared Sparrowhawk				X
	Accipiter fasciatus	Brown Goshawk				X
	Aquila audax	Wedge-tailed Eagle			X	X
	Elanus axillaris	Black-shouldered Kite			X	X
	Haliaeetus leucogaster	White-bellied Sea-Eagle	M			X
Alcedinidae						
	Alcedo azurea	Azure Kingfisher				X
Anatidae						
	Anas superciliosa	Pacific Black Duck			X	X
	Chenonetta jubata	Australian Wood Duck			X	X
Anhingidae						
	Anhinga melanogaster	Darter				X
Ardeidae						
	Egretta novaehollandiae	White-faced Heron			X	X
Artamidae						
	Cracticus nigrogularis	Pied Butcherbird				X
	Cracticus torquatus	Grey Butcherbird			X	X
	Gymnorhina tibicen	Australian Magpie			X	X
	Strepera graculina	Pied Currawong			X	X
Cacatuidae						
	Cacatua galerita	Sulphur-crested Cockatoo			X	X
	Calyptorhynchus lathami	Glossy Black-Cockatoo		V		X
	Cacatua roseicapilla	Galah			X	
Campephagidae						
	Coracina novaehollandiae	Black-faced Cuckoo-shrike			X	X
	Coracina tenuirostris	Cicadabird				X

Family Name	Latin Name	Common Name	EPBC Act	TSC Act	Present Survey	Previous Surveys
Charadriidae						
	Vanellus miles	Masked Lapwing			X	X
Cinclosomatidae						
	Psophodes olivaceus	Eastern Whipbird			X	X
Climacteridae						
	Cormobates leucophaeus	White-throated Treecreeper			X	X
Columbidae						
	Geopelia striata	Peaceful Dove				X
	Leucosarcia melanoleuca	Wonga Pigeon			X	X
	Macropygia amboinensis	Brown Cuckoo-Dove			X	
	Ocyphaps lophotes	Crested Pigeon			X	
Coraciidae						
	Eurystomus orientalis	Dollarbird				X
Corcoracidae						
	Corcorax melanorhamphos	White-winged Chough				X
Corvidae						
	Corvus coronoides	Australian Raven			X	X
Cuculidae						
	Cacomantis flabelliformis	Fan-tailed Cuckoo			X	
Dicruridae						
	Grallina cyanoleuca	Magpie-lark			X	X
	Monarcha melanopsis	Black-faced Monarch	M		X	X
	Rhipidura fuliginosa	Grey Fantail			X	X
	Rhipidura leucophrys	Willie Wagtail			X	X
Falconidae						
	Falco cenchroides	Nankeen Kestrel			X	X
Halcyonidae						
	Dacelo novaeguineae	Laughing Kookaburra			X	X
	Todiramphus sanctus	Sacred Kingfisher				X
Hirundinidae						
	Hirundo neoxena	Welcome Swallow			X	
Maluridae						
	Malurus cyaneus	Superb Fairy-wren			X	X
Meliphagidae						
	Acanthorhynchus tenuirostris	Eastern Spinebill			X	X
	Anthochaera carunculata	Red Wattlebird				X
	Anthochaera chrysoptera	Little Wattlebird			X	X
	Lichenostomus chrysops	Yellow-faced Honeyeater			X	X
	Lichenostomus leucotis	White-eared Honeyeater			X	X
	Lichenostomus	Yellow-tufted Honeyeater				X

Family Name	Latin Name	Common Name	EPBC Act	TSC Act	Present Survey	Previous Surveys
	melanops					
	Lichenostomus penicillatus	White-plumed Honeyeater				X
	Manorina melanocephala	Noisy Miner			X	X
	Manorina melanophrys	Bell Miner			X	X
	Meliphaga lewinii	Lewin's Honeyeater			X	X
	Melithreptus albogularis	White-throated Honeyeater				X
	Melithreptus lunatus	White-naped Honeyeater			X	
	Philemon corniculatus	Noisy Friarbird			X	X
	Phylidonyris novaehollandiae	New Holland Honeyeater			X	
Menuridae						
	Menura novaehollandiae	Superb Lyrebird			X	
Neosittidae						
	Daphoenositta chrysoptera	Varied Sittella			X	X
Oriolidae						
	Oriolus sagittatus	Olive-backed Oriole			X	
Pachycephalidae						
	Colluricincla harmonica	Grey Shrike-thrush			X	X
	Pachycephala pectoralis	Golden Whistler			X	
	Pachycephala rufiventris	Rufous Whistler			X	
Pardalotidae						
	Acanthiza lineata	Striated Thornbill			X	X
	Acanthiza pusilla	Brown Thornbill			X	X
	Acanthiza reguloides	Buff-rumped Thornbill			X	
	Gerygone mouki	Brown Gerygone			X	
	Gerygone olivacea	White-throated Gerygone			X	X
	Origma solitaria	Rockwarbler				X
	Pardalotus punctatus	Spotted Pardalote			X	X
	Pardalotus striatus	Striated Pardalote			X	X
	Sericornis frontalis	White-browed Scrubwren			X	X
Passeridae						
	Neochmia temporalis	Red-browed Finch			X	X
	Taeniopygia bichenovii	Double-barred Finch			X	
Petroicidae						
	Eopsaltria australis	Eastern Yellow Robin			X	
Phalacrocoracidae						
	Phalacrocorax melanoleucos	Little Pied Cormorant			X	X
Podicipedidae						
	Tachybaptus novaehollandiae	Australasian Grebe			X	
Psittacidae						

Family Name	Latin Name	Common Name	EPBC Act	TSC Act	Present Survey	Previous Surveys
	Alisterus scapularis	Australian King-Parrot			X	X
	Platycercus elegans	Crimson Rosella			X	X
	Platycercus eximius	Eastern Rosella			X	X
	Psephotus haematonotus	Red-rumped Parrot			X	X
	Trichoglossus haematodus	Rainbow Lorikeet			X	X
Ptilonorhynchidae						
	Ptilonorhynchus violaceus	Satin Bowerbird				X
Rallidae						
	Gallinula tenebrosa	Dusky Moorhen			X	X
	Porphyrio porphyrio	Purple Swamphen				X
Strigidae						
	Ninox novaeseelandiae	Southern Boobook			X	
Threskiornithidae						
	Threskiornis molucca	Australian White Ibis			X	X
	Threskiornis spinicollis	Straw-necked Ibis				X
Turnicidae						
	Turnix varia	Painted Button-quail				X
Zosteropidae						
	Zosterops lateralis	Silvereye			X	X
Mammals - Introduced						X
Bovidae						
	Bos taurus	Cattle (feral)		U	X	X
	Capra hircus	Goat (feral)		U		X
	Ovis aries	Sheep (feral)		U	X	X
Canidae						
	Vulpes vulpes	Fox		U	X	X
Cervidae						
	Cervus elaphus	Red Deer		U		X
Equidae						
	Equus caballus	Horse (feral)		U	X	X
Leporidae						
	Oryctolagus cuniculus	Rabbit		U	X	X
Mammals - Native						X
Macropodidae						
	Macropus giganteus	Eastern Grey Kangaroo			X	
	Wallabia bicolor	Swamp Wallaby			X	X
Pteropodidae						
	Pteropus poliocephalus	Grey-headed Flying-fox	V	V		X
Tachyglossidae						
	Tachyglossus aculeatus	Short-beaked Echidna				X
Vombatidae						
	Vombatus ursinus	Common Wombat			X	X
Reptiles						X

Family Name	Latin Name	Common Name	EPBC Act	TSC Act	Present Survey	Previous Surveys
Agamidae						
	Amphibolurus muricatus	Jacky Lizard				X
	Physignathus lesueurii	Eastern Water Dragon			X	X
Chelidae						
	Chelodina longicollis	Eastern Snake-necked Turtle			X	X
Elapidae						
	Pseudechis porphyriacus	Red-bellied Black Snake				X
Scincidae						
	Ctenotus taeniolatus	Copper-tailed Skink				X
	Eulamprus quoyii	Eastern Water Skink			X	X
	Lampropholis guichenoti	Garden Skink			X	X
Invertebrates						
Camaenidae						
	Meridolum corneovirens	Cumberland Plain Land Snail		E1	X	

Appendix 3

CONSERVATION RATING ACCORDING TO BRIGGS & LEIGH (1996)

Conservation Rating According to Briggs and Leigh (1996)

Briggs and Leigh (1996) list over 5,031 species, subspecies and varieties of plants (5% of native vascular flora of Australia) that have been ranked according to their conservation status. These are known as ROTAPs (Rare Or Threatened Australian Plants). While many of these species are contained within the schedules of various state and federal threatened species legislation (eg. TSC Act and EPBC Act), and are subject to legislative provisions under those acts, a great many more do not and as a such are extraneous to statutory assessment processes.

The modified list below presents the range of codes that are, in various combinations, applied to each listed plant species.

- **1** Species only known from one collection
- **2** Species with a geographic range of less than 100km in Australia
- **3** Species with a geographic range of more than 100km in Australia
- **X** Species presumed extinct; no new collections for at least 50 years
- **E** Endangered species at risk of disappearing from the wild state if present land use and other causal factors continue to operate
- **V** Vulnerable species at risk of long-term disappearance through continued depletion.
- **R** Rare, but not currently considered to be endangered.
- **K** Poorly known species that are suspected to be threatened.
- **C** Known to be represented within a conserved area.
- **a** At least 1,000 plants are known to occur within a conservation reserve(s).
- **i** Less than 1,000 plants are known to occur within a conservation reserve(s).
- **-** The reserved population size is unknown.
- **t** The total known population is reserved.
- + The species has a natural occurrence overseas.

Appendix 4

EP&A ACT ASSESSMENTS OF SIGNIFICANCE

The TSC Act Assessment of Significance is a statutory mechanism under Section 5A of the EP&A Act, as amended by the *Threatened Species Conservation Amendment Act* 2002, for assessing whether a proposed development activity may have a significant impact on threatened species, populations or ecological communities or their habitats. The results of this test are used to determine if a Species Impact Statement is required for each species potentially occurring or known to occur within the Study Area.

When a threatened species is known to occur within the vicinity of the Study Area but is not recorded during the field survey, the presence of potential habitat for this species is used to determine the need to undertake an Assessment of Significance. Where there is no potential habitat in the Study Area for threatened species, there is unlikely to be any impact on these species and therefore Assessments of Significance are not required.

FLORA

Section 5.0 discusses the potential impact of mine subsidence associated with mining of Longwalls 705 to 710 in regards to four EECs and three threatened flora species as listed on the TSC Act. The EEC's included Cumberland Plain Woodland, Shale Sandstone Transition Forest, River-flat Eucalypt Forest Woodland and Moist Shale Woodland. The threatened plant species were *Eucalyptus benthamii*, *Pomaderris brunnea* and *Pterostylis saxicola.*

It was concluded that Assessments of Significance were not required for Cumberland Plain Woodland and Moist Shale Woodland, but it is considered prudent to conduct Assessments of Significance for Shale Sandstone Transition Forest and River-flat Eucalypt Forest. Assessments of Significance have also been prepared for the three plant species.

Endangered Ecological Communities

Shale Sandstone Transition Forest

Shale Sandstone Transition Forest (SSTF) occurs on areas transitional between the clay soils derived from Wianamatta Shale and the sandy soils derived from Hawkesbury Sandstone on the margins of the Cumberland Plain. Shale Sandstone Transition Forest generally occurs on soils derived from shallow shale or clay material overlying sandstone, or where shale-derived materials have washed down over sandstone-derived substrate. Such sites are generally close to the geological boundary between the Wianamatta Shale and the Hawkesbury Sandstone. Shale Sandstone Transition Forest occurs on plateau and hillsides and at the margins of shale capping over sandstone. Many occurrences of SSTF are linear stands of vegetation which may be as narrow as 20 m.

Shale Sandstone Transition Forest occurs in the Study Area, as shown on Figure 4. The impacts of the proposal on SSTF are likely to be minimal but potentially include:

- Fracturing of surface rocks and soil along the Nepean River and other creek banks may damage some tree and plant roots. Any fracturing that does occur is expected to be minor in nature and located in isolated areas within the limit of subsidence;
- The emission of gas at the surface may adversely affect flora and fauna, although this is not normally a major issue, since such emissions tend to be localised, temporary events and the consequences are generally minor. In the unlikely event that vegetation dieback was observed, it is likely that these areas would be isolated and relatively small in size and not represent a significant impact to terrestrial flora and fauna within the

Study Area. Any such impacts are short lived and regeneration is known to occur rapidly; and,

- Large-scale slope failure is considered unlikely. Impacts on steep slopes are not anticipated to have a significant impact on terrestrial flora and fauna values as cliff instabilities are predicted to be minor.

Changes to water flows are predicted to be minor and are not likely to impact on the occurrence of SSTF in the Study Area as this plant community is terrestrial and is not reliant on surface water flows.

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 to Endangered Ecological Communities.

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 to Endangered Ecological Communities.

c) In the case of a critically endangered or endangered ecological community, whether the action proposed:

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

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.

Shale Sandstone Transition Forest occurs or has occurred in the Bankstown, Baulkham Hills, Blue Mountains, Campbelltown, Hawkesbury, Liverpool, Parramatta, Penrith, and Wollondilly Local Government Areas (TSC Act Final Determination Gazetted 11/9/1998). The estimated current extent of the community ranges from 7,918 to 16,264 ha, which is a 60-80% decline from its estimated pre-European extent (DEH 2005). Small areas of SSTF are presently included in three conservation reserves, Blue Mountains National Park, Cattai National Park and Gulguer Nature Reserve.

The potential impacts of subsidence are described in MSEC (2008) and summarised in Section 2.5 of this report. None of the SSTF that occurs in the

Study Area is to be cleared; therefore the extent of the community is unlikely to be adversely affected by the proposal.

Potential impacts of subsidence that may result in modification of the composition of the community include potential surface cracking, slope slippage and gas emissions. Such impacts may result in localised loss of individual plants. It is worth noting that assessments of areas previously affected by gas emission in the Cataract Gorge indicate that regeneration of the potential habitat following gas emissions is good and large trees appear to be unaffected. It is therefore considered unlikely that the proposal would affect the composition of SSTF in the Study Area such that its local occurrence is likely to be placed at risk of extinction.

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

the extent to which habitat is likely to be removed or modified as a result of the action proposed, and

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 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.

Habitat for SSTF occurs on plateau and hillsides and at the margins of shale capping over sandstone, on the margins of the Cumberland Plain. No habitat for SSTF would be removed by the proposal. It is therefore unlikely that any area of potential habitat for this community will become isolated from interconnecting or proximate areas of habitat as a result of the proposal.

This plant community is widespread in the locality and also regionally within the Nepean River gorge and tributaries. The proposed mining activities are unlikely to modify this plant community within the Study Area and given the regional distribution of this community it is highly unlikely to result in a threat to the long term survival of this community.

Any modification of habitat caused by subsidence would be localised and minor, and would not affect the long term survival of the community in the locality.

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

Critical habitats are areas of land that are crucial to the survival of particular threatened species, populations and ecological communities. Under the TSC Act,

the Director-General maintains a register of critical habitat. To date, no critical habitat has been declared for this community (NPWS Threatened Species Unit).

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

The recovery of SSTF is being addressed as part of the Cumberland Plain Endangered Ecological Communities Recovery Plan, which is currently being drafted. The proposal is unlikely to interfere with the recovery of this community as no areas are proposed to be cleared and indirect impacts are likely to be minor and temporary if impacts occur at all.

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.

Key Threatening Processes (KTP) are listed on Schedule 3 of the TSC Act. Subsidence resulting from longwall mining is listed as a KTP on the TSC Act, and SSTF is listed as a community for which habitat may be altered by subsidence or mining related activities. However, additional assessments are not required by the minister as existing systems are accepted as thorough.

The potential impacts of subsidence are described in MSEC (2008) and summarised in Section 2.5 of this report. Impacts of subsidence relevant to SSTF include potential surface cracking, slope slippage and gas emissions. Any impacts resulting from these are expected to be localised and minor. As such, though the impacts may potentially cause the localised loss of individual plants (although this is considered to be unlikely), such impacts are unlikely to have a significant impact on the functioning of this ecological community.

A large proportion of the area where SSTF occurred in the past has been cleared for agriculture and urban development. Patches are small and scattered. Identified threats include: clearing, physical damage from recreational activities, rubbish dumping, grazing, mowing and weed invasion. The proposed action is unlikely to result in a significant increase in these threatening processes.

Conclusion:

The proposed development is unlikely to have a significant impact on Shale Sandstone Transition Forest. A Species Impact Statement is not recommended.

River-flat Eucalypt Forest

River-flat Eucalypt Forest (RFEF) occurs on periodically inundated alluvial flats, drainage lines and river terraces associated with coastal floodplains. The structure of the community may vary from tall open forests to woodlands. The community forms a complex of forested wetland and treeless wetland communities found throughout the coastal floodplains of NSW.

River-flat Eucalypt Forest occurs in the Study Area, as shown in Figure 4. The impacts of the proposal on RFEF are likely to be minimal if they occur at all and potentially include:

- Fracturing of surface rocks and soils along the Nepean River and other creek banks may damage some tree and plant roots. Any fracturing that does occur is expected to be minor in nature and located in isolated areas within the limit of subsidence;

- The predicted uplift of the valley floor may result in some desiccation of the banks within small sections of the Nepean River, although the area of land that may be affected by desiccation during and after mining is very small, due to the steepness of the river banks;

- Potential surface water flow diversions may occur into subterranean layers, rock bar leakages and groundwater infiltration through fractured or buckled bedrock strata. For the current proposal the potential for surface water flow diversion or rockbar leakage is very low for the Nepean River as it is a flooded valley within the Study Area and the gradient of the river is very flat. Surface cracking could lead to the short-term draining of pools found in tributaries of the Nepean River, resulting in the absence of surface flows along sections of the creeks/drainage line. The remaining smaller, unnamed tributaries within the Study Area were found to be ephemeral and mostly dry. In which case MSEC (2008) state that the majority of the runoff would flow over the beds of these watercourses and would not divert into the dilated strata. Thus loss of surface water as a result of mining Longwalls 705 to 710 is unlikely to significantly impact terrestrial plant communities.

- The emission of gas at the surface may adversely affect flora and fauna, although this is not normally a major issue, since such emissions tend to be localised, temporary events and the consequences are generally minor. In the unlikely event that vegetation dieback was observed, it is likely that these areas would be isolated and relatively small in size and not represent a significant impact to terrestrial flora and fauna within the

Study Area. Any such impacts are short lived and regeneration is known to occur rapidly; and,

- Large-scale slope failure is considered unlikely. Impacts on steep slopes are not anticipated to have a significant impact on terrestrial flora and fauna values as the predicted cliff instabilities are predicted to be minor.

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 to Endangered Ecological Communities.

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 to Endangered Ecological Communities.

c) In the case of a critically endangered or endangered ecological community, whether the action proposed:

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

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.

This community occurs in the NSW North Coast, Sydney Basin and South-east Corner Bioregions. River-flat Eucalypt Forest is known from parts of the Local Government Areas of Port Stephens, Maitland, Singleton, Cessnock, Lake Macquarie, Wyong, Gosford, Hawkesbury, Baulkham Hills, Blacktown, Parramatta, Penrith, Blue Mountains, Fairfield, Holroyd, Liverpool, Bankstown, Wollondilly, Camden, Campbelltown, Sutherland, Wollongong, Shellharbour, Kiama, Shoalhaven, Palerang, Eurobodalla and Bega Valley, but may occur elsewhere in these bioregions. It is estimated that less than 10,000 ha of RFEF occurs in the area between Sydney and Moruya, of which more than three quarters occurs on the Cumberland Plain (NSW Scientific Committee 2004).

RFEF occurs in the Study Area adjacent to the Nepean River and as scattered patches along smaller creeks and drainage lines. The potential impacts of subsidence are described in MSEC (2008) and summarised in Section 2.5. None

of the RFEF in the Study Area would be cleared by the proposal. Therefore the extent of the community in the locality is unlikely be affected by the proposal.

Although unlikely, impacts of subsidence that may potentially affect the composition of RFEF include potential surface cracking, desiccation, loss of surface water flows, slope slippage and gas emissions. Any impacts resulting from these are expected to be localised and/or minor and may potentially cause the localised, short term loss of some individual plants. It is worth noting that assessments of areas previously affected by gas emission in the Cataract Gorge indicate that regeneration of the potential habitat following gas emissions is very good and large trees appear to be unaffected. It is therefore considered unlikely that such impacts would affect the composition of RFEF in the Study Area such that its local occurrence is likely to be placed at risk of extinction.

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

the extent to which habitat is likely to be removed or modified as a result of the action proposed, and

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 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.

Habitat for this community occurs on periodically inundated alluvial flats, drainage lines and river terraces associated with coastal floodplains. No habitat for RFEF would be removed as a result of the proposal, therefore it is unlikely that any area of potential habitat for this community will become isolated from interconnecting or proximate areas of habitat. Any modification of habitat due to subsidence would be localised and minor. Any loss of surface water as a result of mining Longwalls 705 to 710 is considered unlikely to significantly modify habitat for RFEF. While changes to surface water flows have the potential to modify habitat for RFEF, the current proposal does not involve mining beneath the Nepean River, thus the potential for subterranean flow diversion or leakage is very low. The remaining smaller, unnamed tributaries within the Study Area were found to be ephemeral and mostly dry, therefore the majority of the runoff would flow over the beds of these watercourses and would not divert into the dilated strata. The proposal is therefore unlikely to affect the long term survival of this community in the locality.

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

Critical habitats are areas of land that are crucial to the survival of particular threatened species, populations and ecological communities. Under the TSC Act, the Director-General maintains a register of critical habitat. To date, no critical habitat has been declared for this community (NPWS Threatened Species Unit).

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

To date, no recovery plan or threat abatement plan has been prepared for this community. The proposal is unlikely to interfere with the recovery of this community given no areas are proposed to be cleared and potential indirect impacts are likely to be temporary, localised and minor.

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.

Key Threatening Processes (KTP) are listed on Schedule 3 of the TSC Act. Alteration of habitat following subsidence due to longwall mining is listed as a KTP on the TSC Act. River-flat Eucalypt Forest is not listed as a community whose habitat may be altered by subsidence and mining associated activities.

The potential impacts of subsidence are described in MSEC (2008) and summarised in Section 2.5. Impacts of subsidence relevant to RFEF include potential surface cracking, desiccation, loss of surface water flows, slope slippage and gas emissions. Any impacts resulting from these are expected to be localised and/or minor. As such they may potentially cause the localised loss of individual plants. Such impacts (if they occur at all) are unlikely to have a significant impact on the functioning of this ecological community. While changes to surface water flows have the potential to cause a significant impact on RFEF, the current proposal does not involve mining beneath of the Nepean River, thus the potential for subterranean flow diversion or leakage is very low. The remaining smaller, unnamed tributaries within the Study Area were found to be ephemeral and mostly dry, therefore the majority of the runoff would flow over the beds of these watercourses and would not divert into the dilated strata.

It is therefore considered unlikely that the proposal would significantly impact this community.

Conclusion:

The proposed development is unlikely to have a significant impact on River-flat Eucalypt Forest. A Species Impact Statement is not recommended.

Threatened Flora Species

Eucalyptus benthamii

Eucalyptus benthamii is listed as a Vulnerable species on the TSC Act (NSW Scientific Committee 1997a). The original habitat for *E. benthamii* was to the south-west of Sydney on the flats of the Nepean River and its tributaries, particularly the Coxs River (Benson 1985). Two populations are known: along the Nepean River between Wallacia and Camden and another (larger) population on Kedumba Creek (Benson 1985). Seventy four records of *E. benthamii* are listed in the *Atlas of NSW Wildlife*, many of which occur within Blue Mountains and Nattai National Parks. The species is known from two main localities: Camden and Kedumba (NSW Scientific Committee 1997a)

Eucalyptus benthamii was not recorded in the Study Area and it has not been previously recorded within 10 km of the Study Area (Figure 5). Potential habitat exists in the Study Area within River-flat Eucalypt Forest adjacent to the Nepean River.

Impacts associated with the proposed longwall mining (see MSEC (2008) and Section 2.5) may result in indirect impacts on potential habitat of *E. benthamii*, with subsidence predictions including potential surface cracking, desiccation, loss of surface water flows, slope slippage and gas emissions. Any impacts resulting from these are expected to be localised and/or minor.

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.

The proposed longwall mining will not involve the direct removal of any individuals of *E. benthamii*, but may result in some impacts to potential habitat for the species. The predicted impacts to the potential habitat for the species are considered minimal.

Eucalyptus benthamii is known to require a combination of deep alluvial sands and a flooding regime that permits seedling establishment (DEC, 2005c). Desiccation of the Nepean River is considered unlikely to occur as a result of the proposed longwall mining as the Nepean River is a flooded valley (MSEC 2008). MSEC (2008) predicts that the water level along the Nepean River will remain essentially unchanged after mining. Predicted uplift of the valley floor may result in some desiccation of the banks within small sections of the Nepean River, although the area of land that may be affected is very small (MSEC 2008). Further, the drainage lines in the Study Area may be affected by increased flooding and ponding, however this is predicted to be minor and not impact the drainage lines significantly (MSEC 2008).

It is considered unlikely that the proposed activities would result in disruption to the lifecycle of a viable local population of this species.

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.

An endangered population is defined under the TSC Act as 'a population specified in Part 2 of Schedule 1'. At the present time, there are no endangered populations of this species listed under the Act.

c) In the case of a critically endangered or endangered ecological community, whether the action proposed:

> **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**
>
> **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.**

Not applicable to threatened species.

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

> **the extent to which habitat is likely to be removed or modified as a result of the action proposed, and**
>
> **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 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.**

Potential habitat for *E. benthamii* within the Study Area that may be impacted by subsidence is within River-flat Eucalypt Forest. Potential habitat for this species occurs throughout the region in this plant community. *Eucalyptus benthamii* has not been previously recorded within a 10 km radius of the Study Area in the Atlas of NSW Wildlife (Figure 5). *Eucalyptus benthamii* is known from two main localities: Camden and Kedumba (NSW Scientific Committee 1997a). The Study Area is therefore to the southeast of the known distribution of this species.

The proposed works will not involve clearing of any potential habitat for the species, and therefore is not likely to isolate currently interconnecting or proximate areas of habitat for *E. benthamii*. The proposal may result in indirect impacts to potential habitat, with subsidence predictions including potential surface cracking, desiccation, loss of surface water flows, slope slippage and gas emissions. The impacts are, however, predicted to be minor: no vegetation is required to be cleared, desiccation of banks is expected to be minimal and localised, surface flows are unlikely to change, and fracturing, cliff falls and erosion of steep slopes are considered to be unlikely and/or minimal (MSEC 2008).

Habitat for this species occurs on the alluvial flats along the Nepean River and its tributaries both within the Study Area and more broadly within the region. These habitat types are widespread within the Nepean River gorge and tributary creeks which suggests that the amount of available habitat for this species within the Study Area, compared to the regional distribution of similar habitats, is not likely to be significant to the long term survival of the species. Further, the subsidence predictions summarised in this report suggest that potential habitat for this species is unlikely to be significantly impacted by the proposal, further reducing any potential impact to the species as a whole.

In addition, assessments of areas previously affected by gas emission in the Cataract Gorge indicate that regeneration of the potential habitat following gas emissions is very good and large trees appear to be unaffected.

Considering the nature of the predicted impacts, the proposal is unlikely to affect the long term survival of this species in the locality.

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

Critical habitats are areas of land that are crucial to the survival of particular threatened species, populations and ecological communities. Under the TSC Act, the Director-General maintains a register of critical habitat. To date, no critical habitat has been declared for this species (DEC Threatened Species Unit).

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

To date, no recovery plan has been prepared for this species. The proposal is unlikely to affect the recovery of this species.

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.

No vegetation clearing activities are required for the proposed longwall mining. Alteration of habitats following subsidence due to longwall mining is listed as a KTP on Schedule 3 of the TSC Act. Impacts of subsidence on the potential habitat for *E. benthamii* are predicted to be minimal.

Conclusion:

It is not likely that a population of *E. benthamii* is at risk of extinction for the following reasons:

- No individuals or potential habitat for the species will be cleared as a result of the proposal.
- The proposal is not likely to have an impact on the lifecycle of the species.
- The proposal is not likely to fragment or isolate known or potential habitat.
- No critical habitat for the species will be impacted.
- The proposal is not likely to interfere with the recovery of the species.

For these reasons it is considered unlikely that the proposed mining of Longwalls 705 to 710 would have a significant impact on this species. A Species Impact Statement is not recommended.

Pomaderris brunnea

Pomaderris brunnea is listed as a Vulnerable species on the TSC Act. It is a shrub 2-3 m high, stems with long spreading brownish simple hairs above a short whitish tomentum (Harden and Murray 2000). Its habitat is open forest, confined to the Colo River and Upper Nepean River (Harden and Murray 2000). *Pomaderris brunnea* was not recorded in the Study Area; however, the species has been recorded in a number of locations within a 10 km radius of the Study Area (Figure 5):

- Approximately 6 km to the north of the Study Area
- Approximately 1 km to the south of the Study Area.

Potential habitat for *P. brunnea* occurs in the Study Area within River-flat Eucalypt Forest.

Impacts associated with the proposed longwall mining (see MSEC (2008) and Section 2.5) may result in indirect impacts on potential habitat of *P. brunnea*,

with subsidence predictions including potential surface cracking, desiccation, loss of surface water flows, slope slippage and gas emissions. Any impacts resulting from these are expected to be localised and/or minor.

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.

The proposed longwall mining will not involve the direct removal of any individuals of *P. brunnea*, but may result in some minor impacts to potential habitat for the species. The predicted impacts to the potential habitat for the species are considered to be localised and minor.

It is considered unlikely that the proposed activities would result in disruption to the lifecycle of a viable local population of this species.

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.

An endangered population is defined under the TSC Act as 'a population specified in Part 2 of Schedule 1'. At the present time, there are no endangered populations of this species listed under the Act.

c) In the case of a critically endangered or endangered ecological community, whether the action proposed:

> **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**
>
> **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.**

Not applicable to a threatened species.

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

> **the extent to which habitat is likely to be removed or modified as a result of the action proposed, and**
>
> **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 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.

Pomaderris brunnea is known from the Colo River, the Nepean River floodplain at Menangle, in creeklines at Wirrumbirra Sanctuary (Bargo) and on the Hawkesbury River (DEWHA, 2008b). Potential habitat for *P. brunnea* within the Study Area that may be impacted by subsidence occurs within River-flat Eucalypt Forest. Potential habitat for this species occurs throughout the region in this plant community. There are numerous previous recordings of this species on the DECC Atlas of NSW Wildlife within a 10 km radius of the Study Area, to the north and south of the Study Area (Figure 5).

The proposed works will not involve clearing of any potential habitat for the species; therefore the proposal is not likely to isolate currently interconnecting or proximate areas of habitat for *P. brunnea*. The proposal may result in indirect impacts to potential habitat, with subsidence predictions including potential surface cracking, desiccation, loss of surface water flows, slope slippage and gas emissions. The impacts are, however, predicted to be minimal, as no vegetation is required to be cleared, desiccation of banks is expected to be minimal and localised, surface flows are unlikely to change and, fracturing, cliff falls and erosion of steep slopes are considered to be unlikely and/or minimal (MSEC 2008).

Habitat for his species is relatively restricted within the region to the upper Nepean River which suggests that the amount of available habitat for this species within the Study Area, compared to the regional distribution of similar habitats, may have some significance for the long term survival of the species should it occur within the Study Area. However, the subsidence predictions summarised in this report suggest that potential habitat for this species is unlikely to be significantly impacted by the proposal, reducing any potential impact to the species as a whole.

Considering the nature of the predicted impacts, the proposal is considered unlikely to affect the long term survival of the species in the locality.

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

Critical habitats are areas of land that are crucial to the survival of particular threatened species, populations and ecological communities. Under the TSC Act, the Director-General maintains a register of critical habitat. To date, no critical habitat has been declared for this species (DEC Threatened Species Unit).

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

To date, no recovery plan or threat abatement plan has been prepared for this species. The proposal is unlikely to interfere with the recovery of this species.

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.

No vegetation clearing activities are required for the proposed longwall mining. Alteration of habitats following subsidence due to longwall mining is listed as a KTP on Schedule 3 of the TSC Act. *Pomaderris brunnea* is not listed as a species known to occur in areas affected by subsidence due to longwall mining. Impacts of subsidence on the potential habitat for *P. brunnea* are predicted to be minimal.

Conclusion

It is not likely that a population of *Pomaderris brunnea* is at risk of extinction for the following reasons:

- No individuals or potential habitat for the species will be cleared as a result of the proposal.
- The proposal is not likely to have an impact on the lifecycle of the species.
- The proposal is not likely to fragment or isolate known or potential habitat.
- No critical habitat for the species will be impacted.
- The proposal is not likely to interfere with the recovery of the species.

For these reasons it is considered unlikely that the proposed mining of Longwalls 705 to 710 would have a significant impact on this species. A Species Impact Statement is not recommended.

Pterostylis saxicola

Pterostylis saxicola is listed as Endangered in Schedule 1 of the TSC Act. *Pterostylis saxicola* is a ground orchid, which has a preference for the shale-sandstone interface (T. James *pers. comm*.) The species is commonly found growing in small pockets of shallow soil in depressions on sandstone rock shelves above cliff lines (NSW Scientific Committee 1997c).

Pterostylis saxicola was not recorded in the Study Area. However, potential habitat exists in the Study Area in Shale Sandstone Transition Forest, specifically rock shelves above cliff lines, which may potentially be impacted by subsidence.

Impacts associated with the proposed longwall mining may result in indirect impacts on potential habitat of *Pterostylis saxicola*, with subsidence predictions including potential surface cracking, slope slippage and gas emissions. Any impacts resulting from these are expected to be localised and/or minor.

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.

The proposed longwall mining will not involve the direct removal of any individuals of *Pterostylis saxicola*, but may result in some impacts to potential habitat for the species. The predicted impacts to the potential habitat for the species are considered minimal.

The following is known about the lifecycle of *Pterostylis saxicola* (DEC, 2005s):

- All species of *Pterostylis* are deciduous and die back to fleshy, rounded underground tuberoids
- The time of emergence and withering has not been recorded for this species
- Flowering occurs from October to December and may vary due to climatic conditions
- The above ground parts of the plant whither and die following seed dispersal and the plant persists as a tuberoid until the next year.

The proposal is not likely to interfere with the lifecycle of the species. It is considered unlikely that the proposed activities would place a viable local population of the species at risk of extinction.

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.

An endangered population is defined under the TSC Act as ‘a population specified in Part 2 of Schedule 1’. At the present time, there are no endangered populations of this species listed under the Act.

c) In the case of a critically endangered or endangered ecological community, whether the action proposed:

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

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.

Not applicable to threatened species.

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

the extent to which habitat is likely to be removed or modified as a result of the action proposed, and

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 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.

Pterostylis saxicola is known only from five localities: Georges River National Park (near Yeramba Lagoon), Ingleburn, Holsworthy, Peter Meadows Creek and St Marys Towers near Douglas Park (NSW Scientific Committee 1997c). Potential habitat for *P. saxicola* within the Study Area that may be impacted by subsidence is within Shale Sandstone Transition Forest. There is one previous recording of this species on the *Atlas of NSW Wildlife* within a 10 km radius of the Study Area, approximately 2.5 km to the south-west of the Study Area (Figure 5).

The proposed longwall mining will not involve clearing of any potential habitat for the species; therefore the proposal is not likely to isolate currently interconnecting or proximate areas of habitat for *P. saxicola*. The proposal may result in indirect impacts to potential habitat, with subsidence predictions including potential surface cracking, slope slippage and gas emissions. The MSEC report notes that none of the rock shelves and overhang structures are likely to be impacted by the extraction of Longwalls 705 to710. Potential impacts such as fracturing, cliff falls and erosion of steep slopes are considered to be unlikely and/or minimal.

Habitat for this species is described somewhat broadly as small pockets of shallow soil in depressions on sandstone rock shelves above cliff lines (DEC, 2005s). The plant communities above the shelves where *Pterostylis saxicola* occurs are sclerophyll forest or woodland on shale/sandstone transition soils or shale soils (DEC, 2005s). These habitat types are widespread within the Nepean River gorge and tributary creeks which suggests that the amount of available habitat for this species within the Study Area, compared to the regional distribution of similar habitats, may not be significant to the long term survival of the species. Further, the subsidence predictions summarised in this report suggest that potential habitat for this species is highly unlikely to be impacted by the proposed development, further reducing any potential impact to the species as a whole.

It is considered highly unlikely that the proposal will have a significant impact on potential habitat for *P. saxicola*. Considering the nature of the predicted impacts, the proposal is considered unlikely to affect the long term survival of *P. saxicola* in the locality.

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

Critical habitats are areas of land that are crucial to the survival of particular threatened species, populations and ecological communities. Under the TSC Act, the Director-General maintains a register of critical habitat. To date, no critical habitat has been declared for this species (DEC Threatened Species Unit).

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

To date, no recovery plan has been prepared for this species. The proposal is unlikely to interfere with the recovery of this species.

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.

Alteration of habitats following subsidence due to longwall mining is listed as a KTP on Schedule 3 of the TSC Act. *Pterostylis saxicola* is not listed as a species known to occur in areas affected by subsidence due to longwall mining. Impacts of subsidence on the potential habitat for *P. saxicola* are predicted to be minimal. No vegetation clearing activities are required for the proposed longwall mining.

Conclusion

Pterostylis saxicola is known to occur within 10 km of the Study Area, it was not recorded during the field surveys for this assessment and the Study Area is at the southern limit of the known distribution for this species.

It is not likely that a population of *Pterostylis saxicola* is at risk of extinction due to the proposed longwall mining and therefore it is considered unlikely that the proposed development would have a significant impact on this species. A Species Impact Statement is not recommended.

FAUNA

Section 5.0 discusses the potential impact of mine subsidence associated with mining of Longwalls 705 to 710 in regards to threatened fauna. Assessments of Significance have been prepared for four animal species: Red-crowned Toadlet, Giant Burrowing Frog, Littlejohn's Tree Frog, and Large-footed Myotis.

Threatened Fauna Species

Giant Burrowing Frog *Heleioporus australiacus*

The Giant Burrowing Frog is listed as Vulnerable on Schedule 2 of the TSC Act. This species is also listed as Vulnerable on the EPBC Act. This species prefers hanging swamps on sandstone shelves adjacent to perennial non-flooding creeks. It can also occur within shale outcrops within sandstone formations. In the southern part of its range it can occur in wet and dry forests, montane sclerophyll woodland and montane riparian woodland (Daly 1996). Individuals can be found around sandy creek banks or foraging along ridge-tops during or directly after heavy rain. Males often call from burrows located in sandy banks next to water (Barker *et al.* 1995).

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.

Subsidence beneath watercourses has the potential to result in surface cracking, which could lead to the short-term draining of pools, resulting in the absence of surface flows along sections of the river. This species breeds in relatively large and deep pools due to their slow maturation time. Loss of water from pools is likely to reduce the available breeding habitat for this species.

The potential for surface water flow diversion or rockbar leakage caused by the proposal is very low within the Nepean River as it is a flooded valley and the gradient of the river is very flat. Surface cracking could lead to the short-term draining of pools found in tributaries of the Nepean River, resulting in the absence of surface flows along sections of the creeks/drainage line. However, the majority of tributaries within the Study Area were found to be ephemeral and mostly dry, MSEC (2008) state that the majority of the runoff would flow over the beds of these watercourses and would not divert into the dilated strata.

Based on the subsidence impact assessment provided by MSEC (2008) it is considered unlikely that surface water flows in the Nepean River and its tributaries would be impacted significantly.

Given that further habitat for the Giant Burrowing Frog occurs within the vicinity of the area and in the greater region, it is considered that the potential short-term loss of some surface water flows within the Study Area is unlikely to have a significant impact on this species. Furthermore, this species was not recorded during the current assessment and there are no records for this species within 5 km of the Study Area. It is unlikely that the proposed activity would disrupt the lifecycle of this species such that a viable local population would be placed at risk of extinction.

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.

An endangered population is defined under the TSC Act as 'a population specified in Part 2 of Schedule 1'. At the present time, there are no endangered populations of this species listed under the Act.

c) In the case of a critically endangered or endangered ecological community, whether the action proposed:

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

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.

Not applicable to threatened species.

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

the extent to which habitat is likely to be removed or modified as a result of the action proposed, and

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 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.

This species ranges from the central coast of New South Wales to the Highlands of Victoria with the majority of records from the Sydney Basin (DECC 2005x). Locally this species occurs in Dharawal State Conservation Area and the

Metropolitan Special Area, with the closest records to the Study Area being approximately 6 km to the east (Figure 6)

Within the Study Area potential habitat for this species exists predominantly along the Nepean River and tributaries. This habitat is considered to be probably only marginal and therefore unlikely to be critical to the long term survival of the species in the locality. Other drainage lines such as Foot Onslow Creek, Harris Creek and Navigation Creek are not considered potential habitat for this species.

The subsidence impact assessment provided by (MSEC 2008) suggests that it is unlikely that all the surface water flows within the Study Area would be significantly disturbed by subsidence, if any. Since subsidence impacts on habitat of this species within the Study Area will be patchy, both spatially and temporally, areas of currently interconnecting or proximate habitat are unlikely to be further isolated.

While there is marginal potential habitat for this species within the Study Area, the area of habitat for this species that may be impacted by subsidence is small and it is unlikely that suitable habitat would be removed significantly modified or fragmented.

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

Critical habitats are areas of land that are crucial to the survival of particular threatened species, populations and ecological communities. Under the TSC Act, the Director-General maintains a register of critical habitat. To date, no critical habitat has been declared for this species (DECC Threatened Species Unit).

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

There is currently no recovery plan for the Giant Burrowing Frog. However, the DECC has prepared 19 Priority Actions to help recover this species. None of which are relevant to the current proposal.

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.

KTPs are listed under Schedule 3 of the TSC Act. KTPs relevant to the Proposal that may impact on known and potential habitat for the Giant Burrowing Frog include:

- 'Alteration of habitat following subsidence due to longwall mining' – known and potential habitat for the Giant Burrowing Frog occurs within

creek lines with sandy soils and ridge lines; all of which are known and/or likely to be vulnerable to the effects of subsidence;

- 'Alteration to the natural flow regimes of rivers, streams, floodplains and wetlands' – Giant Burrowing Frogs require first or second order creeks and ponded drainage lines for breeding. Loss of water or changes to flow patterns could impact on the species;

For reasons already discussed the proposal is unlikely to result in the loss of significant habitat for this species.

Conclusion:

The proposed development is unlikely to have a significant impact on this species. A Species Impact Statement is not recommended.

Large-footed Myotis *Myotis macropus*

The Large-footed Myotis is listed as Vulnerable on Schedule 2 of the TSC Act. This species is mainly a coastal bat species which occurs in eastern and northern Australia, ranging from the Kimberley in Western Australia to Victoria and South Australia (Churchill 1998). The Large-footed Myotis is regarded as having a primarily coastal distribution but may occur further inland along major rivers (Churchill 1998).

This species has been recorded in mangroves, paperbark swamps and in a range of forest and woodland habitats, but only near permanent water bodies, including streams, lakes and reservoirs (Churchill 1998). The Large-footed Myotis are cave dwellers but are also known to roost in tree hollows, under bridges, in clumps of vegetation and in mine tunnels and stormwater drains (Hoye and Richards 1995, Churchill 1998, Menkhorst and Knight 2001). Roosts are usually in close proximity to water over which the bats forage. The large feet and hind claws are used to rake the water surface for insects and small fish (Churchill 1998), however, this species is also capable of foraging aerially (Menkhorst and Knight 2001).

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.

The Large-footed Myotis is commonly known as a cave dweller, but has been known to roost in mines, tree hollows, tunnels, stormwater drains and under bridges. The proposed activity is unlikely to have a significant effect on the breeding habitat for this species. However, the Large-footed Myotis forages along streams and pools where it feeds on insects and small fish by trawling its

feet across the water surface. Loss of pools in creeks as a result of subsidence may reduce the overall foraging area available to individuals.

The potential for surface water flow diversion or rockbar leakage caused by the proposal is very low within the Nepean River as it is a flooded valley and the gradient of the river is very flat. Surface cracking could lead to the short-term draining of pools found in tributaries of the Nepean River, resulting in the absence of surface flows along sections of the creeks/drainage line. The majority of these tributaries within the Study Area were found to be ephemeral and mostly dry, MSEC (2008) state that the majority of the runoff would flow over the beds of these watercourses and would not divert into the dilated strata.

Based on the subsidence impact assessment provided by MSEC (2008), it is considered unlikely that surface water flows in the Nepean River and its tributaries would be impacted significantly. Given the mobility of this species and further foraging resources within the vicinity of the Study Area, it is unlikely that the potential short-term loss of some pools within the Study Area would disrupt the lifecycle of the species such that a viable local population would be placed at risk of extinction.

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.

An endangered population is defined under the TSC Act as ‘a population specified in Part 2 of Schedule 1’. At the present time, there are no endangered populations of this species listed under the Act.

c) In the case of a critically endangered or endangered ecological community, whether the action proposed:

> **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**
>
> **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.**

Not applicable to threatened species.

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

the extent to which habitat is likely to be removed or modified as a result of the action proposed, and

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 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.

This species is mainly a coastal species occurring along the length of NSW. It has also been recorded occasionally along major inland rivers such as the Murray (Churchill 1998). Regionally this species has been recorded from the Woronora, O'Hares Creek and Metropolitan Special Areas (DECC 2007a). This species has been recorded within the Study Area in the Nepean River Gorge and to the east of the Nepean River.

The subsidence impact assessment provided by (MSEC 2008) suggests that it is unlikely that surface water flows within the Study Area would be substantially reduced. Therefore, it is unlikely that foraging habitat (mostly in the open water of the Nepean River) is likely to be removed or significantly modified as a result of the proposed action. Breeding habitat (caves or tree hollows) is unlikely to be affected by the proposal. It is unlikely that currently interconnecting or proximate areas of habitat will be further isolated.

While there is potential habitat for this species within the Study Area, the area of foraging habitat for this species that may be impacted by subsidence is small compared to the potential habitat within the local area. It is therefore unlikely that the proposal would affect the long term survival of the species in the locality.

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

Critical habitats are areas of land that are crucial to the survival of particular threatened species, populations and ecological communities. Under the TSC Act, the Director-General maintains a register of critical habitat. To date, no critical habitat has been declared for this species (DECC Threatened Species Unit).

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

To date, no recovery or threat abatement plans have been prepared for this species. However, the DECC has prepared 15 Priority Actions to help recover this species. Those relevant to the Proposal are outlined below

- Encourage recovery of natural hydrological regimes, including retention and rehabilitation of riparian vegetation, -subsidence has the potential to impact riparian vegetation by gas emissions and water loss, although, such impacts are predicted to be unlikely and/or insignificant

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.

KTPs are listed under Schedule 3 of the TSC Act. KTPs relevant to the Proposal that may impact on known and potential habitat for the Large-footed Myotis include:

- Alteration to the natural flow regimes of rivers, streams, floodplains & wetlands.
- Alteration of habitat following subsidence due to longwall mining.

For reasons already discussed the proposal is unlikely to result in the loss of significant habitat for this species.

Conclusion:

The proposed activities are considered unlikely to have a significant impact on this species, a Species Impact Statement is not recommended.

Littlejohn's Tree Frog *Litoria littlejohni*

This species is listed as Vulnerable on Schedule 2 of the TSC Act and Vulnerable on the EPBC Act. Habitat for this species includes wet and dry sclerophyll forests associated with sandstone outcrops on the eastern slopes of the Great Dividing Range (Barker *et al.* 1995). This species prefers rocky, flowing streams, but individuals have also been collected from semi-permanent dams with some emergent vegetation (Barker *et al.* 1995). It forages both in the tree canopy and on the ground, and has been observed sheltering under rocks on high exposed ridges during summer. It is not known from coastal habitats.

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.

Littlejohn's Tree Frog breeds in deep permanent pools in slow moving creeks within heath or woodland, but is also known to breed in temporary isolated pools. One of the potential impacts of subsidence is the short-term loss of

surface water within the creek habitat, which may reduce the available breeding habitat for this species.

The potential for surface water flow diversion or rockbar leakage caused by the proposal is very low within the Nepean River as it is a flooded valley and the gradient of the river is very flat. Surface cracking could lead to the short-term draining of pools found in tributaries of the Nepean River, resulting in the absence of surface flows along sections of the creeks/drainage line. However, the majority of tributaries within the Study Area were found to be ephemeral and mostly dry. MSEC (2008) states that the majority of the runoff would flow over the beds of these watercourses and would not divert into the dilated strata. Therefore, it is unlikely that all the pools located on tributaries of the Nepean River within the Study Area would be disturbed by subsidence, if any.

This species has not been recorded within the Study Area and the potential short-term loss of some surface water flows within the Study Area is unlikely to have a significant impact on this species. For these reasons it is unlikely that the proposed activity would disrupt the lifecycle of the species such that a viable local population would be placed at risk of extinction.

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.

An endangered population is defined under the TSC Act as 'a population specified in Part 2 of Schedule 1'. At the present time, there are no endangered populations of this species listed under the Act.

c) In the case of a critically endangered or endangered ecological community, whether the action proposed:

> **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**
>
> **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.**

Not applicable to threatened species.

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

the extent to which habitat is likely to be removed or modified as a result of the action proposed, and

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 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.

In NSW this species is distributed along the eastern slopes of the Great Dividing Range from Watagan State Forest near Wyong, south to Buchan in north-eastern Victoria (DEC 2005). This species is known from the nearby Dharawal State Conservation Area and Metropolitan Special Areas. While there is marginal habitat for this species within the Study Area, the area of habitat for this species that may be impacted by the proposed activity is small compared to the area of potential habitat within the region.

The subsidence impact assessment provided by MSEC (2008) suggests that it is unlikely that surface flows within the Study Area would be significantly disturbed by subsidence. Therefore, it is unlikely that breeding habitat (pools of water) will be removed or significantly modified as a result of the proposed action. Since subsidence impacts on potential habitat for this species within the Study Area will be patchy (if they occur), both temporally and spatially, areas of currently interconnecting or proximate habitat are unlikely to be further isolated.

Although it is unlikely that suitable habitat would be removed, significantly modified or fragmented, the habitat within the Study Area is probably only marginal and therefore probably not critical to the long-term survival of the species in the locality.

It is considered unlikely that the proposal would affect the long term survival of this species in the locality.

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

Critical habitats are areas of land that are crucial to the survival of particular threatened species, populations and ecological communities. Under the TSC Act, the Director-General maintains a register of critical habitat. To date, no critical habitat has been declared for this species (DECC Threatened Species Unit).

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

There is currently no recovery plan for Littlejohn's Tree Frog. However, the DECC has prepared 13 Priority Actions to help recover this species. Those relevant to the Proposal include:

- Develop management strategies where possible that protect existing water flow and quality or restore natural water flows and water quality – subsidence has the potential to impact on water flow and water quality of known habitat for Littlejohn's Tree Frog; although these impacts are expected to be minor,

- Develop strategies for providing supplementary breeding habitat at selected locations throughout the species range – subsidence has the potential to impact potential breeding sites within the Study Area although these impacts are expected to be minor,

- Retain riparian native vegetation – subsidence has the potential to impact riparian vegetation by gas emissions and water loss, although, such impacts are predicted to be unlikely and/or insignificant

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.

KTPs are listed under Schedule 3 of the TSC Act. KTPs relevant to the Proposal that may impact on known and potential habitat for Littlejohn's Tree Frog include:

- 'Alteration of habitat following subsidence due to longwall mining'– potential habitat for Littlejohn's Tree Frog occurs within forest and woodland habitat where permanent slow-flowing creeks, deep pools and fringing vegetation are present; all of which are known and/or likely to be vulnerable to the effects of subsidence;

- 'Alteration to the natural flow regimes of rivers, streams, floodplains & wetlands' – Littlejohn's Tree Frog requires permanent slow-flowing creeks with deep pools and fringing vegetation for breeding within the Study Area. Loss of water or changes to flow patterns could impact on the species; and,

For reasons already discussed the proposal is unlikely to result in the loss of significant habitat for this species.

Conclusion:

The proposed activity is considered unlikely to have a significant impact on this species. A Species Impact Statement is not recommended.

Red-crowned Toadlet *Pseudophryne australis*

The Red-crowned Toadlet is listed as Vulnerable on Schedule 2 of the TSC Act. This species occurs on wetter ridge tops and upper slopes of sandstone formations on which the predominant vegetation is dry open forests and heaths. This species typically breeds within small ephemeral creeks that feed into larger semi-perennial streams. These creeks are characterised after rain by a series of shallow pools lined by dense grasses, ferns and low shrubs (Thumm and Mahoney 1997 Also Thumm 1996)). The Red-crowned Toadlet disperses outside the breeding period to shelter under rocks and logs on sandstone ridges and to forage amongst leaf-litter (DEC, 2005o).

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.

The Red-crowned Toadlet breeds in small pools after heavy rain. The loss of such pools due to subsidence, although minimal, is likely to result in a reduction of breeding habitat for this species.

The potential for surface water flow diversion or rockbar leakage caused by the proposal is very low within the Nepean River as it is a flooded valley and the gradient of the river is very flat. Surface cracking could lead to the short-term draining of pools found in tributaries of the Nepean River. The majority of these tributaries are ephemeral and only flow after significant rain events MSEC (2008) state that the majority of the runoff would flow over the beds of these watercourses and would not divert into the dilated strata. Therefore, it is unlikely that all the pools located on tributaries of the Nepean River within the Study Area would be disturbed by subsidence, if any.

Ridgetop habitat that is important for non-breeding season foraging is unlikely to be impacted by the proposal. MSEC (2008) states that cliff instabilities are unlikely given the depth of cover and distance of the Nepean River Gorge from the proposed Longwalls. There may be rockfalls and slippage type events but these are likely to be minor in nature.

Given the unlikely occurrence of impacts to potential habitat for this species it is considered unlikely that the proposed activity will disrupt the lifecycle of the species such that a viable local population would be placed at risk of extinction.

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.

An endangered population is defined under the TSC Act as 'a population specified in Part 2 of Schedule 1'. At the present time, there are no endangered populations of this species listed under the Act.

c) In the case of a critically endangered or endangered ecological community, whether the action proposed:

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

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.

Not applicable to threatened species.

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

the extent to which habitat is likely to be removed or modified as a result of the action proposed, and

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 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 regional distribution coincides with the Greater Sydney Metropolitan District, which is the area covered by Sydney Triassic Sandstone geological formation (Thumm and Mahoney 1997). This species is known from isolated portions within the Sydney Basin, from the Pokolbin State Forest to Nowra in the south and Mt Victoria in the west (DEC, 2005o). Populations of this species are currently present in the Blue Mountains, Bouddi, Brisbane Water, Dharug, Garigal, Heathcote, Kuring-gai Chase, Lane Cove, Marramarra, Morton, Popran,

Royal, Sydney Harbour, Wollemi & Yengo National Parks; Barren Grounds, Muogamarra, & Nattai Nature Reserves; Bargo, Dharawal & Parr State Conservation Areas.

This species is known to occur throughout the sandstone areas of the local region. It has been recorded in high numbers on the Illawarra Escarpment and adjacent Sydney Catchment Authority Special Area and it has been suggested that it may be considered locally common in suitable habitat along the plateau (NPWS 1998). This species has been recorded approximately 7.5 km to the east of the Study Area (Figure 6), and in the Woronora, O'Hares Creek and Metropolitan Special Areas as well as Dharawal SCA (DECC 2007). The area of habitat for this species that may be impacted by the proposed development is small compared to the potential habitat within the region. Within the Study Area potential habitat for this species exists predominantly along the Nepean River and tributaries. Other drainage lines such as Foot Onslow Creek, Harris Creek and Navigation Creek are not considered potential habitat for this species.

The subsidence impact assessment provided by MSEC (2008) suggest that it is unlikely that all the pools of tributaries of the Nepean River within the Study Area would be disturbed by subsidence. Since subsidence impacts on habitat of this species within the Study Area would be patchy (if they occurred), both spatially and temporarily, areas of currently interconnecting or proximate habitat are unlikely to be further isolated.

Although it is unlikely that suitable habitat would be removed, significantly modified or fragmented, the habitat within the Study Area is probably in moderate condition due to run-off from urban and farming areas, and therefore probably not critical to the long-term survival of the species in the locality.

It is considered unlikely that the proposal would affect the long term survival of this species in the locality.

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

Critical habitats are areas of land that are crucial to the survival of particular threatened species, populations and ecological communities. Under the TSC Act, the Director-General maintains a register of critical habitat. To date, no critical habitat has been declared for this species (DECC Threatened Species Unit).

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

There is currently no recovery plan or threat abatement plan for the Red-crowned Toadlet. However, the DECC has prepared 14 Priority Actions to help recover this species. Those relevant to the Proposal are outlined below.

- Develop best practice management strategies that buffer and protect important headwater/ridge top breeding sites from changes to water flow, flow regimes and water quality changes – subsidence has the potential to impact on water flow and water quality of breeding sites for the Red-crowned Toadlet.

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.

KTPs are listed under Schedule 3 of the TSC Act. KTPs relevant to the Proposal that may impact on known and potential habitat for the Red-crowned Toadlet include:

- 'Alteration of habitat following subsidence due to longwall mining' – known and potential habitat for the Red-crowned Toadlet occurs within ephemeral creek lines and rocky slopes; both of which are known and/or likely to be vulnerable to the effects of subsidence;

- 'Alteration to the natural flow regimes of rivers, streams, floodplains and wetlands' – Red-crowned Toadlets prefer ephemeral creeks and drainage lines for breeding. Loss of water or changes to flow patterns could impact on the species;

The possible diversion to surface water flows would negatively impact on this species, if they occur. For reasons already discussed the proposal is unlikely to result in the loss of significant habitat for this species.

Conclusion:

The proposed activities are considered unlikely to have a significant impact on this species. A Species Impact Statement is not recommended.

Appendix 5
EPBC ACT – ASSESSMENTS OF SIGNIFICANCE

Under the EPBC Act, if the proposed development has the potential to have an adverse impact on a threatened species, population or ecological community listed on the Act, the proposal must be referred to the Federal Minister for the Environment for further consideration.

An Assessment of Significance is carried out in order to determine if a Referral is required.

FLORA

Section 5.0 discusses the potential impact of mine subsidence associated with the proposed works in regards to one EEC (Shale Sandstone Transition Forest) and three threatened plant species (*Pterostylis saxicola*, *Eucalyptus benthamii* and *Pomaderris brunnea*) as listed on the EPBC Act.

Endangered Ecological Communities

Shale Sandstone Transition Forest

Shale Sandstone Transition Forest (SSTF) is listed as an Endangered Ecological Community on the EPBC Act. It is also listed on the TSC Act.

Shale Sandstone Transition Forest occurs in the Study Area as shown on Figure 4. Impacts of the proposed longwall mining are likely to be minimal, as no vegetation is required to be cleared and potential impacts are considered to be minimal.

Is the action likely to lead to a long-term adverse affect on an ecological community?

The potential impacts of subsidence are described in MSEC (2008) and summarised in Section 2.5. Impacts of subsidence relevant to SSTF include potential surface cracking, slope slippage and gas emissions. Any impacts resulting from these are expected to be localised and minor. As such they may potentially cause the localised loss of individual plants. Such impacts are unlikely to have a significant impact on the functioning of this ecological community.

The potential, although unlikely, for habitat modification for this community in the Study Area is not likely to lead to a long term adverse affect on the ecological community.

Is the action likely to reduce the extent of an ecological community?

The Study Area is near to the southern limit of the Cumberland Plain. Therefore the SSTF in the Study Area is likely to be at or near the southern limit of its distribution. The predicted impacts of subsidence are considered unlikely to significantly impact the community such that the extent of the community will be reduced.

Is the action likely to fragment or increase fragmentation of an ecological community?

The proposed longwall mining will not result in the removal of any areas of SSTF. The proposal is therefore unlikely to result in the fragmentation of currently interconnecting or proximate areas of habitat for SSTF.

Is the action likely to adversely affect habitat critical to the survival of an ecological community?

Critical habitats are areas of land that are crucial to the survival of particular threatened species, populations or ecological communities. Under the EPBC Act, the Minister maintains a register of critical habitat. To date, no critical habitat has been declared for this community.

The EPBC Act Administrative Guidelines on Significance define Critical Habitat as areas that are necessary:

- for activities such as foraging, breeding, roosting, or dispersal,
- for succession,
- to maintain genetic diversity and long term evolutionary development, or
- for the reintroduction of populations or recovery of the species / community.

No habitat critical to the survival of SSTF will be adversely affected by the proposal.

Is the action likely to modify or destroy abiotic (non-living) factors (such as water, nutrients, or soil) necessary for an ecological community's survival?

The potential impacts of subsidence are described in MSEC (2008) and summarised in Section 2.5. Impacts of subsidence relevant to SSTF include potential surface cracking, slope slippage and gas emissions. Any impacts resulting from these are expected to be localised and minor. As such they may potentially cause the localised loss of individual plants. Such impacts are unlikely to have a significant impact on the functioning of this ecological community. The proposal is not likely to result in loss of water from the catchment, as any redirected water will re-emerge further downstream. Furthermore no clearing of vegetation or soil disturbance is proposed. The proposed works would not involve the use of chemicals or other substances that may find their way into the surface or ground water of the Study Area.

The proposal is therefore unlikely to modify or destroy abiotic factors necessary for the survival of SSTF in the Study Area.

Is the action likely to cause a substantial change in the species composition of an ecological community, including causing a decline or loss of functionally important species?

Potential impacts of subsidence that may result in modification of the composition of the community include potential surface cracking, slope slippage and gas emissions. Such impacts may result in localised loss of individual plants.

Though the predicted impacts may potentially cause the localised loss of individual plants, such impacts are unlikely to have a significant impact on the functioning of this ecological community, as they are likely to be minor and temporary.

Is the action likely to cause a substantial reduction in the quality or integrity of an occurrence of an ecological community, including, but not limited to:

> **assisting invasive species, that are harmful to the listed ecological community, to become established, or**
>
> **causing regular mobilisation of fertilisers, herbicides, or other chemicals or pollutants into the ecological community which kills or inhibit the growth of species in an ecological community, or**

It is unlikely that the proposed works will result in the introduction of invasive species into SSTF in the Study Area, as no above ground workings are proposed.

The proposal is not likely to result in the regular mobilisation of fertilisers, herbicides, or other chemicals or pollutants which may impact the SSTF in the Study Area, as no above ground workings are proposed.

Is the action likely to interfere with the recovery of an ecological community?

There is currently no recovery plan for this community. The proposed works will not interfere with the recovery of SSTF as no vegetation clearing is proposal and the indirect impacts of subsidence are likely to be minimal.

Conclusion

The proposed longwall mining is considered unlikely to have a significant impact on this community and therefore a Referral of this action to DEWHA is not recommended.

Critically Endangered or Endangered Plant Species

Potential habitat occurs within the study site for one Endangered plant species listed on the EPBC Act*:*

- *Pterostylis saxicola.*

Pterostylis saxicola

Pterostylis saxicola was not recorded in the Study Area; however, potential habitat exists in the Study Area in Shale Sandstone Transition Forest.

Impacts of the proposed longwall mining on potential habitat for *P. saxicola* are likely to be minimal, as no vegetation is required to be cleared and potential impacts such as fracturing, cliff falls and erosion of steep slopes are considered to be unlikely and/or minimal.

Is the action likely to lead to a long-term decrease in the size of a population of a species?

Pterostylis saxicola was not recorded in the Study Area and the proposal does not involve the clearing of any vegetation. The only possible impacts to this species involve the modification of the species habitat, which is considered to be minimal and unlikely. The action is not likely to lead to a long-term decrease in the size of a population of *P. saxicola*.

Is the action likely to reduce the area of occupancy of the species?

Pterostylis saxicola is known only from five localities: Georges River National Park (near Yeramba Lagoon), Ingleburn, Holsworthy, Peter Meadows Creek and St Marys Towers near Douglas Park (NSW Scientific Committee 1997c). The Study Area is likely to be near the southern limit of the distribution of this species. However, the proposed works are unlikely to removal any individuals of *P saxicola* as the species was not recorded in the Study Area and modifications to the species habitat are likely to be only minimal, unlikely and/or temporary.

Is the action likely to fragment an existing population into two or more populations?

The proposal will not result in the clearing of any vegetation; therefore it will not result in the fragmentation of any existing populations.

Is the action likely to adversely affect habitat critical to the survival of a species?

Critical habitats are areas of land that are crucial to the survival of particular threatened species, populations or ecological communities. Under the EPBC Act, the Minister maintains a register of critical habitat. To date, no critical habitat has been declared for this species.

The EPBC Act Administrative Guidelines on Significance define Critical Habitat as areas that are necessary:

- for activities such as foraging, breeding, roosting, or dispersal,
- for succession,
- to maintain genetic diversity and long term evolutionary development, or
- for the reintroduction of populations or recovery of the species / community.

The Study Area does not contain any such habitat for *P. saxicola*. Therefore, no habitat critical to the survival of *P. saxicola* will be adversely affected by the proposal.

Is the action likely to disrupt the breeding cycle of a population?

The proposed longwall mining will not involve the direct removal of any individuals of *P. saxicola*, but may result in some impacts to potential habitat for the species. The predicted impacts to potential habitat for the species are considered minimal.

It is considered unlikely that the proposed activities would result in disruption to the breeding cycle of this species.

Is the action likely to modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline?

The proposed works will not involve clearing of any potential habitat for the species, but may result in indirect impacts, with subsidence predictions suggesting possible fractures in the river and creek beds, emission of gases, cliff falls and ground strains resulting in increased erosion on steep slopes. These impacts are, however predicted to be minor, localised and temporary. Therefore, the proposal is not considered likely to modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.

Is the action likely to result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species' habitat?

The proposal does not involve any surface works. Therefore the proposal is not likely to result in invasive species that are harmful to *Pterostylis saxicola* becoming established in the species habitat.

Is the action likely to introduce disease that may cause the species to decline?

The proposal does not involve any surface works. Therefore the proposal is not likely to introduce disease that may cause *Pterostylis saxicola* to decline.

Will the action interfere with the recovery of the species?

To date there is no recovery plan for *Pterostylis saxicola.* The proposal is not likely to interfere with the recovery of the species as no habitat for the species will be cleared and impacts from subsidence are likely to be minimal.

Conclusion

Based on the above assessment, *Pterostylis saxicola* is unlikely to be significantly impacted by the proposed activities and as such a Referral under the provisions of the EPBC Act is not recommended for this species.

Vulnerable Plant Species

Potential habitat occurs within the study site for two Vulnerable plant species listed on the EPBC Act*:*

- *Eucalyptus benthamii;* and
- *Pomaderris brunnea.*

Neither of these species were recorded within the Study Area during the current survey. Populations of these species that may occur within the Study Area are not considered important populations because:

- they are unlikely to be key source populations either for breeding or dispersal;
- unlikely to be necessary for maintaining genetic diversity; and/or ,
- the study site is not at or near the limit of the species range.

Eucalyptus benthamii

Eucalyptus benthamii was not recorded within the Study Area during the current survey. Potential habitat for *E. benthamii* occurs in River-flat Eucalypt Forest in the Study Area.

Is the action likely to lead to a long-term decrease in the size of an important population of a species?

The potential habitat for *E. benthamii* is not likely to support an important population of the species. *Eucalyptus benthamii* was not recorded within the Study Area during the current or previous surveys.

The proposed longwall mining will not involve the direct removal of any individuals of *E. benthamii,* but may result in some impacts to potential habitat for the species. The predicted impacts to the potential habitat for the species are considered minimal.

It is considered unlikely that the proposed activities would lead to a long term decrease in the size of an important population of the species.

Is the action likely to reduce the area of occupancy of an important population?

The Study Area is not considered to contain an important population of *E. benthamii.* Therefore the proposal is not likely to reduce the area of occupancy of an important population.

Is the action likely to fragment an existing important population into two or more populations?

The Study Area is not considered to contain an important population of *E. benthamii* plus no vegetation is required to be cleared as part of the proposal. The proposal is therefore unlikely to result in the fragmentation of an existing important population of *E. benthamii*.

Is the action likely to adversely affect habitat critical to the survival of a species?

Critical habitats are areas of land that are crucial to the survival of particular threatened species, populations or ecological communities. Under the EPBC Act, the Minister maintains a register of critical habitat. To date, no critical habitat has been declared for this species.

The EPBC Act Administrative Guidelines on Significance define Critical Habitat as areas that are necessary:

- for activities such as foraging, breeding, roosting, or dispersal,
- for succession,
- to maintain genetic diversity and long term evolutionary development, or
- for the reintroduction of populations or recovery of the species / community.

The Study Area does not contain any such habitat for *E. benthamii*. Therefore, no habitat critical to the survival of *E. benthamii* will be adversely affected by the proposal.

Is the action likely to disrupt the breeding cycle of an important population?

The Study Area is not considered to contain an important population of *E. benthamii.* The proposal is therefore unlikely to disrupt the breeding cycle of an important population.

Is the action likely to modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline?

The proposed works will not involve clearing any potential habitat for the species, but may result in indirect impacts, with subsidence predictions suggesting possible fractures in the river and creek beds, emission of gases and ground strains resulting in increased erosion on steep slopes.

Considering the minimal and/or unlikely nature of the predicted impacts, potential habitat for *E. benthamii* is not likely to be modified, destroyed, removed or isolated to the extent that the species is likely to decline.

Is the action likely to result in invasive species that are harmful to a Vulnerable species becoming established in the Vulnerable species' habitat?

It is unlikely that the works will result in the introduction of invasive species into potential habitat *E. benthamii* for as there are no surface works required for the proposed longwall mining.

Is the action likely to introduce disease that may cause the species to decline?

The proposal does not involve any surface works. Therefore the proposal is not likely to introduce diseases that may cause *Eucalyptus benthamii* to decline.

Is the action likely to interfere substantially with the recovery of the species?

To date there is no recovery plan for *E. benthamii*. The proposed works are unlikely to interfere with the recovery of this species.

Conclusion

Based on the above assessment, *Eucalyptus benthamii* is unlikely to be significantly impacted by the proposed activities and as such a Referral under the provisions of the EPBC Act is not recommended for this species.

Pomaderris brunnea

Pomaderris brunnea was not recorded within the Study Area during the current survey. Potential habitat for *P. brunnea* occurs in River-flat Eucalypt Forest in the Study Area.

Is the action likely to lead to a long-term decrease in the size of an important population of a species?

The potential habitat for *P. brunnea* is not likely to support an important population of the species. *Pomaderris brunnea* was not recorded within the Study Area during the current survey.

The proposed longwall mining will not involve the direct removal of any individuals of *P. brunnea*, but may result in some impacts to potential habitat for the species. The predicted impacts to the potential habitat for the species are considered minimal.

It is considered unlikely that the proposed activities would lead to a long term decrease in the size of an important population of the species.

Is the action likely to reduce the area of occupancy of an important population?

The Study Area is not considered to contain an important population of *P. brunnea.* Therefore the proposal is not likely to reduce the area of occupancy of an important population.

Is the action likely to fragment an existing important population into two or more populations?

The Study Area is not considered to contain an important population of *P. brunnea.* The proposal is therefore unlikely to result in the fragmentation of an existing important population of *P. brunnea* as no vegetation is required to be cleared.

Is the action likely to adversely affect habitat critical to the survival of a species?

Critical habitats are areas of land that are crucial to the survival of particular threatened species, populations or ecological communities. Under the EPBC Act, the Minister maintains a register of critical habitat. To date, no critical habitat has been declared for this species.

The EPBC Act Administrative Guidelines on Significance define Critical Habitat as areas that are necessary:

- for activities such as foraging, breeding, roosting, or dispersal,
- for succession,
- to maintain genetic diversity and long term evolutionary development, or
- for the reintroduction of populations or recovery of the species / community.

The Study Area does not contain any such habitat for *P. brunnea*. Therefore, no habitat critical to the survival of *P. brunnea* will be adversely affected by the proposal.

Is the action likely to disrupt the breeding cycle of an important population?

The Study Area is not considered to contain an important population of *P. brunnea.* The proposal is therefore unlikely to disrupt the breeding cycle of an important population.

Is the action likely to modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline?

The proposed works will not involve clearing any potential habitat for the species, but may result in indirect impacts, with subsidence predictions suggesting possible fractures in the river and creek beds, emission of gases and ground strains resulting in increased erosion on steep slopes.

Considering the minimal and/or unlikely nature of the predicted impacts, potential habitat for *P. brunnea* is not likely to be modified, destroyed, removed or isolated to the extent that the species is likely to decline.

Is the action likely to result in invasive species that are harmful to a Vulnerable species becoming established in the Vulnerable species' habitat?

It is unlikely that the works will result in the introduction of invasive species into potential habitat *P. brunnea* for as there are no surface works required for the proposed longwall mining.

Is the action likely to introduce disease that may cause the species to decline?

The proposal does not involve any surface works. Therefore the proposal is not likely to introduce disease that may cause *Pomaderris brunnea* to decline.

Is the action likely to interfere substantially with the recovery of the species?

To date there is no recovery plan for *P. brunnea*. The proposed works are unlikely to interfere with the recovery of this species.

Conclusion

Based on the above assessment, *Pomaderris brunnea* is unlikely to be significantly impacted by the proposed activities and as such a Referral under the provisions of the EPBC Act is not recommended for this species.

FAUNA

Vulnerable Animal Species

The Study Area contains potential habitat for two frog species, Giant Burrowing Frog and Littlejohn's Tree Frog, listed as Vulnerable on the EPBC Act.

Giant Burrowing Frog	***Heleioporus australiacus***
Littlejohn's Tree Frog	***Litoria littlejohni***

Populations of the Giant Burrowing Frog and Littlejohn's Tree Frog that may occur within the Study Area are not considered important populations because:

- they are unlikely to be key source populations either for breeding or dispersal;
- they are unlikely to be necessary for maintaining genetic diversity; and/or,
- the Study Area is not at or near the limit of the species range.

These species were not recorded within the Study Area during the current survey. However, the Giant Burrowing Frog has been previously recorded approximately 6 km to the north and east of the Study Area and the Littlejohn's Tree Frog approximately 10 km to the east, both in less disturbed and more intact vegetation.

Is the action likely to lead to a long-term decrease in the size of an important population of a species?

The Study Area is not considered to contain an important population of the Giant Burrowing Frog or Littlejohn's Tree Frog. Therefore proposed action is unlikely to lead to a long-term decrease in the size of an important population.

Is the action likely to reduce the area of occupancy of an important population?

The study site is not considered to contain an important population of the Giant Burrowing Frog or Littlejohn's Tree Frog. Therefore proposed action is unlikely to reduce the area of occupancy of an important population.

Is the action likely to fragment an existing important population into two or more populations?

The Study Area is not considered to contain an important population of the Giant Burrowing Frog or Littlejohn's Tree Frog. Therefore, the proposed action is unlikely to fragment an existing important population into two or more populations.

Is the action likely to adversely affect habitat critical to the survival of a species?

The Giant Burrowing Frog and Littlejohn's Tree Frog breed in deep pools within creek lines. Any loss of pools in tributaries of the Nepean River as a result of subsidence may reduce the amount of potential breeding habitat within the Study Area. Based on the subsidence impact assessment provided by MSEC (2008), it is considered unlikely that all pools within the Study Area would be disturbed by subsidence.

Given that the potential habitat within the Study Area is of marginal quality to these species and that further habitat for the Giant Burrowing Frog and Littlejohn's Tree Frog occurs within the vicinity of the area and in the greater region, it is considered that the potential loss of some pools located along tributaries of the Nepean River within the Study Area is unlikely to have a significant impact on these species. Therefore the Study Area is not considered to contain habitat critical for survival of these species. It is unlikely that the proposed activity will adversely affect habitat critical to the survival these species.

Is the action likely to disrupt the breeding cycle of an important population?

The Study Area is not considered to contain an important population of the Giant Burrowing Frog and/or Littlejohn's Tree Frog. Therefore, the proposed action is unlikely to disrupt the breeding cycle of an important population.

Is the action likely to modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline?

Loss of pools in tributaries of the Nepean River as a result of subsidence may reduce the amount of potential breeding habitat of the frog species within the Study Area. Based on the subsidence impact assessment provided by MSEC (2008) it is considered unlikely that all pools within the Study Area would be disturbed by subsidence.

Given the marginal value of the habitat in the Study Area and large areas of further habitat for the Giant Burrowing Frog and Littlejohn's Tree Frog occurs within the vicinity of the area, and in the greater region, it is considered that the potential loss of some pools located along tributaries of the Nepean River within the Study Area is unlikely to have a significant impact on these species. It is unlikely that the action would modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that these species are likely to decline.

Is the action likely to result in invasive species that are harmful to a Vulnerable species becoming established in the Vulnerable species' habitat?

The proposed activity is unlikely to disturb any vegetation with the exception of possible localised gas release related dieback. Furthermore the nature of the subsidence impacts are such that it is considered unlikely to result in invasive species becoming established in habitat for either of these species.

Is the action likely to introduce disease that may cause the species to decline?

The proposal does not involve any surface works. Therefore the proposal is not likely to introduce disease that may cause Giant Burrowing Frog or Littlejohn's Tree Frog to decline.

Is the action likely to interfere substantially with the recovery of the species?

Neither frog species has been recorded from within the Study Area. The proposed activities will not require the clearing of any habitat or any above ground disturbance and subsidence related impacts are likely to be low given the distance of the proposed longwalls from the Nepean River Gorge (MSEC 2008). The proposed action is therefore considered unlikely to interfere substantially with the recovery of these species.

Conclusion

Based on the above assessment, the Giant Burrowing Frog and Littlejohn's Tree Frog are unlikely to be significantly impacted by the activities and as such a Referral under the provisions of the EPBC Act is not recommended for these species.

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