BIOSIS
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West Cliff Colliery
Area 5 - Longwalls 34-36
Impacts of Subsidence on Terrestrial Flora and Fauna

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Report for
BHP Billiton

WEST CLIFF COLLIERY
AREA 5 – LONGWALLS 34-36
IMPACTS OF SUBSIDENCE ON TERRESTRIAL FLORA AND FAUNA

DECEMBER 2007

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ABBREVIATIONS

CPW	Cumberland Plain Woodland
DEC	NSW Department of Environment and Conservation (now DECC)
DECC	NSW Department of Environment and Climate Change (formerly DEC and incorporates NPWS)
DEH	Commonwealth Department of Environment and Heritage (now DEW)
DEW	Commonwealth Department of Environment and Water Resources
EEC	Endangered Ecological Community
EIS	Environmental Impact Statement
EP&A Act	NSW *Environmental Planning and Assessment Act* 1979
EPBC Act	Commonwealth *Environmental Protection and Biodiversity Conservation Act* 1999
GIS	Geographic Information System
LGA	Local Government Area
NPWS	NSW National Parks and Wildlife Service
ROTAP	Rare or Threatened Australian Plant
SIS	Species Impact Statement
sp.	Species (singular)
spp.	Species (plural)
SCA	Sydney Catchment Authority
SSTF	Shale Sandstone Transition Forest
TSC Act	NSW *Threatened Species Conservation Act* 1995
UBBS	Urban Bushland Biodiversity Study

CONTENTS

Tables:

Figures:

1.0 SUMMARY

Biosis Research Pty. Ltd. was commissioned by BHP Billiton Illawarra Coal (BHPBIC) to undertake a terrestrial flora and fauna impact assessment for subsidence impacts associated with Longwalls 34-36 of the West Cliff Colliery.

Two Endangered Ecological Communities (EECs) are present within the Study Area. These include Cumberland Plain Woodland and Shale Sandstone Transition Forest. Both Cumberland Plain Woodland and Shale Sandstone Transition Forest are listed as EECs on the NSW *Threatened Species Conservation Act 1995* (TSC Act) and the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). The impact assessment within this report concludes that mine-subsidence associated with the proposed development of Longwalls 34-36 is not likely to have a significant impact on either of these EECs.

During the field survey a large population of *Grevillea parviflora* ssp. *parviflora* was found within the Study Area at points GPP 1-4 in Figures 2 and 3. This was the only threatened plant species detected during the field survey. *Grevillea parviflora* ssp. *parviflora* is listed as vulnerable under both the TSC Act and the EPBC Act.

A further nine threatened plant species are considered to have potential habitat within the Study Area. These include *Acacia bynoeana, Callistemon linearifolius, Leucopogon exolasius, Persoonia bargoensis, Persoonia hirsuta, Pimelea spicata, Pomaderris brunnea, Pterostylis saxicola* and *Pultenaea pedunculata*.

The impact assessment within this report concludes that mine-subsidence associated with the proposed extraction of Longwalls 34-36 is not likely to have a significant impact on these threatened flora species.

One threatened animal species (Koala) was recorded within the Study Area during a previous survey (Richardson, English et al. 2003). Although not recorded during this or previous assessments, the Eastern Pygmy Possum is purported to occur within a property within the Study Area. The Study Area contains limited potential habitat for a total of 36 threatened and/or migratory animal species. As subsidence may alter surface flow and water quality in the Georges River or other creeks, only animal species with potential habitat in the Study Area that rely on surface water for their survival were considered further. Four of the 36 threatened and/or migratory animal species (Giant Burrowing Frog, Littlejohn's Tree Frog, Red-crowned Toadlet and Large-footed Myotis) with potential habitat in the Study Area are likely to be dependent on surface water for breeding or foraging. A detailed assessment of the potential impacts on

these species was conducted and concludes that the proposed activity is unlikely to have a significant impact on any threatened and/or migratory animal species.

Several recommendations pertaining to terrestrial ecological values have been included in this assessment and include:

- In the unlikely event that methane die-off in vegetation is observed, action should be taken to monitor the extent and recovery of any such vegetation. Locally indigenous plant species should be utilised for any rehabilitation that may be required.
- In the unlikely event that fractures in the bedrock results in fractures in major surface flow diversion and/or drainage of significant pools, remedial actions(s) should be undertaken to re-establish surface flows and pool function.

In conclusion, this assessment does not recommend a Species Impact Statement and/or a Referral to the Environment Minister for any threatened vegetation communities or plant or animal species is required.

2.0 INTRODUCTION

Biosis Research Pty. Ltd. was commissioned by BHP Billiton Illawarra Coal to undertake a terrestrial flora and fauna assessment of the potential subsidence impacts of proposed Longwall mining of West Cliff Area 5 (Figure 1). The area considered in this report (Study Area) is considered to be the SMP Area as defined in MSEC (MSEC 2007) and illustrated in Figure 2. It includes the surface impact area above Longwalls 34-36. This report assesses the ecological values of the Study Area and the potential impacts associated with Longwall mining subsidence in this area.

2.1 Aims

The specific aims of this assessment are to:

1. conduct a literature review and database search for the locality;
2. undertake field surveys targeting threatened biota (as defined in Section 2.2) likely to occur in the Study Area as listed on the NSW *Threatened Species Conservation Act* 1995 (TSC Act) and the Commonwealth *Environment Protection and Biodiversity Conservation Act* 1999 (EPBC Act);
3. provide Assessments of Significance for threatened biota listed on the TSC Act and Significant Impact Criteria for threatened biota listed on the EPBC Act. These are conducted where threatened biota or their potential habitats are recorded within the Study Area.
4. provide an assessment of the habitat values of the site;
5. provide recommendations to minimise, manage and monitor the environmental impacts of the proposed development.

2.2 Definitions

The following terms are used frequently throughout the report:

- ***The proposal*** is the development, activity or action proposed. In this case the proposal is the mining of Longwalls 34-36 of West Cliff Colliery Area 5.
- ***Subject site*** is the area directly affected by the proposal.
- ***Study area*** is defined as the subject site and any additional areas that are likely to be affected by the proposal, either directly or indirectly. This is defined as the SMP area as outlined in Section 2.3.
- ***Subject species*** means those threatened species that are known or considered likely to occur in the Study Area.
- ***Affected subject species*** means subject species likely to be affected by the proposal.
- ***Abundance*** means a quantification of the population of the species or community.
- ***Regional*** means the area defined within the applicable IBRA Bioregion (Thackway and Cresswell 1995), i.e., The Sydney Basin Bioregion.
- ***Local population*** is defined as the population of a species within the Study Area.
- ***Local occurrence*** is used in reference to endangered ecological communities and is defined in (Thackway and Cresswell 1995) as the community that occurs within the Study Area.
- ***Locality*** is the area within a 10 kilometre radius of the Study Area.
- ***Threatened biota*** refers to threatened species, populations and ecological communities as listed on the TSC Act and EPBC Act.

2.3 Relevant Terminology

For consistency with other reports associated with the Subsidence Management Plan (MSEC 2006) for this mining application, the following terminology is used:

- **MSEC** – Mining Subsidence Engineering Consultants.

- **The MSEC report** – MSEC (2007) *West Cliff Colliery Area 5 - Report on The Prediction of Subsidence Parameters and the Assessment of Mine Subsidence Impacts on Natural Features and Surface Infrastructure Resulting from the Extraction of Proposed Longwalls 34 to 36*, Chatswood NSW.

- **SMP Area** – the surface area that is likely to be affected by the proposed Longwalls 34 to 36. The SMP Area is defined in the MSEC report. The SMP area will hereafter be referred to as the **Study Area** in this report.

- **Subsidence** – in terms of this assessment subsidence is taken to mean the total of vertical (upsidence and subsidence) and horizontal surface movements due to the extraction of coal using Longwall mining techniques. The MSEC report describes the predicted vertical and horizontal movements in detail and the predicted surface impacts associated with these movements.

2.4 Features With Potential Ecological Significance

The Study Area for the current assessment includes unnamed creeks and drainage lines located near to the eastern extent of Longwalls 34-36 which are associated with the Georges River valley. Although the Georges River will not be directly mined beneath by the proposed Longwalls, that area of the river that may be subject to subsidence impacts has also been included. Aerial photography of the Study Area (Figure 2) shows that the remainder of the Study Area is predominantly cleared agricultural land with a very small area of existing vegetation. These and other natural features within the Study Area that may provide important habitat values for terrestrial flora and fauna are described generally, in this section, and with specific reference to threatened flora and fauna values elsewhere in this report. Subsidence impact predictions and discussion of the natural features within the Study Area follow the MSEC report unless otherwise noted. The natural features of the Study Area are described in Sections 2.4.1 to 2.4.8 below.

Of the built (or artificial) features within the Study Area the Devines Tunnel and a number of farm dams may provide potential habitat for threatened biota. These are described in Section 2.4.9.

2.4.1 Rivers

2.4.1.1 Nepean River

The Nepean River is an incised river valley, similar in nature to the Georges River. It is located outside the general SMP Area and, at its closest point, is at a distance of 800 metres west of Longwalls 34 and 35.

2.4.1.2 Georges River

The Georges River crosses the eastern side of the SMP Area. The proposed Longwalls 34 to 36 mine up to the Georges River, but do not directly mine beneath the river.

The total length of the Georges River within the general SMP Area is approximately 2.8 kilometres. The total length of the Georges River within the SMP Area, which extends the general SMP Area to sections of the river which are predicted to experience far field movements, is approximately 3.3 kilometres.

The section of river within the SMP Area is moderately incised, with Hawkesbury Sandstone to the east and Wianamatta Shale outcrops to the west. The overall height of the Georges River Valley within the SMP Area varies

between 15 metres and 40 metres. The base of the river is Hawkesbury Sandstone.

The Georges River has been defined as an area of environmental sensitivity for the purposes of the SMP Application.

Flows in the Georges River result from natural catchment runoff, as well as the licensed discharge of water from the Appin and West Cliff Collieries. A comparison of water flow and discharges from the collieries suggests that in periods of little or no rain, should mine discharges cease, the river would cease to flow. Under these conditions the river is likely to consist of a series of disconnected pools, some of which may naturally completely or partially drain.

The MSEC report notes that – given natural weathering within the bed rock of the Georges River – there is likely to be some naturally occurring surface water flow diversions under natural (un-mined) conditions. Further, water quality within the Georges River is influenced by a range of factors including natural rainfall, as well as the quality of the water discharged from the upstream collieries and runoff from un-sewered urban areas.

2.4.2 Drainage Lines – Creeks and Gullies

The land in the eastern part of the SMP Area drains into the Georges River. The land in the central and western parts of the SMP Area drains into the Nepean River via the Mallaty Creek, Leafs Gully and Nepean Creek catchments. Appin Road is nominally the ridgeline separating the east and west catchments.

Mallaty Creek is an ephemeral creek which is located directly above the proposed Longwalls 34 to 36. The creek generally flows in a westerly direction until it joins Ousedale Creek, approximately 1.4 kilometres south-west of Longwall 34. The natural gradient of the creek within the general SMP Area varies between 10 mm/m and 100 mm/m, with an average gradient of approximately 30 mm/m.

Leafs Gully is an ephemeral creek which is located directly above proposed Longwalls 34 and 35. The creek flows in a north-westerly direction until it joins the Nepean River approximately 830 metres west of Longwall 36. The natural gradient of the gully within the general SMP Area varies between 10 mm/m and 125 mm/m, with an average gradient of approximately 50 mm/m.

Nepean Creek is also ephemeral and is located in the southern part of the SMP Area, directly above the proposed Longwall 31. The creek flows in a southerly direction until it joins Ousedale Creek approximately 800 metres south of Longwall 31. The natural gradient of the creek in the vicinity of the proposed

longwalls varies between 10 mm/m and 150 mm/m, with an average gradient of approximately 40 mm/m.

There are also a number of tributaries within the SMP Area. The tributaries are located directly above and across the extents of the proposed longwalls.

2.4.3 Natural Dams

There are no natural dams within the Study Area. There are however some farm dams that may provide limited habitat for some flora and fauna. These are described in Section 2.4.9.

2.4.4 Cliffs and Natural Rock Platforms

Two cliffs were identified within the SMP Area at the eastern end of Longwalls 35-36 and adjacent to the Georges River. Cliff GR-CL01 is situated on the outside of a bend in the Georges River directly above the finishing (eastern) end of Longwall 35. Cliff GR-CL02 is situated on relatively straight section of the Georges River and the southern end of this cliff line is located above the north-eastern corner of Longwall 36. These cliffs are shown in Figure 3.

Several other cliffs were identified along the Nepean River and Ousedale Creek, south of the proposed longwalls. These cliffs are located more than 800 metres from the proposed longwalls and unlikely, therefore, to be subjected to any significant systematic, valley related, or far-field horizontal movements.

2.4.5 Steep Slopes

Steep slopes for the purposes of the SMP are defined as those areas where existing ground slopes are considered to be marginally stable. These are typically considered to be slopes of a gradient between 18.4^{o} and 63.4^{o}. Steep slopes occur within the Georges River valley. Most steep slopes within the Study Area are stabilised to some extent by natural vegetation.

2.4.6 Land Prone to Flooding or Inundation

The land within the SMP Area drains freely into the Georges and Nepean Rivers and no areas would be considered flood prone. The banks and the narrow river flats along the Georges River, however, are susceptible to inundation during major flood events. There is no development of infrastructure within the valley of the Georges River.

2.4.7 Wetlands and Swamps

There are no swamps or wetlands within the SMP Area. There are, however, water-related ecosystems within the SMP Area, in particular, along the Georges River and the major drainage lines. The ecological values associated with these features have been investigated and are described in this report (Biosis Research 2007) and in The Ecology Lab (2007).

2.4.8 Native Vegetation, Threatened Biota and Critical Habitat

Native vegetation occurs throughout the SMP area and is described in Section 4.1 of this report.

Threatened Biota as listed on the TSC Act or the EPBC Act either occurs or has the potential to occur in the SMP area and has been described in Section 4.2 and 4.4 of this report.

No Critical Habitat as listed in the TSC or EPBC Acts occurs or has the potential to occur within the SMP area.

2.4.9 Built Features with Potential Ecological Significance

2.4.9.1 Devines Tunnel

Devines Tunnel crosses the western side of the general SMP Area. The tunnel is made up of two sections, known as Devines Tunnel No. 1, between two unnamed creeks north of Mallaty Creek, and Devines Tunnel No. 2, between the northern unnamed creek and Leafs Gully. A short length of open canal (97 metres) joins the two sections of tunnel.

The tunnel is an unlined rock tunnel approximately 3.2 metres wide and, when flowing at maximum capacity, the tunnel has a water depth of 2.44 metres and a freeboard of approximately 150 mm. The gradient of the tunnel is 0.66 metres per kilometre. Devines Tunnel No. 1 is approximately 183 metres long and Devines Tunnel No. 2 is approximately 817 metres long. The surface levels over the length of the tunnel vary from 128 metres to 143 metres above AHD and the maximum depth of cover is approximately 15 metres.

Devines Tunnel may be subjected to far-field movements, resulting from the extraction of the proposed longwalls and, therefore, have been included as part of the SMP Area.

It is considered that Devines Tunnel provides limited potential habitat for threatened bat species as listed on the TSC and EPBC Acts.

2.4.9.2 Farm Dams

There are 75 farm dams that have been identified within the SMP Area. The maximum lengths of the farm dams varies between 5 and 215 metres and the surface areas of the farm dams vary between 15 and 4600 square metres. Some or all of these farm dams are considered to provide potential habitat for migratory or threatened bird species as listed on the TSC or EPBC Acts.

2.5 Potential Impacts of Mine Subsidence

Subsidence of the surface is an unavoidable consequence of coal extraction using Longwalls mining methods. As well as vertical subsidence, it is now recognised that upsidence is likely to occur in the base of the creek lines that cross the proposed Longwalls due to valley bulging. 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. While some pools may be drained, differential subsidence effects could result in other pools being formed or existing ponds being made deeper. Upsidence and subsidence impacts have been considered collectively and are grouped under the heading of subsidence impacts throughout the remainder of this document.

2.5.1 Rivers

2.5.1.1 Nepean River

Due to its location outside the general SMP and the fact that it lies some 800m from the nearest proposed longwall workings, the MSEC report considers it is unlikely that the Nepean River would be subjected to any significant systematic subsidence, upsidence or far-field horizontal movements resulting from the extraction of the proposed longwalls. As such, it is considered unlikely that the terrestrial ecology in the immediate vicinity of the Nepean River would be impacted by the proposed longwall mining.

2.5.1.2 Georges River

In relation to terrestrial flora and fauna values, mine subsidence impacts within the Georges River have the potential to alter habitat or the riparian/in stream vegetation. These impacts may manifest in several ways as discussed below.

Potential for Increased Ponding, Flooding and Scouring

As the Georges River has a relatively shallow natural gradient within the SMP Area, it is unlikely that there would be any significant increases in the levels of ponding, flooding, or scouring of the river banks (MSEC 2007). It is possible,

however, that there could be some very localised increased levels of ponding or flooding where the predicted maximum tilts coincide with existing pools, steps or cascades along the river. The MSEC report concluded that such localised changes are not expected to result in significant impacts.

The potential impacts of scouring are also likely to be minimal due to the nature of the sandstone river bed.

Potential for Desiccation

Desiccation of existing pools within the river may occur as a result of subsidence and resultant fracturing. In the current proposal the impacts of desiccation on existing pools is unlikely to be significant or wide spread, and was not observed in the adjacent mining domain. Desiccation associated with the extraction of Longwalls 34-36 is unlikely therefore to significantly alter terrestrial flora and fauna values in the Study Area.

Potential for Changes in Stream Alignment

The predicted changes in the cross-bed gradients are very small and are expected to be an order of magnitude smaller than the natural river cross-bed gradients (MSEC 2007). The potential impacts associated with changes in the stream alignment, resulting from the extraction of the proposed longwalls are, therefore, not expected to be significant. Therefore alterations to the stream alignment of the Georges River associated with the extraction of Longwalls 34-36 is unlikely to significantly alter terrestrial flora and fauna values in the Study Area.

The potential impacts of the changes in the stream alignment at times of low flow would be minor when compared to the changes in the river depth and width that occur during times of high flow in the river.

Potential for Fracturing of Bedrock and Surface Water Flow Diversions

The MSEC report notes that fracturing of the bedrock within the Georges River may occur as a result of the extraction of the Longwalls, although any fracturing that does occur is expected to be minor in nature and located in isolated areas. In association with surface water flow diversion and gas emissions, fracturing has the potential to impact terrestrial flora and fauna values and has been considered further in this report.

While mine subsidence may impact surface water flow in a number of ways, the MSEC report states that potential diversions may occur into subterranean layers, rock bar leakages and groundwater infiltration through fractured or buckled bedrock strata. Such diversions occur naturally within the river and the extraction of Longwalls 34-36 is considered to have a low likelihood of increasing diversions in the Georges River.

While increased flow diversions are not likely to occur as a result of the extraction of Longwalls 34-36, it is possible that some features of the Georges River may become drain (wholly or in part), depending on the rate of licensed discharges from the upstream collieries, especially in low rainfall periods (MSEC 2007). This is because pre-existing flow diversions are known to exist within the river. It is expected that, at these times, the river would continue to provide aquatic habitats for those terrestrial flora and fauna values that may require surface water. These habitats are likely to exist as a series of disconnected or drained pools.

The MSEC report further states that while the likelihood of increased flow diversions is considered to be relatively low, any flow diversions that might occur can be fully or partially restored by remediation works, which have previously been undertaken successfully in the Georges River.

In general terms, water is not lost from a catchment in an area affected by subsidence (MSEC 2007). While water may be diverted from surface flows resulting in a dry creek or river feature, flow continues downstream in rock strata below the creek or river bed, returning at some point further downstream (NECS 2001).

Any surface flow diversions within the Georges River as a result of the extraction of Longwalls 34-36 are therefore considered likely to have a negligible, localised impact on any terrestrial flora and fauna values within the Study Area.

2.5.2 Water Quality

Ecoengineers (2007) have assessed the likely water quality impacts associated with the extraction of Longwalls 34-36 and a summarised extract of the Ecoengineers (2007) assessment is provided below:

Water quality associated with River Bed Flow Diversions

Fracturing of the river or creek beds has the potential to redirect surface flows to the fractured substrata, re-emerging that the surface further downstream. In the process of being diverted various chemical compounds in the newly created voids may be dissolved and returned to the surface and represent as a water quality change. Ecoengineers (2007) state that river bed flow diversions due to river bed fracturing from the development of Longwalls 34-36 are considered unlikely as such diversions were not observed from Longwalls 29-31 which, like the proposal will not directly mine beneath the River.

Ecoengineers (2007) assess water quality changes associated with river bed flow diversions for the extraction of Longwalls 34-36 in the following manner:

1. the Likelihood of one or more sub-bed diversions arising within Georges River as a consequence of the mining of proposed Longwalls 34 - 36 is Minor

2. the Consequences of such a diversion to the Ecological Health of immediate downstream pool(s) in the Georges River would be Major but only under low flow conditions (<0.3 ML/day) which have occurred no more than 15% of the time since the introduction of the controlled discharge to the River from West Cliff Colliery

3. the Consequences of such a diversion to the Ecological Health of immediate downstream pool(s) would be Insignificant provided the Georges River continued to receive an environmental flow e.g. from West Cliff Colliery

For the purposes of the current terrestrial ecological assessment, water quality impacts associated with surface flow redirection are considered to be minimal. If surface flows are redirected, there is likely to be limited impact on the water quality of pools immediately downstream of the point where redirected flows resurface.

Water quality associated with development or enhancement of Ferruginous Springs

With regards to the Georges River catchment, a ferruginous spring (Pool 11 spring) adjacent to the Georges River was induced when Longwalls 5A1 and 5A2 mined directly beneath the River. However, as subsequent extraction of Longwalls 29 and 31, which did not mine directly beneath the River, has not led to the creation of any ferruginous spring, even though the upland catchment on the western side of the river (of significant size 0.72 km2) has been mined beneath. It might be inferred that the smaller catchments further to the north which will be mined beneath by Longwalls 34 to 36 pose an even lower probability of risk from this phenomenon.

Ecoengineers (2007) conclude that:

1. the Likelihood of one or more ferruginous spring(s) arising within the Georges River from effects within the small western catchments draining towards the Georges River is Rare

2. the Consequences of such a spring or springs to the ecological health of immediate downstream pool(s) would be Insignificant provided the Georges River continued to receive an environmental flow e.g. from West Cliff Colliery

With regards to the Nepean River Catchment Ecoengineers (2007)conclude that:

1. the Likelihood of one or more ferruginous springs arising within Upper Mallaty Creek catchment from subsidence-related effects within that catchment is Minor as the mining of Longwalls 31 and 32 (from the west) has not led to observed occurrences of such springs

2. the Consequences of such a spring or springs to the Ecological Health of immediate downstream pool(s) in Mallaty Creek would be Minor under all flow conditions

3. the Likelihood of one or more ferruginous springs arising within Leafs Gully Creek or Upper Nepean Creek catchment is Minor

For the purposes of the current terrestrial ecological assessment, water quality impacts associated with surface flow redirection are considered to be unlikely.

2.5.3 Drainage Lines – Creeks and Gullies

The MSEC report states that it is possible there could be localised areas along the creeks and gullies which could experience a small increase in the levels of ponding and flooding due to tilting. The report also states that it is possible that some fracturing of the bed rock of some of the creeks may occur and lead to localised areas of water diversion. However, any changes are expected to be minor, localised and not result in any significant impact on the creeks and gullies outside of natural variance.

In addition to these factors, the native vegetation and habitat along the creeklines is not dependent on water flows. Therefore any changes are not likely to have a significant impact on native vegetation or potential habitat along the creeks.

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. Given that farm dams are unlikely to be impacted by the proposal (MSEC 2007), and also that they provide only marginal habitat for some terrestrial plant and animal species, it is not likely that impacts to dams would have a significant impact on terrestrial flora and fauna values within the Study Area.

2.5.5 Cliffs and Natural Rock Platforms

Based on an assessment of tilts, compressive and tensile strains MSEC have compared the predicted subsidence parameters for Longwalls 34-36 to both predicted and observed impacts of mining case studies on cliffs associated with extraction of Longwalls 301 and 302 of Appin Colliery and Longwalls 1 and 2.

On that basis a summary of the MSEC predictions regarding potential impact of extraction of Longwalls 34-36 on the cliff lines is reproduced below.

The potential for cliff instabilities at Cliffs GR-CL01 and GR-CL02 are expected to be similar to, or slightly greater than that observed as a result of Appin Longwalls 301 and 302, and significantly less than that observed as a result of Dendrobium Longwalls 1 and 2. The reasons for this are:

- Cliffs GR-CL01 and GR-CL02 are located above the goaf edges of West Cliff Longwalls 35 and 36, respectively, where Appin Longwalls 301 and 302 are located at a minimum distance of 50 metres from the cliffs along the Cataract River Gorge, and Dendrobium Longwalls 1 and 2 directly mined beneath the ridge line

- The maximum predicted tensile and compressive strains at Cliffs GR-CL01 and GR-CL02 of 0.4 mm/m and 0.2 mm/m, respectively, are slightly greater than those predicted at the cliffs adjacent to Appin Longwalls 301 and 302 of 0.2 mm/m and 0.1 mm/m, respectively, and are significantly less than those above Dendrobium Longwalls 1 and 2 of 5 mm/m and 11 mm/m, respectively

- The heights of Cliffs GR-CL01 and GR-CL02 of 10 and 15 metres, respectively, are similar to or less than those adjacent to Appin Longwalls 301 and 302, which ranged between 10 and 37 metres, and are slightly greater than those above Dendrobium Longwalls 1 and 2, which ranged up to 10 metres

The percentage of cliffline disturbed along Cliffs GR-CL01 and GR-CL02, resulting from the extraction of the Longwalls 34 to 36 is, therefore, expected to between 1% and 7 % of the lengths of these cliff lines. This equates to between 1 m and 4.5 m (GR-CL01) and 1 m and 6 m (GR-CL02).

It is expected that the potential impact would be at the lower end of this range, as the predicted movements at these cliffs are closer to those predicted at the cliffs adjacent to Appin Longwalls 301 and 302, than those predicted at the cliffs directly mined beneath by Dendrobium Longwalls 1 and 2.

It is our assessment that such small areas of potential impact along rock faces do not pose a significant alteration to the landscape and are unlikely to impact significantly the terrestrial ecological values of the Study Area.

2.5.6 Steep Slopes

The MSEC report states that it would be expected that any surface cracking that occurs along the steep slopes, as a result of the extraction of the proposed longwalls, would be of a minor nature due to the relatively small magnitudes of predicted systematic strains and due to the relatively high depths of cover. Minor surface cracking tends to heal naturally, especially during rain events. If any significant cracking were to be left untreated, however, erosion channels could develop along the steep slopes. In this case, it is recommended that appropriate mitigation measures should be undertaken, including infilling of surface cracks with soil or other suitable materials, or by locally regrading and re-compacting the surface.

The slopes within the Study Area have natural gradients typically less than 1 in 2, and the depths of cover where these slopes occur are greater than 500 metres. It is unlikely, therefore, that the predicted systematic strains would be of sufficient magnitudes to result in the slippage of soils down the steep slopes.

With remediation measures in place, it is unlikely that there would be any significant impact on the native vegetation of the Study Area and on threatened biota or their potential habitats.

2.5.7 Devines Tunnel

Devines Tunnel 1 is located outside the general SMP Area and is at a distance of 860 metres south of Longwall 34. Devines Tunnel 2 crosses the western side of the general SMP Area and is at a distance of 340 metres west of Longwall 33. It is unlikely, therefore, that the tunnels would be subjected to any significant systematic subsidence movements resulting from the extraction of the proposed longwalls.

The tunnels could be subjected to very small far-field horizontal movements as a result of the extraction of the proposed longwalls but these are considered unlikely to be significant.

It is therefore, considered unlikely that any native fauna utilising Devines Tunnel would be impacted by the proposal.

2.5.8 The Likelihood of Surface Cracking in Soils

The MSEC report states soil cracking caused by subsidence associated with the extraction of Longwalls 34-36 may occur within the Study Area. These cracks may occur within topsoil layers and are likely to be approximately 25 mm in

width. Surface cracking in itself is not considered likely to significantly impact any terrestrial flora and fauna values.

2.5.9 The Likelihood of Gas Emissions at the Surface

Gas emissions may result from the liberation of gases that are trapped below the grounds surface when surface fracturing or cracking occurs.

Gas emissions, under certain environmental conditions, may sometimes result in vegetation dieback. This phenomenon has previously been observed within the Cataract River where small patches of vegetation were affected. Such impacts are usually short lived and in the case of the riparian vegetation within the Cataract River it has adequately revegetated.

The MSEC report states that it is therefore possible, that gas emissions would result in vegetation dieback in the Georges River due to the extraction of the proposed Longwalls. In the unlikely event that vegetation die-back was observed in the Georges River, 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.

3.0 METHODS

3.1 Taxonomy

Plants

Plants were identified using *PlantNET* (Botanic Gardens Trust 2007) and relevant volumes of the *Flora of NSW* (Harden 1992a; Harden 1993b; Harden 2000; Harden 2002b). Other key references consulted for this report included Fairley and Moore (Fairley and Moore 2000b), Robinson (Robinson 2003) and advice was sort from the National Herbarium of NSW for unconfirmed specimens.

Where necessary, current plant names were verified with the *Australian Plant Name Index* (ANBG 2007).

In the body of this report, plants are referred to by their scientific names only. Common names, where available, have been included in the Appendices.

Animals

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

3.2 Literature and Database Review

3.2.1 Relevant Previous Reports

Relevant previous reports referred to as background information for this assessment include; (Richardson and O'Sullivan 2001; Richardson 2001; Harrington and English 2002; Richardson 2002; Richardson, English et al. 2003, Harrington and Smith 2005). Further, the field work for some of these assessments included surveys that took in some of the current Study Area including the Georges River, the Nepean River and tributary creeks.

3.2.2 Threatened Species Records And Potential Habitat Information

A list of documents used to prepare this report is located in *References*. Records of threatened species, populations and communities were obtained from the

Department of Environment and Climate Change (DECC) *Atlas of NSW Wildlife* within a 10 km radius of the Study Area.

Potential occurrences of threatened species, populations and communities listed on the EPBC Act were obtained from the Department of Environment and Water Resources (DEW) *EPBC Online Database* within a 10 km radius of the Study Area. Database searches were conducted in June 2007.

Potential habitat information on each of the considered threatened species was derived from the internal Biosis Research Threatened Species Database.

3.2.3 Mapping

MapInfo was the GIS package used for the production of the relevant figures. The GIS layers utilised were derived from a variety of sources and included:

- digital topographic data;
- IBRA regions (Thackway and Cresswell 1995);
- local vegetation mapping; Vegetation mapping used for this report included (NPWS 2003b; NPWS 2002b)
- threatened species data derived from the *Atlas of NSW Wildlife*; and,
- relevant aerial photography.

This data was used to create base maps that aid in development of survey design and effort. All maps were produced by qualified GIS officers at Biosis Research.

3.3 Flora Survey

The Study Area was inspected on the 12 and 13 of July 2007. The condition of the Study Area was assessed and observations of plants, animals and plant communities were made (as detailed below). During the site visit the weather was cold and fine.

3.3.1 Flora

Flora and vegetation communities were surveyed using the random-meander method, as described by Cropper (Cropper 1993). The meander route is designed to traverse all communities and topographical features within the Study Area, recording plants as they are encountered. Potential habitat for threatened species was surveyed in greater detail. This approach aims to provide a list of dominant flora species within the Study Area. It does not seek to provide an exhaustive list of plants that occur within the Study Area or analyse plant community similarity, as may be achieved through vegetation quadrat sampling program.

Information recorded during the flora survey at each of the survey sites included; location (GPS), photograph, soil type, aspect, slope, horizon visibility, community structure and composition, the presence of threatened plants and ecological communities (or their potential habitat), fire history, condition, flora species list and habitat description.

3.3.2 Vegetation Condition Assessment

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

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

The categories are as follows:

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

Moderate: containing a moderate number of indigenous species; moderate level of weed invasion; weeds occurring in isolated patches or scattered throughout; one or more of original layers of vegetation are modified; 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,

Unnatural landscape: highly modified landscape containing few or no indigenous species; exotic species dominant; original native vegetation layers

removed; natural soil profile disturbed; unable to be regenerated to natural condition; requires a high input of resources to achieve restoration goals.

3.4 Fauna Survey

Animal species using the site 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.

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

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

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

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

3.5 Impact Assessment Methodology

Impact assessments were carried out on threatened biota that occur or have the potential to occur within the Study Area and only if subsidence related landscape alteration may impact upon potential habitat.

Where subsidence may impact threatened biota listed on the TSC Act, or their potential habitats, Assessments of Significance (Seven Part Tests) are conducted to assess the significance of the impact. In the instance that a Seven Part Test concludes that a significant impact on a species is likely, a Species Impact Statement may be required.

Where subsidence may impact threatened biota listed on the EPBC Act, or their potential habitats, an address of Significant Impact Criteria is required. In the instance that the address of the Significant Impact Criteria concludes that a significant impact on a species is likely, a Referral to the Federal Minister for the Environment may be required.

It should be noted that, where potential habitat for threatened biota has been recorded within the Study Area, there may be no known mechanism in which that particularly habitat type may be impacted by subsidence (e.g. tree hollows). In the absence of direct or indirect impacts on potential habitat for threatened biota, Seven Part Tests under the TSC Act and Significant Impact Criteria under the EPBC Act have not been conducted for these species.

3.6 Limitations

Field surveys were focussed on the major drainage lines within the Study Area, which are likely to be the main areas of potential impact in respect to ecological values associated with longwall mining subsidence in the Study Area. These drainage lines also coincide with the main patches of native vegetation found in the Study Area. Inspection from adjacent roads and review of high definition aerial photography is considered appropriate for the assessment of ecological values in the cleared paddocks for this impact assessment.

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.

This study was by design a habitat based assessment and was conducted in accordance with the methodology employed for an assessment under Section 5A of the EP&A Act. Therefore 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 biota, such techniques are not necessary. The habitat based approach is conservative in nature, requiring only the presence of habitat, not individual records, for threatened biota to be considered further.

The methodology employed for this assessment is sufficient to determine if mining Longwalls 34-36 would have a significant impact on any threatened biota as listed under the TSC or EPBC Acts.

It is important to note that the methodology employed in this impact assessment would have limited capacity to allow quantitative pre and post mining impact analysis to be made.

4.0 RESULTS

4.1 Plant Communities

Figure 3 illustrates that six plant communities are present within the Study Area. Figure 3 is derived from NPWS (NPWS 2000). These include;

- Sandstone Ridgetop Woodland,
- Cumberland Plain Woodland,
- Shale Sandstone Transition Forest,
- Moist Shale Wooland,
- Upper Georges River Sandstone Woodland, and
- Western Sandstone Gully Forest.

Cleared land with little or no flora habitat value was also present within the Study Area. It should be noted that this vegetation is highly modified and does not constitute a native vegetation community. This was mostly improved pasture, which reflects the previous disturbances of vegetation clearing, over-grazing and the addition of fertilisers to the paddocks.

4.1.1 Sandstone Ridgetop Woodland

Sandstone Ridgetop Woodland is dominated by *Corymbia gummifera* and *Eucalyptus sclerophylla* with *Banksia serrata* frequently present at lower abundance. A variety of other tree species occur more sporadically, including *E. punctata, E. oblonga* and *Angophora costata*. A diverse array of shrub species is always present, although depending on the time of the last fire a shrub stratum may not be fully developed. Shrub species may include *Banksia spinulosa* var. *spinulosa, Isopogon anemonifolius, Leptospermum trinervium, Phyllanthus hirtellus, Dillwynia retorta* and *Eriostemon australasius* subsp. *australasius*. The ground stratum is similarly diverse and features species such as *Lomandra obliqua*, *Entolasia stricta*, *Cyathochaeta diandra*, *Dampiera stricta* and *Stipa pubescens*.

This community occurs predominantly on sandstone ridgetops and plateaux, but may extend to the floor of shallow gullies. Sandstone Ridgetop Woodland is structurally variable and may lack a tree stratum. Shrub density is highly variable, with the density of obligate seeders varying as a function of fire frequency. In steeper gullies, woodland grades into one of two forms of Sandstone Gully

Forest, depending on rainfall. In poorly drained areas Woodland abruptly changes to sedgeland.

Approximately 10 hectares of this vegetation type was present as four small patches on the eastern edges of the Study Area. Whilst not all these patches were sampled during the field survey, those that were are considered to be in good condition. Sandstone Ridgetop Woodland does not constitute an Endangered Ecological Community and, due to its position in the landscape, is not likely to be impacted by the proposal.

4.1.2 Cumberland Plain Woodland

Cumberland Plain Woodland is listed as an EEC on both the TSC Act and the EPBC Act. It is composed of two sub-communities, Shale Hills Woodland and Shale Plains Woodland (NPWS 2000), reflecting variation in floristic composition.

Shale Hills Woodland is found on the rugged slopes in the southern half of the Cumberland Plain, with its northern limit at Prospect Reservoir. It occurs on clay influenced soils derived from Wianamatta Shale. The dominant tree species include *Eucalyptus moluccana* and *E. tereticornis* with *E. crebra* occurring less frequently. A small tree layer dominated by *Acacia implexa* is sometimes present with *Bursaria spinosa* usually dominating the shrub layer. Common grasses and ground covers include *Dichondra repens, Brunoniella australis, Aristida ramosa, Desmodium varians, Microlaena stipoides* var. *stipoides, Themeda australis* and *Cheilanthes sieberi* ssp. *sieberi*.

Shale Plains Woodland is found in flatter areas of the Cumberland Plain characterised by clay influenced soils derived from Wianamatta Shale. It grades into a variety of other vegetation communities including Shale Hills Woodland, Shale Gravel Transition Forest and Shale Sandstone Transition Forest. The dominant tree species include *Eucalyptus moluccana* and *E. tereticornis* with *E. crebra, E. eugenoides* and *Corymbia maculata* occurring less frequently. *Exocarpus cupressiformis, Acacia parramettensis* ssp. *parramettensis* and *Acacia decurrens* may occur as a small tree layer and the shrub layer is usually dominated by *Bursaria spinosa*. Ground covers *Dichondra repens, Aristida vagans, Microlaena stipoides* var *stipoides, Themeda australis, Brunoniella australis, Desmodium varians, Opercularia diphylla, Wahlenbergia gracilis* and *Dichelachne micrantha*.

Approximately 64 hectares of Cumberland Plain Woodland is present within the Study Area as isolated and fragmented patches on the western side of Appin Road. These patches are, however, linked by the adjacent Shale Sandstone Transition Forest which is relatively un-fragmented. The bulk of this community

was assessed as being in a poor to moderate condition with substantial impacts from land clearance and grazing. An assessment of the possible impacts of mine subsidence on Cumberland Plain Woodland within the Study Area is provided in Section 5.

4.1.3 Shale Sandstone Transition Forest

Shale Sandstone Transition Forest is listed as an EEC on both the TSC and EPBC Acts. Shale Sandstone Transition Forest is composed of two sub-communities, Shale Sandstone Transition Forest – High Sandstone Influence and Shale Sandstone Transition Forest – Low Sandstone Influence (NPWS 2000).

Shale Sandstone Transition Forest occurs in the transition zone between the surrounding Hawkesbury Sandstone and the clay derived Cumberland Plain and is dominated by *Eucalyptus tereticornis*, with *E. eugenioides*, *E. crebra*, *E. fibrosa* with *E. punctata* occurring less frequently. The sub-community SSTF – High Sandstone Influence is dominated in the understorey by sandstone shrub-layer species such as *Kunzea ambigua* and *Persoonia linearis* (NPWS 2000). The other sub-community SSTF – Low Sandstone Influence is dominated in the understorey by *Bursaria spinosa*, *Themeda australis* and *Echinopogon ovatus* (NPWS 2001).

Approximately 273 hectares of Shale Sandstone Transition Forest is present within the Study Area and forms contiguous patches of vegetation along the plateau above the western bank of the Georges River. It is also present along Mallaty Creek and Leafs Gully on the western side of Appin Road. This community was assessed as being in a moderate condition within the Study Area due to its inherent resilience and un-fragmented state. This assessment was made despite impacts from land clearance, grazing and weed invasion. An assessment of the possible impacts of mine subsidence on Shale Sandstone Transition Forest within the Study Area is provided in Section 5.

4.1.4 Moist Shale Woodland

Moist Shale Woodland is dominated by *Eucalyptus tereticornis* and *E. moluccana*, with *E. crebra* and *Corymbia maculata* occurring more occasionally. A small tree stratum consisting of the same species is often evident, and this may occasionally include species such as *Acacia implexa* or *Acacia parramattensis* subsp. *parramattensis*. A relatively sparse shrub stratum is usually present and dominated by mesophyllic species. *Breynia oblongifolia*, *Clerodendrum tomentosum, Sigesbeckia orientalis* subsp. *orientalis*, *Bursaria spinosa* and *Olearia viscidula* are commonly occurring shrub species. The ground stratum is variable in cover and contains species such as *Desmodium varians*, *Cyperus*

gracilis, Galium propinquum, Cayratia clematidea, Glycine clandestina, Brunoniella australis, Desmodium brachypodum, Dichondra repens, Microlaena stipoides var *stipoides* and *Solanum prinophyllum.*

Moist Shale Woodland is listed as an EEC on the TSC Act, occurs exclusively on soils derived from Wianamatta Shale and is restricted to rugged areas at higher elevations in the southern half of the Cumberland Plain. This community appears to represent the endpoint of the gradient in increasing elevation, rainfall and ruggedness from the central Cumberland Plain to the Razorback range at Picton. It is also possible that Moist Shale Woodland represents a stage in the recovery of Western Sydney Dry Rainforest from fire.

Approximately 0.6 hectares of Moist Shale Woodland is present on the edge of the SMP area, approximately 450 metres to the south of Longwall 34. This community was not sampled during the field assessment, however from the aerial photography (Figure 2) it is likely to be highly disturbed and in poor condition. It is unlikely that this patch of vegetation will be impacted by subsidence as it is not ecologically dependent on water flows and is located on the edge of the SMP area. An assessment of the possible impacts of mine subsidence on Moist Shale Woodland within the Study Area is provided in Section 5.

4.1.5 Upper Georges River Sandstone Woodland

Upper Georges River Sandstone Woodland is dominated by *Eucalyptus punctata* and *Corymbia gummifera*, with *E. oblonga* occurring frequently at lower abundance. *Allocasuarina littoralis* is frequently present, particularly on the upper slopes of gullies where it forms a small tree layer. Diverse shrub and ground strata are always present. Typical shrub species include *Acacia ulicifolia, A. terminalis, A. linifolia, Persoonia linearis, Leptospermun trinervium* and *Exocarpus strictus*. The ground stratum is often dominated by grass species such as *Entolasia stricta, Themeda australis, Stipa pubescens, Aristida vagans* and *Danthonia linkii*. Other species frequently recorded in the ground stratum include *Dianella revoluta, Pomax umbellata, Lepidosperma laterale, Cyathochaeta diandra, Lomandra multiflora* and *Lomandra cylindrica*.

This community is typically found on upper slopes and ridges, with *E. pilularis* becoming dominant descending into the gullies. Soils are sandy in texture, and sandstone outcropping is evident. A strong shale influence in the soil is a result of proximity to the shale/sandstone boundary. The boundary with adjacent shale derived communities is usually abrupt. Upper Georges River Sandstone Woodland grades into Sandstone Ridgetop Woodland with increasing distance from the shale/sandstone boundary. Descending into gullies, the community grades into Western Sandstone Gully Forest.

Approximately 63 hectares of Upper Georges River Sandstone Woodland is present within the Study Area and, in conjunction with Sandstone Ridgetop Woodland and Western Sandstone Gully Forest, forms a band of contiguous vegetation along the sandstone slopes and scarps above the eastern and western banks of the Georges River. This community was assessed as being in a good condition within the Study Area due to its inherent resilience and un-fragmented state. Upper Georges River Sandstone Woodland does not constitute an Endangered Ecological Community and, due to its position in the landscape, is not likely to be impacted by the proposal.

4.1.6 Western Sandstone Gully Forest

Western Sandstone Gully Forest is dominated by *Angophora costata*, *Corymbia gummifera* and *E. pilularis*, with *E. punctata* occurring sporadically on mid-slopes. A sparse layer of smaller trees is usually present, and dominated by *Ceratopetalum gummiferum* and *Allocasuarina littoralis*. The shrub and ground strata are also sparse and often contain slightly fewer species relative to ridgetop communities. Shrub species include *Acacia terminalis*, *Leptospermum trinervium*, *Persoonia linearis* and *Banksia spinulosa* var. *spinulosa*. In the ground stratum, the fern species *Pteridium esculentum* is invariably present, along with the climber *Smilax glycyphylla*. These species were seldom recorded in other communities. Other species frequently recorded in the ground stratum include *Entolasia stricta, Dianella caerulea, Lomandra obliqua, L. longifolia, L. gracilis, Lepidosperma laterale* and *Gonocarpus teucriodes*.

Western Sandstone Gully Forest occurs on the lower slopes of sandstone gullies on the western side of the Woronora Plateau where annual rainfall falls below approximately 1050 mm. The gradation into Sandstone Ridgetop woodland generally occurs less than half way up the slope from the gully floor. In particularly sheltered gullies, mesic species such as *Backhousia myrtifolia* and *Pittosporum undulatum* form a dense small tree stratum. Vines such as *Cissus hypoglauca* may also be locally abundant, and dense patches of fern such as *Calochlaena dubia* also occur.

Approximately 74 hectares of Western Sandstone Gully Forest is present within the Study Area and forms a band of contiguous vegetation along the banks of Georges River. A narrow band of Riparian Scrub usually occupies the creekline, however in this case no Riparian Scrub is present in the Study Area.

Western Sandstone Gully Forest was assessed as being in a good condition within the Study Area due to its inherent resilience and un-fragmented state, despite localised areas of weed infestation. This vegetation community does not constitute an Endangered Ecological Community. However, as outlined in

Sections 2.5.1, 2.5.8 and 2.5.9, Western Sandstone Gully Forest could be affected by subsidence due to longwall mining.

4.2 Flora

4.2.1 Plant Species

A list of all plant species recorded during the field survey is provided in Appendix 1. One hundred and seventy-five (175) vascular plant species were recorded within the Study Area, comprising 147 (84%) native species and 28 (16%) exotic species.

4.2.2 Threatened Plant Species

The database searches as outlined in Section 3.2.2 revealed that 26 threatened plant species listed on the TSC or EPBC Acts have previously been recorded or have potential habitat within 10 km of the Study Area (Table 1).

During the field survey a large population of *Grevillea parviflora* ssp. *parviflora* was found within the Study Area at points GPP 1-4 in Figures 2 and 3. This was the only threatened plant species detected during the field survey. *Grevillea parviflora* ssp. *parviflora* is listed as vulnerable under both the TSC Act and the EPBC Act. As such, *Grevillea parviflora* ssp. *parviflora* is considered further in the Impact Assessment in Section 5.

A further nine threatened plant species are considered to have potential habitat within the Study Area. These include *Acacia bynoeana, Callistemon linearifolius, Leucopogon exolasius, Persoonia bargoensis, Persoonia hirsuta, Pimelea spicata, Pomaderris brunnea, Pterostylis saxicola* and *Pultenaea pedunculata*. The listings for these species are provided in Table 1 and each is considered further for impact assessment in Section 5. It should be noted that *Pultenaea pedunculata* has been previously recorded within the Study Area, whilst *Acacia bynoeana, Callistemon linearifolius, Persoonia hirsuta* and *Pomaderris brunnea* have been previously recorded near or adjacent to the Study Area.

Table 1: Threatened flora with potential habitat within the Study Area.

*Key: **Endangered (E), Endangered Population (EP), Vulnerable (V), Extinct (X)***

Species	EPBC Act	TSC Act	Habitat	Potential Habitat
Acacia baueri ssp. *aspera*	-	V	Restricted to the Sydney region, occurring on the Kings Tableland in the central Blue Mountains and with sporadic occurrences on the Woronora Plateau in the Royal National Park, Mt. Keira district and at Wedderburn. Occurs in low, damp heathlands, often on exposed rocky outcrops. Appears to prefer open conditions; rarely observed where there is any shrub or tree canopy development; and many of the observations of this species have been made following fire, suggesting the species prefers early successional habitats. Peak flowering occurs December to March. ROTAP - 2R (DEC 2005g)	NO
Acacia bynoeana Bynoe's Wattle	V	E	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).	YES
Caladenia tessellata Tessellated Spider Orchid	V	E	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 2005c).	NO
Callistemon linearifolius	-	V	Occurs chiefly from Georges River to the Hawkesbury River where it grows in dry sclerophyll forest (Harden 2002a), open forest, scrubland (Fairley and Moore 2000a) or woodland on sandstone. Found in damp places, usually in gullies (Robinson 1994). Flowers in Spring.	YES
Cryptostylis hunteriana Leafless Tongue Orchid	V	V	This species typically grows in swamp-heath on sandy soils chiefly in coastal districts (Harden 1993a) but has also been recorded on steep bare hillsides (Bishop 1996). Within the Central Coast bioregion, this species has been recorded within Coastal Plains Smooth-barked Apple Woodland (mu 30) and Coastal Plains Scribbly Gum Woodland (Sinclair *et al.* 2006) (Bell 2001).	NO
Cynanchum elegans White-flowered Wax Plant	E	E	Rainforest gullies scrub and scree slopes in Gloucester and Wollongong districts (Harden 1992b). Occurs mainly at the ecotone between dry subtropical rainforest and sclerophyll forest/woodland communities (NPWS 2002a). Has been recorded in dry subtropical rainforest, littoral rainforest, *Leptospermum laevigatum-Banksia integrifolia* Coastal scrub, *Eucalyptus tereticornis* forest and woodland, *Corymbia maculata* forest and woodland and *Melaleuca armillaris* scrub to open scrub (NPWS 2002a).	NO
Epacris purpurascens var. *purpurascens*	-	V	Sclerophyll forest, scrub and swamps from Gosford and Sydney districts (Harden 1992b) specifically this species is thought to require wet heath vegetation (T. James pers. comm.). Characteristically found in a range of habitat 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 2005d).	NO
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. Restricted but locally abundant (Harden 1991).	NO

Species	EPBC Act	TSC Act	Habitat	Potential Habitat
Genoplesium baueri Bauer's Midge Orchid	-	V	This terrestrial orchid species grows in open sclerophyll forest or moss gardens on sandstone. Typically the habtiat is a drier heathy forest (Harden 1993a; Bishop 1996). The species has been recorded from locations between Nowra and Pittwater and may occur as far north as Port Stephens. About half the records were made before 1960 with most of the older records being from Sydney suburbs including Asquith, Cowan, Gladesville, Longueville and Wahroonga. No collections have been made from those sites in recent years. Flowers Dec. - Mar (DEC 2005e).	NO
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 2005f).	YES Recorded in Study Area during field survey
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.	YES
Melaleuca deanei Dean's Melaleuca	V	V	Grows in wet heath on sandstone (Harden 1991). 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 2005h). The species grows in heath on sandstone. Flowers appear in summer but seed production appears to be small and consequently the species exhibits a limited capacity to regenerate. ROTAP; 3R	NO
Persoonia bargoensis Bargo Geebung	V	E	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 Transtion Forest. Like most Geebungs this species seems to benefit from the reduced competition and increased light available on disturbance margins including roadsides (DEC 2005i).	YES
Persoonia hirsuta Hairy Geebung	E	E	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 2002a) 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 2005j).	YES
Persoonia nutans Nodding Geebung	E	E	Grows in Woodland to dry sclerophyll forest on clay soils and old alluviums on the Cumberland Plain (Robinson 1994; Harden 2002a). It is restricted to Castlereagh Scribbly Gum Woodlands, Agnes Banks Woodland, Shale Gravel Transition Forest and Cooks River Castlereagh Ironbark Forest (NPWS 2003a). Peak flowering is from December to January with sporadic flowering all year round.	NO
Pimelea spicata Spiked Rice-flower	E	E	In western Sydney, *Pimelea 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.	YES

Species	EPBC Act	TSC Act	Habitat	Potential Habitat
Pomaderris brunnea Rufous Pomaderris	V	V	Open forest confined to the Colo River & upper Nepean River (Harden 1990), on clay & alluvial soils (Fairley and Moore 1995). In the Hawkesbury/Nepean region, the species is known to be associated with Dry sclerophyll forests (Cumberland, Upper Riverina, Sydney Coastal, Sydney Hinterland, Sydney Sand Flats), Coastal Floodplain Wetlands and Coastal Valley Grassy Woodlands (DEC 2005k).	YES
Pterostylis saxicola Sydney Plains Greenhood	E	E	Most commonly found growing in small pockets of shallow soil in depressions on sandstone rock shelves above cliff lines (NSW Scientific Committee 1997). The vegetation communities that occur above the shelves are either shale/sandstone transition or shale communities. Often occurs near streams. Picnic Point to Picton (Harden 1993a). Currently known from only 5 localities (NSW Scientific Committee 1997). ROTAP; 2E	YES
Pultenaea aristata Prickly Bush-pea	V	V	Restricted to the Woronora Plateau, a small area between Helensburgh, south of Sydney, and Mt Kiera above Wollongong. The species occurs in either dry sclerophyll woodland or wet heath on sandstone. Flowering has been recorded in winter and spring (DEC 2005l).	NO
Pultenaea pedunculata Matted Bush-pea	-	E	Restricted to the Cumberland Plain and near Merimbula where it grows in dry sclerophyll forest and disturbed sites (Harden 2002a). 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 2005m). 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 2005m). At all sites there is a lateritic influence in the soil with characteristic ironstone gravels present (DEC 2005m). This species is known to occur in remnants of Cooks River Clay Plain Scrub Forest (James *et al.* 1999).	YES Previously recorded within the western portion of Study Area
Thesium australe Austral Toad-flax	V	V	Clay soils in grassy woodlands or coastal headlands (James *et al.* 1999). Found in very small populations scattered across eastern NSW, along the coast, and from the Northern to Southern Tablelands. Often found in damp sites in association with *Themeda australis*. A root parasite that takes water and some nutrient from other plants, especially Kangaroo Grass (DEC 2005n).	NO

4.3 Fauna Habitats

The area surrounding the Georges River was burnt in 2001/2002 and then again in 2003. Although there has been sufficient time for the vegetation to recover, fauna habitats recorded in the current assessment are unlikely to fully represent habitats that occurred in the Study Area prior to burning. There was a moderate layer of leaf litter and ground debris such as logs, and many of the shrubs had fully regenerated providing shelter and foraging habitat for animals.

Based on the habitat assessment of the entire Study Area, there are three distinct habitat types: Open Woodland and Forest, Open Water and Disturbed Grasslands. These habitat types are described in more detail below.

4.3.1 Open Woodland and Forest

This habitat type corresponds to the native plant communities as described in Section 4.1 and can be divided between the open forest adjacent to and along the

Georges River and the open woodland along Mallaty Creek and Leaf's Gully west of Appin Road.

Georges River

Habitat along the Georges River was burnt during the 2003 fires, but contains moderate habitat for animals. *Eucalyptus pilularis, E. piperita, A. costata* and *Corymbia gummifera* reaching up to 20 m, dominate the canopy. A number of small to medium hollows are present, providing potential habitat for hollow-dependent species such as small arboreal mammals and microchiropteran bats.

The understorey contains a moderate shrub layer, most of which had fully regenerated at the time of the surveys. The shrub layer is dominated by *Banksia* spp., *Acacia* spp., *Grevillea* spp. and *Hakea* spp. There is a moderate layer of leaf litter and fallen timber within this habitat, which may provide shelter for reptiles and a foraging substrate for birds.

Rock outcrops and overhangs are scattered throughout and these areas may provide shelter for small reptiles and mammals.

This habitat is considered to be in moderate condition.

Mallaty Creek and Leaf's Gully

Habitat along Mallaty Creek and Leaf's Gully corresponded to the open woodland plant communities of Cumberland Plain Woodland and Shale Sandstone Transition Forest. Evidence of burning is sparse and most of this woodland was dominated in the shrub layer by even-aged mature stands of *Kunzea ambigua* and *Bursaria spinosa*. This dense shrub layer provides habitat for a range of woodland bird species. *Eucalyptus tereticornis, E. moluccana, E. crebra, E. punctata* and *Angophora floribunda* reaching up to 20 m, dominate the canopy. A number of small to medium hollows are present, providing potential habitat for hollow-dependent species such as small arboreal mammals and microchiropteran bats.

Herbs, forbs and grasses dominate the ground-layer and there is a moderate layer of leaf litter and fallen timber, which may provide shelter for reptiles and a foraging substrate for some birds.

Rock outcrops and overhangs are not typical in this habitat type though they become more common toward the western end of the Study Area as the creeks and gullies steepen and eventually feed into the Nepean Gorge. These areas may provide shelter for small reptiles and mammals.

This habitat is considered to be in moderate condition.

4.3.2 Open Water

Open water habitats are largely confined to the Georges River, though several smaller pools within the creeks on the western side of the Appin Road retain some very small areas of open water. This fauna habitat is consistent with the aquatic fauna habitat identified by Biosis Research (Biosis Research 2002).

Within the Georges River there are isolated pools and small areas of riffle habitat (shallow rapids) scattered along the river, which contain overhanging vegetation. The riverbank is a mixture of rock and sandy soil with a scattered cover of vegetation. At the time of this survey the water was slightly turbid.

Within the smaller creeks (Mallaty Creek and Leafs Gully) open water habitat is restricted to small pools of stagnant water that are generally subject to run off from agricultural lands.

Open water habitat within the Georges River is considered to be in moderate condition, while open water habitat within the smaller creeks to the west of the Appin Road is considered to be in poor-moderate condition.

4.3.3 Disturbed Grassland Habitat

The disturbed grassland habitat is not representative of natural habitat types in the vicinity of the Study Area, although it is likely to provide potential foraging and basking habitat for a range of native and introduced mammal and bird species, as well as a variety of native reptile species.

This habitat type exists within the agricultural landscape that is subject to ongoing land management, including grazing and cropping.

This habitat type is considered to be in poor condition.

4.4 Fauna Species

The fauna survey within the Study Area consisted of a habitat-based assessment. Incidental observations of fauna species in the Study Area from this and other recent studies (Richardson, English et al. 2003) include, 41 species of birds (two introduced), two reptiles, two amphibians, two native mammals and seven introduced mammals (Appendix 2).

4.4.1 Threatened Fauna

A total of 44 threatened or migratory animal species, as listed on the TSC and/or EPBC Acts, are considered in this report (Table 2). This was derived from the database queries as described in Section 3.2.

Of the 44 threatened or migratory animal species considered in Table 2, 36 species have limited known or potential habitat within the Study Area.

One threatened animal species, the Koala, was recorded in the Study Area during a previous study (Richardson, English et al. 2003). A single koala was recorded (calling) from the Shale Sandstone Transition Forest on the western bank of the Georges River. Although not recorded during this or previous assessments, the Eastern Pygmy Possum *Cercartetus nanus* is reported to occur on a property within the Study Area (Steve McMahon, Appin Resident, *pers. comm*.). However, neither of these species is likely to be significantly impacted by the subsidence resulting from the extraction of the proposed longwalls and as such they have not been assessed further.

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 proposed development on these species.

The proposed development may significantly 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 only possible impact from subsidence is surface flow diversions in the Georges River or other creeks, only animal species with potential habitat in the Study Area that rely on surface water for their survival are considered further. Four of the 36 threatened or migratory animal species with potential habitat in the Study Area (Giant Burrowing Frog, Littlejohn's Tree Frog, Red-crowned Toadlet and Large-footed Myotis), are likely to be dependent on the Georges River for breeding or foraging.

Table 2: Threatened fauna with potential habitat within the Study Area

Key: Listed as Endangered (E) or Vulnerable (V) on the TSC Act or Endangered (e) or Vulnerable (v) or Migratory (m) on the EPBC Act.

Species	EPBC Act	TSC Act	Habitat	Potential Habitat & Potentially Impacted by Subsidence
Amphibians				
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
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).	No
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
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. These creeks are characterised after rain by a series of shallow pools lined by dense grasses, ferns and low shrubs (Thumm and Mahony 1996; Thumm and Mahoney 1997).	Yes
Birds				
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 1993).	No
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).	No
Calyptorhynchus lathami Glossy Black-cockatoo	-	V	Inhabits forest with low nutrients, characteristically with key Allocasuarina species. 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).	No
Climacteris picumnus victoriae Brown Treecreeper (DEC 2005b)	-	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).	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 1983).	No

Species	EPBC Act	TSC Act	Habitat	Potential Habitat & Potentially Impacted by Subsidence
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
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).	No
Hirundapus caudacutus White-throated Needletail	M	-	An aerial species found in feeding concentrations over cities, hilltops and timbered ranges (Pizzey 1983).	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 an associated insects (Forshaw and Cooper 1981). The Swift Parrot is dependent on flowering resources across a wide range of habitats in its wintering grounds in NSW (Shields and Crome 1992). This species is migratory, breeding in Tasmania and also nomadic, moving about in response to changing food availability (Pizzey 1983).	No
Melanodryas cucullata Hooded Robin	-	V	This species lives in a wide range of temperate woodland habitats, and a range of woodlands and shrublands in semi-arid areas (Traill and Duncan 2000).	No
Melithreptus gularis gularis Black-chinned Honeyeater	-	V	Found mostly in open forests and woodlands dominated by box and ironbark eucalypts (Higgins *et al.* 2001). It is rarerly recorded east of the Great Dividing Range (Higgins *et al.* 2001).	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 1983).	No
Myiagra cyanoleuca Satin Flycatcher	M	-	Migratory species that occurs in coastal forests, woodlands and scrubs during migration. Breeds in heavily vegetated gullies (Pizzey 1983).	No
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 which are moist (Higgins 1999).	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 1983).	No
Ninox strenua Powerful Owl	-	V	Occupies wet and dry eucalypt forests and rainforests. Can occupy both un-logged and lightly logged forests as well as undisturbed forests where it usually roosts on the limbs of dense trees in gully areas. It is most commonly recorded within Red Turpentine in tall open forests and Black She-oak within open forests (Debus and Chafer 1994). Large mature trees with hollows at least 0.5 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).	No
Pyrrholaemus sagittata Speckled Warbler	-	V	This species occurs in eucalypt and cypress woodlands on the hills and tablelands of the Great Dividing Range. They prefer woodlands with a grassy understorey, often on ridges or gullies (Blakers 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. Home ranges vary from 6-12 hectares (NSW Scientific Committee, 2001).	No
Rhipidura rufifrons Rufous Fantail	M	-	Migratory species that prefers dense, moist undergrowth of tropical rainforests and scrubs. During migration it can stray into gardens and more open areas (Pizzey 1983).	No

Species	EPBC Act	TSC Act	Habitat	Potential Habitat & Potentially Impacted by Subsidence
Rostratula benghalensis australis Australian Painted Snipe	V	E1	The Australian Painted Snipe is usually found in shallow inland wetlands, either freshwater or brackish, that are either permanently or temporarily filled. It nests on the ground amongst tall reed-like vegetation near water, and feeds near the water's edge and on mudflats, taking invertebrates, such as insects and worms, and seeds. The Australian Painted Snipe is also possibly nomadic, appearing to temporarily occupy areas of suitable habitat	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).	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 forests associations and wet lowland coastal forests (NPWS 1999c; Pizzey 1983).	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 0.5ha area over a 5 month period (Ward 1990).	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 1998b). This species roosts in caves and mines in groups of between 3 and 37 individuals (Churchill 1998b).	No
Dasyurus maculatus Spotted-tailed Quoll	E	V	Uses a range of habitats including sclerophyll forests and woodlands, coastal heathlands and rainforests (Dickman and Read 1992). Habitat requirements include suitable den sites, including hollow logs, rock crevices and caves, an abundance of food and an area of intact vegetation in which to forage (Edgar and Belcher 1995).	No
Falsistrellus tasmaniensis Eastern False Pipistrelle	-	V	Inhabit sclerophyll forests, preferring wet habitats where trees are more than 20 m high (Churchill 1998b). 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).	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).	No
Miniopterus schreibersii bassanii Common Bent-wing Bat	C	V	Uses a broad range of habitats including rainforests, wet and dry sclerophyll forests, open woodlands and open grasslands (Churchill 1998b). Roosts in caves, but can also use manmade structures such as mines and road culverts (Dwyer 1995; Churchill 1998b). Specific caves are used as nursery caves, containing a large number of individuals, which can be used year after year (Dwyer 1995; Churchill 1998b).	No
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 1998b).	No
Myotis 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 1998b).	Yes
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).	No

Species	EPBC Act	TSC Act	Habitat	Potential Habitat & Potentially Impacted by Subsidence
Petaurus norfolcensis Squirrel Glider	-	V	Generally occurs in dry sclerophyll forests and woodlands but is absent from dense coastal ranges in the southern part of its range (Suckling 1995). Requires abundant hollow bearing trees and a mix of eucalypts, banksias and acacias (Quin 1995). There is only limited information available on den tree use by Squirrel gliders, but it has been observed using both living and dead trees as well as hollow stumps (Gibbons and Lindenmayer 1997). Within a suitable vegetation community at least one species should flower heavily in winter and one species of eucalypt should be smooth barked (Menkhorst *et al.* 1988).	No
Petrogale penicillata Brush-tailed Rock-wallaby	V	E1	Found in rocky areas in a wide variety of habitats including rainforest gullies, wet and dry sclerophyll forest, open woodland and rocky outcrops in semi-arid country. Commonly sites have a northerly aspect with numerous ledges, caves and crevices (Eldridge and Close 1995).	No
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 *et al.* 1990; Reed and Lunney 1990).	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).	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).	No
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 1998b)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 1998b).	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).	No
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).	No
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 2000).	No

4.4.2 Koala Habitat (SEPP 44)

This Policy 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.

Potential habitat for the Koala (*Phascolarctos cinereus*) occurs in parts of the Study Area. However, potential habitat for this species is unlikely to be

significantly impacted by subsidence. Therefore a SEPP 44 Assessment is not required.

5.0 IMPACT ASSESSMENT

Several threatened species and habitat for a range of other threatened species have been recorded from the Study Area. The affects of subsidence associated with the extraction of Longwalls 34-36, on threatened species and habitats for threatened species that may occur within the Study Area have been defined in Section 2.5 above. The impact of the proposed longwall extraction on threatened species therefore only considers those threatened plant or animal species for which the subsidence impacts defined in Section 2.5 may either directly or indirectly affect.

The following impact assessment only considers endangered ecological communities and threatened flora and fauna (and their potential habitats) that are listed on the TSC and EPBC Acts or both.

5.1 Endangered Ecological Communities

Three Endangered Ecological Communities (EECs) were recorded in the Study Area (Figure 3). They include Cumberland Plain Woodland and Shale Sandstone Transition Forest which are both listed as EECs on the TSC Act and the EPBC Act, and Moist Shale Woodland which is listed on the TSC Act only.

Each of these EECs occur on the undulating topography on shale derived and shale influenced sandy soils respectively. While creeks and or drainage lines may cut thorough these EECs, they are entirely terrestrial in nature. Unlike wetlands or other flow-dependent vegetation communities, they are not dependent on the flow of water from creeks or streams. Surface cracking, as predicted by MSEC, is likely to be the only subsidence related impact to occur within these EECs, and cracking alone is unlikely to alter the species composition or distribution of these communities. For these reasons it is considered unlikely that subsidence impacts would have a significant impact on these EECs within 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. The impact of the gas emissions above these workings was localised and resulted in the loss of some plants in a very small area and that the vegetation recovered after gas emissions ceased. Gas emissions are unlikely to result in the alteration of species distribution or composition within the three EECs and, as such, it is considered that the proposed longwall activities would be unlikely to have a significant impact on these EECs. Seven Part Tests (TSC Act) and Significant Impact Criteria (EPBC Act) have not been carried out for these EECs in this case as no significant impacts are predicted to occur.

5.2 Threatened Flora

Potential habitat within the Study Area exists for nine threatened plant species: *Acacia bynoeana, Callistemon linearifolius, Leucopogon exolasius, Persoonia bargoensis, Persoonia hirsuta, Pimelea spicata, Pomaderris brunnea, Pterostylis saxicola* and *Pultenaea pedunculata*. It should be noted that *Pultenaea pedunculata* has been previously recorded within the western part of the Study Area but was not recorded during the field survey for this assessment. *Acacia bynoeana, Callistemon linearifolius*, *Persoonia hirsuta* and *Pomaderris brunnea* have been previously recorded adjacent to the Study Area. *Grevillea parviflora* ssp. *parviflora* was the only threatened plant species recorded within the Study Area during the field survey. Its location can be seen on the eastern side of the Georges River in Figures 2 and 3.

The volume of water available for plant use within the Study Area is unlikely to be significantly altered. It is therefore considered unlikely that subsidence impacts would result in a broad change in the floristic composition of the riparian zone. However, subsidence may affect the way in which water is made available to plants within the area, leading to small changes in riparian vegetation.

Potential changes in the riparian vegetation may include:

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

None of the threatened plant species listed above, or their potential habitats, are dependent on water availability or riparian vegetation. All are found away from potentially impacted riparian areas, if not on relatively unaffected plateau and ridgelines. As such it is unlikely that any of these species would be significantly impacted by subsidence. None of these species are aquatic plants and they would generally be confined in distribution to the drier sclerophyll vegetation of the Sandstone Ridgetop Woodland, Upper Georges River Sandstone Woodland and Western Sandstone Gully Forest communities. Seven Part Tests and Significant Impact Criteria have not been conducted for any threatened flora as no significant impacts are predicted to occur.

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 Georges River bed will occur, but it is unlikely to result in any noticeable loss of surface water flows or quality (Ecoengineers 2007). Any fractures that do occur may result in surface flows being redirected into the dilated strata below to re-surface downstream and/or reduced overflow and increased leakage at rockbars. However, observations indicate that surface flow diversions are generally limited to sections of river located directly above the longwalls, which is not the case here (i.e. none of the longwalls extend completely under the Georges River). It is therefore unlikely that native fauna that rely on these areas will be significantly impacted by the proposed longwall extraction.

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 2007). 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 loss 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 2007). 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 associated pools are ephemeral and it is likely that fauna reliant on them would be adapted to using a non-perennial water source. It is therefore unlikely that native fauna that rely on these areas will be significantly impacted by the proposed longwall extraction.

Small areas of two cliff lines in the Georges River valley have been identified as potentially being subject to alteration by mining. As discussed above, the predicted extent of possible alteration equates to a maximum of 21 and 16 m of the cliff lines respectively. Cliff lines are unlikely to be impacted in the western end of the Study Area (i.e. Nepean River valley and associated tributaries). 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 are unlikely to result in adverse water quality impacts Gas emissions are expected to be very low and it is unlikely that any significant negative impacts on fauna or their habitats will occur.

Water quality has been discussed in detail in Section 2.5.2 of this report. Water quality in both the Georges River in the east and the Nepean River and associated tributaries in the west of the Study Area is not likely to be significantly altered by the proposal and therefore is unlikely to alter habitats of terrestrial ecological values.

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 not 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 36 threatened or migratory animal species (Table 2). Four of these species, if present, are likely to be dependent on the Georges River for breeding or foraging.

The pools along the Georges River and its associated drainage lines 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 hence disrupt their life cycle. Frog species considered further in the impact assessment include the Giant Burrowing Frog, Littlejohn's Tree Frog and the Red-crowned Toadlet.

The impact assessment (Appendix 3) 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 small.

Habitat for the Red-Crowned Toadlet exists within the feeder streams to the Georges and Nepean Rivers. These streams are ephemeral within the Study Area and are dry for most of the year. It would appear that these streams would only flow during and following a substantial rain event. Subsidence impacts may reduce surface flows to these areas though it is recognised that during a high flow event only a very small percentage of the flow would be lost to fractured strata (which may be a result of subsidence). Furthermore, habitat for this species is widespread in the vicinity of the Study Area and in the greater region. For these reasons it is considered unlikely that the proposed Longwalls mining activities would have a significant impact on this species.

One bat species, the Large Footed Myotis may utilise open water habitats as a foraging area. This species forages along the creek line and pools where it feeds on small fish and insects. The potential short-term loss of pools in the creek as a result of subsidence may reduce the foraging area available to individuals. Subsidence is unlikely to result in the loss of all pools in the Study Area and

given the large areas of potential habitat for this species in the vicinity of the Study Area and in the region, it is considered unlikely that subsidence would have a significant impact on this species.

Consideration was also given to fauna species that may be dependent on caves for roosting habitat such as several microchiropteran bat species and the Spotted-tailed Quoll. Rock shelves and caves within the Georges River valley may be subject to impacts from subsidence, in the form of localised rock falls, although these impacts are considered highly unlikely. It is unlikely that a significant area of cave habitat would be impacted by the proposed development.

The remaining threatened fauna species that have 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 likely to remain unaffected by subsidence. Seven Part Tests were not completed for these species in this assessment.

6.0 CONCLUSION

This report assesses the terrestrial flora and fauna of the areas that may be impacted by subsidence associated with the mining of Longwalls 34-36 of the West Cliff Colliery Area 5 workings. Field surveys for this flora and fauna assessment were conducted over several years and will provide some baseline data to which the post-mining habitat type and condition may be compared. However, the habitat based nature of the assessment will limit the comparison of pre and post mining habitat conditions to gross changes in species composition and plant community or fauna habitat features.

Subsidence impacts within the Study Area may potentially result in the alteration of flows from some pools within the Georges River and, possibly, the localised emission of gas and cracking in soils and fracturing bedrock on the surface. However, these effects are not expected to represent a significant impact to the terrestrial ecological values of the area.

Endangered Ecological Communities

Three EECs are mapped as occurring in the Study Area (Figure 3). They include Cumberland Plain Woodland and Shale Sandstone Transition Forest, which are listed on both the TSC and EPBC Acts, and Moist Shale Woodland which is listed on the TSC Act only.

None of these EECs are dependent on continual flows from the creek and rivers of the Study Area and potential surface fracturing and gas emissions 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 that the proposed longwall mining activities and the associated subsidence impacts would be unlikely to have a significant impact on any EEC within the Study Area.

As such, Assessments of Significance under the EP&A Act and Significant Impact Criteria under the EPBC Act have not been conducted for any EEC within the Study Area.

Flora

Grevillea parviflora ssp. *parviflora* was recorded in the eastern portion of the Study Area during the field surveys and potential habitat for a further nine threatened plant species occurs within the Study Area. Habitat for these species occurs within drier habitats that are 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 plant species within the Study Area.

As such, Assessments of Significance under the EP&A Act and Significant Impact Criteria under the EPBC Act have not been conducted for any threatened flora within the Study Area.

Fauna

One threatened animal species, the koala, was recorded from the western bank of the Georges River during a previous study (Richardson, English et al. 2003). This species is unlikely to be directly effected by the proposed longwall mining activities. Furthermore, habitat for this species, including the open woodland and forest vegetation of the Study Area is unlikely to be impacted by the proposed activities. For these reasons it is considered unlikely that there would be a significant impact on this species.

Habitat for several other 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 that the project is unlikely to represent a significant impact to any threatened and/or migratory animal species.

7.0 RECOMMENDATIONS

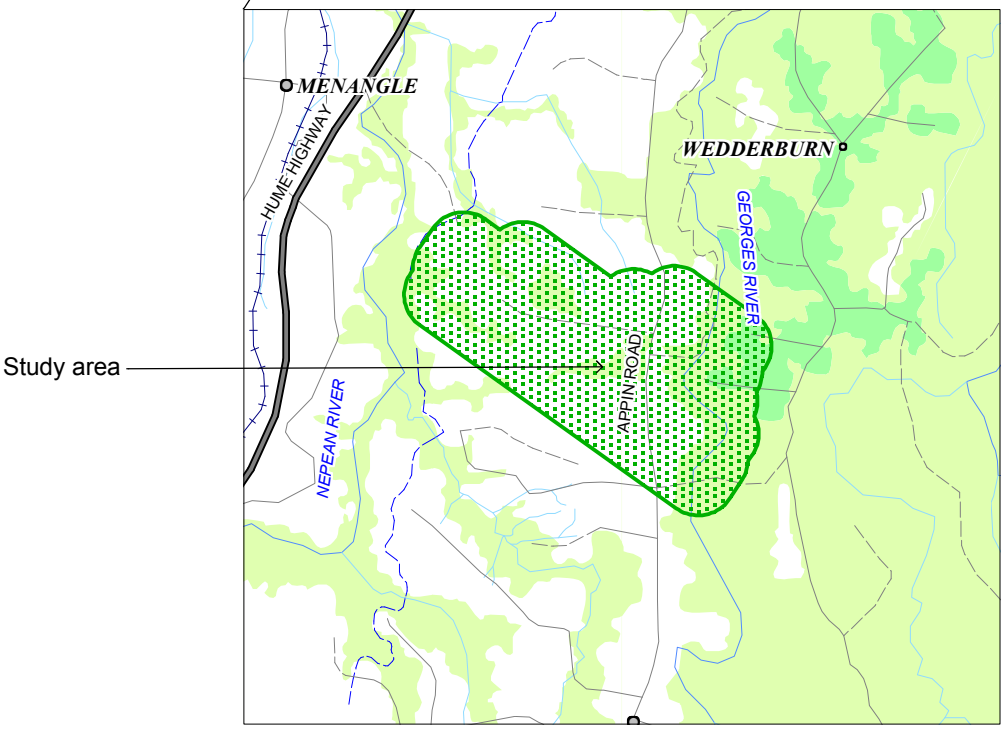
This study provides a qualitative assessment of the potential impacts of mining related subsidence effects on threatened species, populations and ecological communities (threatened biota). The assessment also provides qualitative base-line data on the vegetation communities, fauna habitats and species 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 methane die-off in vegetation is observed, action should be taken to monitor the extent and recovery of any such vegetation. Locally indigenous plant species should be utilised for any rehabilitation that may be required.

- In the unlikely event, that fractures in the bedrock results in fractures in major surface flow diversion and/or drainage of significant pools, remedial actions(s) should be undertaken to re-establish surface flows and pool function.

- Species Impact Statements and/or Referrals to the Environment Minister are not recommended for any vegetation communities or plant or animal species.

FIGURES



Study area

BIOSIS RESEARCH Pty. Ltd.

15 - 17 Henrietta Street
Chippendale
NEW SOUTH WALES 2008

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

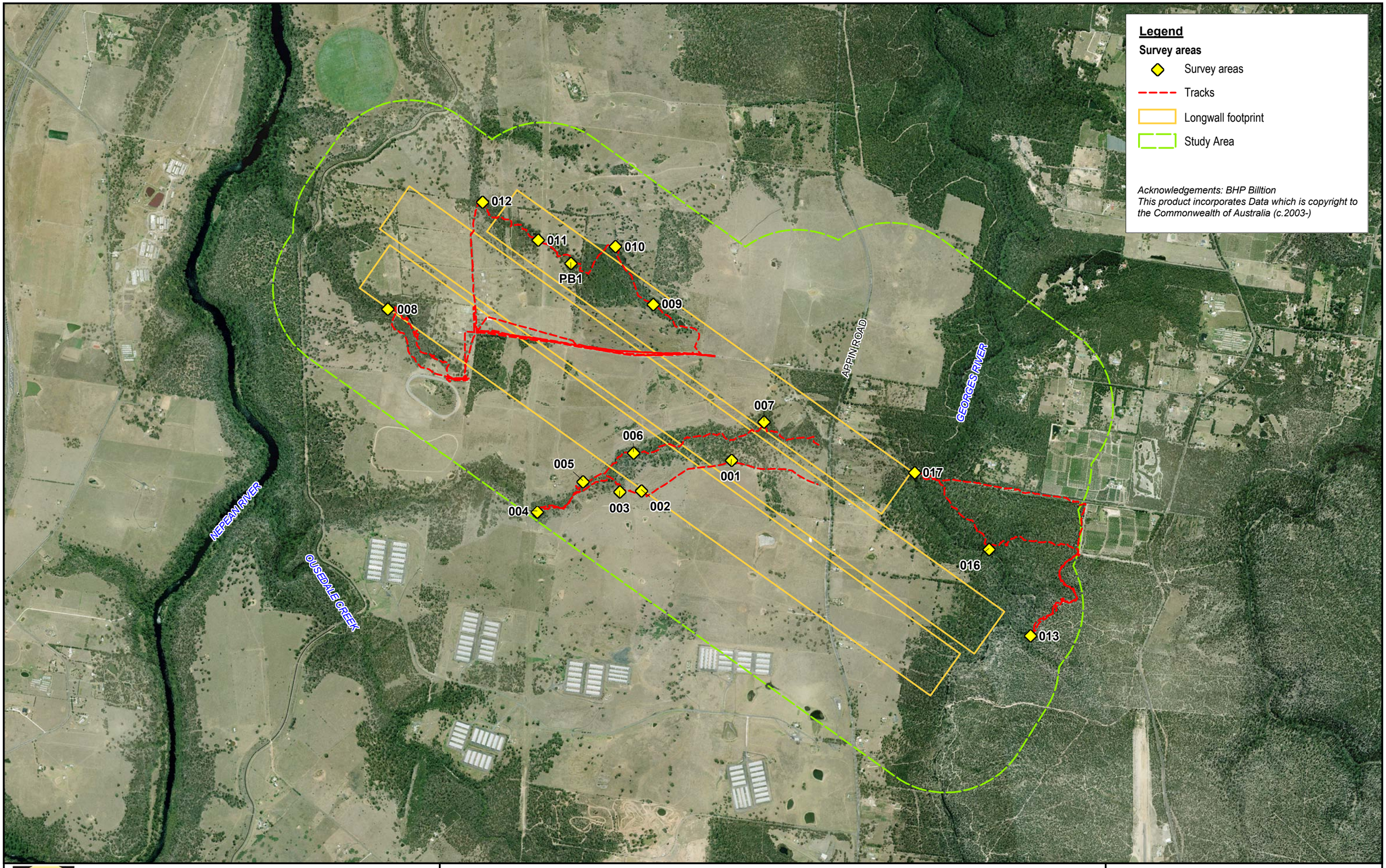
DATE: 16 December 2007

Checked by: NS | File number: S4656

Location:-...4000\4600s\4656\Mapping\S4656 F1_region.WOR

Scale: 0 1 2 3 4 kilometres

N W E S



BIOSIS RESEARCH Pty. Ltd.

15 - 17 Henrietta Street
Chippendale
NEW SOUTH WALES 2008

Figure 2: Overview of the Study Area.

DATE: 19 December 2007

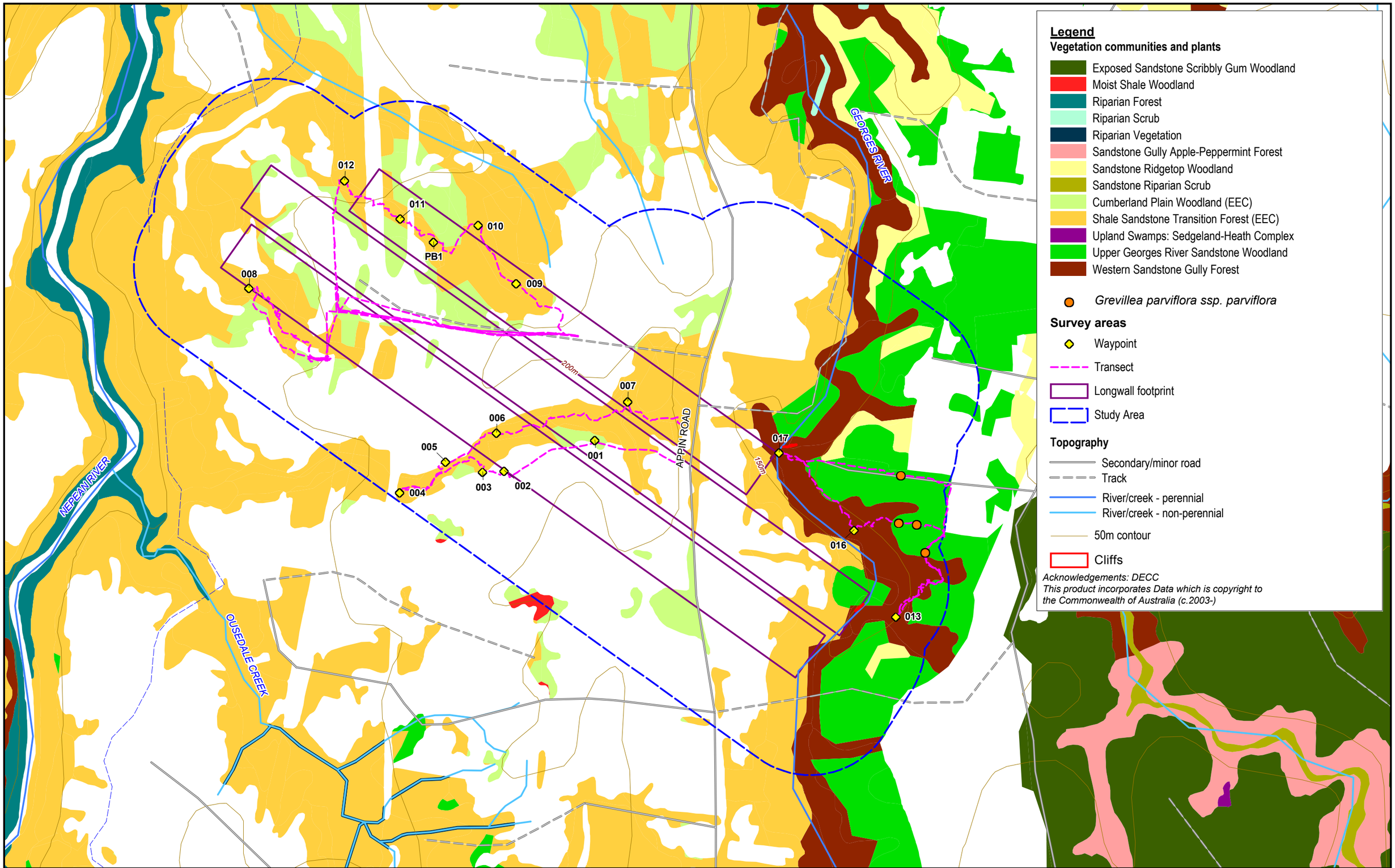
Checked by: NS | File number: S4656

Location:-..4000\4600s\4656\Mapping\S4656 F2_overview.WOR

Scale: 0 0.2 0.4 0.6 0.8 1.0 kilometres

N W E S

Figure 2: Overview of the Study Area.



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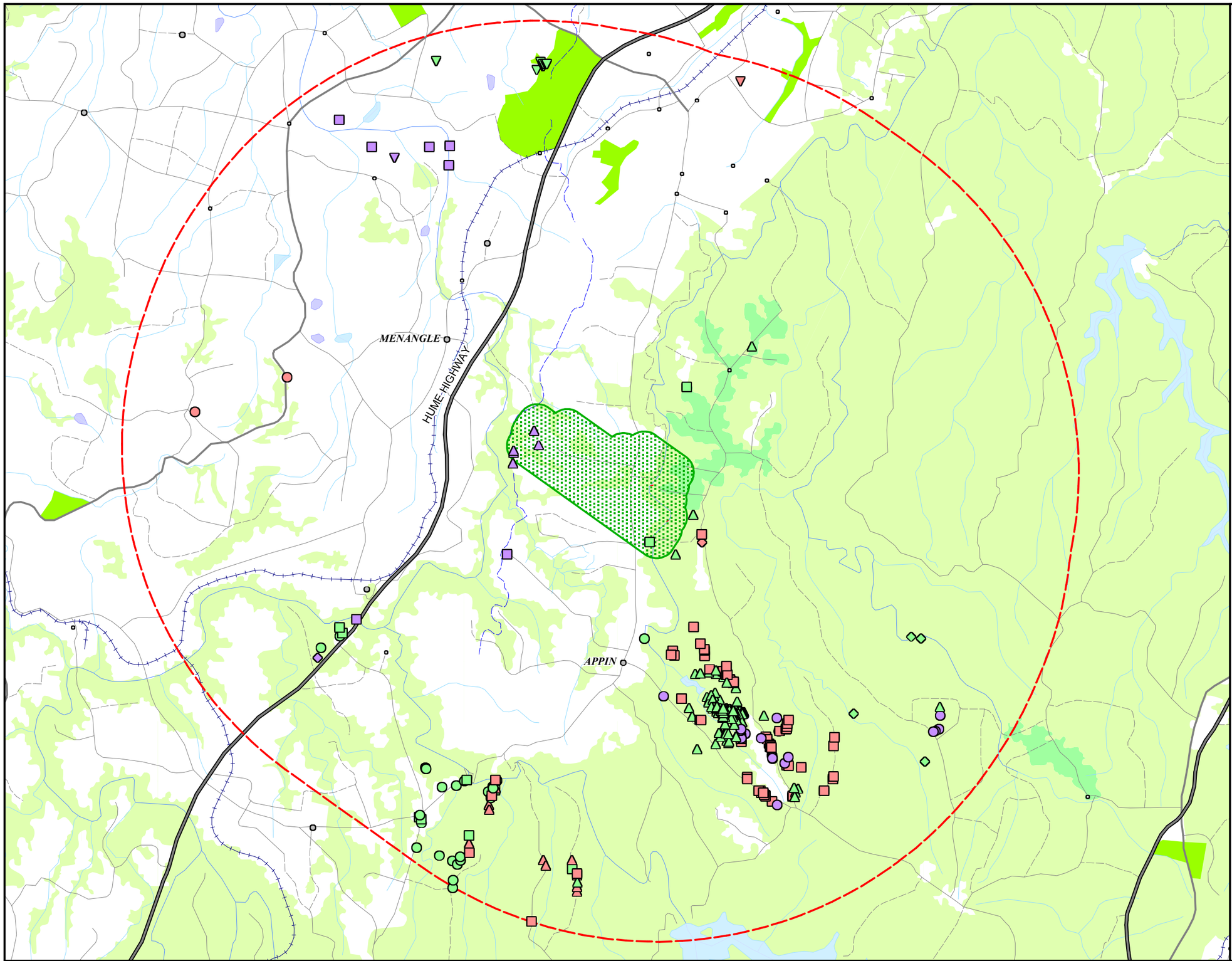
NEW SOUTH WALES 2008

Figure 3: Vegetation communities within the vicinity of the Study Area.

DATE: 3 January 2008
Checked by: MR
File number: S4656
Location:-..4000\4600s\4656\Mapping\S4656 F3_veg.WOR

Scale: 0 0.2 0.4 0.6 0.8 1.0 kilometres

Figure 3: Vegetation communities within the vicinity of the Study Area.



Legend

Threatened flora

- *Acacia bynoeana*
- *Callistemon linearifolius*
- *Cynanchum elegans*
- *Epacris purpurascens var. purpurascens*
- *Genoplesium baueri*
- *Grevillea parviflora subsp. parviflora*
- *Leucopogon exolasius*
- *Persoonia bargoensis*
- *Persoonia hirsuta*
- *Pimelea spicata*
- *Pomaderris brunnea*
- *Pterostylis saxicola*
- *Pultenaea aristata*
- *Pultenaea pedunculata*
- *Thesium australe*

Survey areas

- Study Area
- 10km search area

Topography

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

Acknowledgements:
- *Species records from DEC Atlas of NSW Wildlife and Biosis*
- *This product incorporates Data which is copyright to the Commonwealth of Australia (c.2003-)*

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Figure 4: Threatened flora, listed on the TSC Act, recorded within 10km of the Study Area.

DATE: 3 January 2008

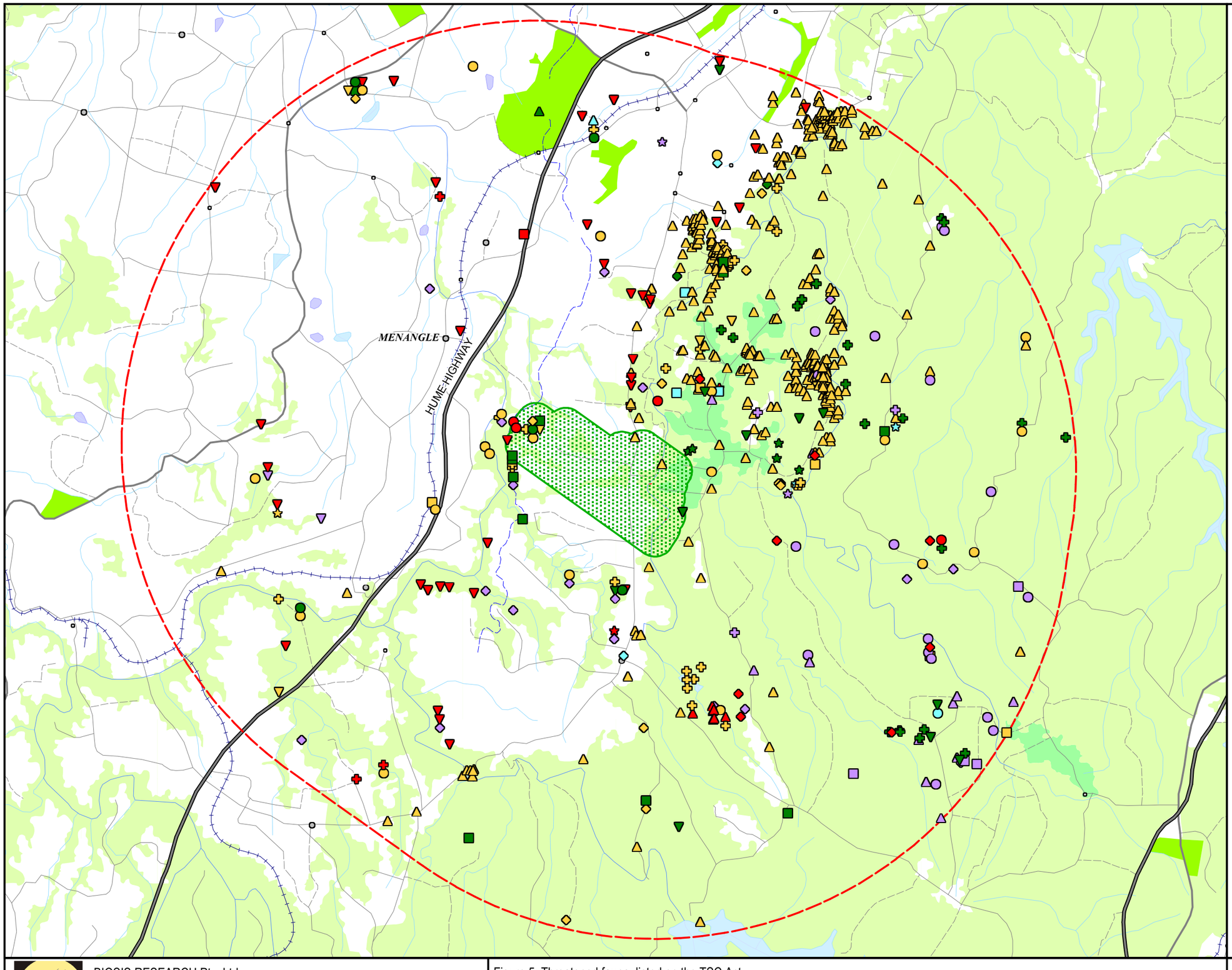
Checked by: NS | File number: S4656

Location:-..4000\4600s\4656\Mapping\S4656 F4_flora.WOR

Scale: 0 1 2 3 4 5 kilometres

N W E S

Figure 4: Threatened flora, listed on the TSC Act, recorded within 10km of the Study Area.



Legend

Threatened fauna

- Black-necked Stork
- Broad-headed Snake
- Brown Treecreeper (eastern subspecies)
- 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
- Littlejohn's Tree Frog
- 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

- Study Area
- 10km search area
- Cliffs

Acknowledgements:
- Species records from DEC Atlas of NSW Wildlife and Biosis
- This product incorporates Data which is copyright to the Commonwealth of Australia (c.2003-)

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15 - 17 Henrietta Street
Chippendale
NEW SOUTH WALES 2008

Figure 5: Threatened fauna, listed on the TSC Act, recorded within 10km of the Study Area.

DATE: 3 January 2008

Checked by: NS | File number: S4656

Location:-..4000\4600s\4656\Mapping\S4656 F5_fauna.WOR

Scale: 0 1 2 3 4 5 kilometres

N W E S

Figure 5: Threatened fauna, listed on the TSC Act, recorded within 10km of the Study Area.

APPENDICES

Appendix 1
FLORA RESULTS

Flora recorded within the Study Area. *Species marked with an asterisk (*) are introduced.*

Species	West end of Study Area	East end of Study Area
	Shale Communities	Sandstone Communities
Acacia binervata	+	
Acacia decurrens	+	
Acacia linifolia		+
Acacia longifolia		+
Acacia melanoxylon		+
Acacia myrtifolia		+
Acacia parramattensis	+	+
Acacia suaveolens		+
Acacia terminalis		+
Acacia ulicifolia	+	+
Actinotus minor		+
Adiantum aethiopicum	+	
**Ageratina adenophora*	+	
Allocasuarina littoralis	+	+
Allocasuarina torulosa	+	
Amperea xiphoclada var. *xiphoclada*		+
**Anagallis arvensis*	+	
Angophora costata		+
Angophora floribunda	+	
Aphanopetalum resinosum	+	
Aristida vagans	+	
Arthropodium milleflorum	+	
**Atriplex hastata*	+	
Atriplex semibaccata	+	
Austrodanthonia tenuior	+	
Austrostipa pubescens	+	
Backhousia myrtifolia	+	+
Banksia serrata		+
Banksia spinulosa var. *spinulosa*		+
**Bidens pilosa*	+	
Billardiera scandens var. *scandens*		+
Bossiaea obcordata		+
Brunoniella australis	+	
Bursaria spinosa ssp. *spinosa*	+	
Calochlaena dubia		+
Cassinia uncata	+	
Ceratopetalum apetalum		+
Ceratopetalum gummiferum		+
Cheilanthes sieberi ssp. *sieberi*	+	
**Chloris gayana*	+	
Chloris ventricosa	+	
**Cirsium vulgare*	+	
Clematis aristata	+	
Clerodendrum tomentosum	+	
Conyza spp.	+	
Corymbia gummifera		+
Crassula helmsii	+	
Cyathochaeta diandra		+
Cynodon dactylon	+	

Species	West end of Study Area	East end of Study Area
	Shale Communities	Sandstone Communities
Dampiera purpurea		+
Dianella caerulea var. *producta*		+
Dianella longifolia var. *longifolia*	+	
Dichelachne crinita	+	
Dichondra repens	+	
Digitaria parviflora	+	
Dillwynia retorta		+
Dodonaea multijuga	+	
Dodonaea triquetra	+	+
Dodonaea viscosa ssp. *angustifolia*	+	
Dodonaea viscosa ssp. *cuneata*	+	
Duboisia myoporoides	+	
Echinopogon ovatus	+	
**Echium vulgare*	+	
Einadia hastata	+	
Elaeocarpus reticulatus		+
Entolasia marginata	+	
Entolasia stricta		+
Epacris pulchella		+
Eragrostis brownii	+	
**Eragrostis curvula*	+	+
Eucalyptus agglomerata		+
Eucalyptus crebra	+	
Eucalyptus eugenioides	+	
Eucalyptus fibrosa	+	
Eucalyptus moluccana	+	
Eucalyptus pilularis		+
Eucalyptus piperita		+
Eucalyptus punctata	+	+
Eucalyptus sieberi		+
Eucalyptus tereticornis	+	
Exocarpos cupressiformis		+
Exocarpos strictus		+
Gahnia aspera	+	
Glycine clandestina	+	
Glycine tabacina	+	
Gonocarpus teucrioides		+
Grevillea mucronulata		+
Grevillea parviflora ssp. *parviflora*		+
Hakea sericea		+
Hardenbergia violacea	+	
Hibbertia diffusa	+	
Hibbertia riparia		+
Indigofera australis	+	
Kunzea ambigua	+	+
Lambertia formosa		+
**Lantana camara*	+	
**Lepidium africanum*	+	
Lepidosperma laterale	+	+
Leptospermum trinervium		+

Species	West end of Study Area	East end of Study Area
	Shale Communities	Sandstone Communities
Lepyrodia scariosa		+
Leucopogon ericoides		+
Leucopogon juniperinus	+	
Leucopogon lanceolatus var. *lanceolatus*		+
**Ligustrum sinense*		+
Lindsaea linearis		+
**Lolium perenne*	+	
Lomandra cylindrica	+	
Lomandra glauca	+	
Lomandra longifolia		+
Lomandra multiflora ssp. *multiflora*	+	+
Lomandra obliqua		+
Lomatia myricoides		+
Lomatia silaifolia		+
**Lycium ferocissimum*	+	
Melaleuca linariifolia	+	
Melaleuca styphelioides	+	
Microlaena stipoides var. *stipoides*	+	
**Modiola caroliniana*	+	
Monotoca scoparia		+
Notelaea longifolia	+	
Notodanthonia longifolia	+	
Olearia viscidula	+	
Pandorea pandorana ssp. *pandorana*	+	
Panicum simile	+	
Parsonsia straminea	+	
Passiflora herbertiana ssp. *herbertiana*	+	
Patersonia glabrata		+
**Pennisetum clandestinum*	+	
Persoonia levis		+
Persoonia linearis	+	+
Persoonia pinifolia		+
Phyllanthus hirtellus		+
**Phytolacca octandra*	+	
Pimelea linifolia ssp. *linifolia*		+
**Plantago lanceolata*	+	
Platysace ericoides		+
Plectranthus parviflorus	+	
Poa affinis	+	
Pomaderris andromedifolia ssp. *andromedifolia*	+	
Pomaderris elliptica ssp. *elliptica*		+
Pomaderris intermedia	+	
Pomaderris vellea	+	
Pomax umbellata	+	+
Poranthera microphylla	+	
Pratia purpurascens	+	
Pteridium esculentum		+
Rapanea howittiana	+	
Ricinocarpos pinifolius		+
**Rorippa palustris*	+	

Species	West end of Study Area	East end of Study Area
	Shale Communities	Sandstone Communities
Santalum obtusifolium	+	
Schoenus melanostachys	+	+
**Senecio madagascariensis*	+	
**Sida rhombifolia*	+	
Sigesbeckia orientalis ssp. *orientalis*	+	
**Solanum mauritianum*	+	
**Solanum nigrum*	+	
Solanum prinophyllum	+	
**Sonchus oleraceus*	+	
**Sporobolus indicus*	+	
Sticherus flabellatus var. *flabellatus*		+
Stylidium productum		+
Stypandra glauca	+	
**Tagetes minuta*	+	
Todea barbara		+
**Trifolium repens*	+	
Tristaniopsis laurina		+
Typha orientalis		+
**Verbena bonariensis*	+	
**Verbena brasiliensis*	+	
Westringia longifolia	+	+
Woollsia pungens		+
Xanthorrhoea media		+
Xanthosia pilosa		+
Xanthosia tridentata		+
Zieria cytisoides	+	

Appendix 2
FAUNA RESULTS

Terrestrial fauna species recorded within the Study Area during the current survey, during a recent surface gas drainage survey by Biosis Research (2007) and in the vicinity during a previous survey by (Smith et al 2005). Species marked with an asterisk (*) are introduced species.

Family Name	Latin Name	Common Name	Current Survey		Recent Survey (2007)	Previous Survey (2005)
			Western section	Eastern section		
Amphibians						
Hylidae	*Litoria verreauxii*	Verreaux's Tree Frog			W	
Myobatrachidae	*Crinia signifera*	Common Eastern Froglet	W	W	W	
	Limnodynastes peronii	Striped Marsh Frog	W			
Birds						
Accipitridae	*Elanus axillaris*	Black-shouldered Kite	O		O	
Anatidae	*Anas gracilis*	Grey Teal	O		O	
	Anas superciliosa	Pacific Black Duck	O		O	
	Chenonetta jubata	Australian Wood Duck	OW		O	
	Cygnus atratus	Black Swan			O	
Ardeidae	*Egretta novaehollandiae*	White-faced Heron	O	O	O	
Artamidae	*Cracticus torquatus*	Grey Butcherbird	OW	W	W	O
	Grallina cyanoleuca	Magpie-lark	O		OW	
	Gymnorhina tibicen	Australian Magpie	OW	OW	OW	
	Strepera graculina	Pied Currawong	OW		OW	
Cacatuidae	*Cacatua galerita*	Sulphur-crested Cockatoo	OW		OW	
	Cacatua roseicapilla	Galah	OW		O	
	Cacatua tenuirostris	Long-billed Corella			OW	
Campephagidae	*Coracina novaehollandiae*	Black-faced Cuckoo-shrike	OW	W	O	O
Charadriidae	*Elseyornis melanops*	Black-fronted Dotterel			O	
	Vanellus miles	Masked Lapwing			OW	
Cinclosomatidae	*Psophodes olivaceus*	Eastern Whipbird	W		W	O
Climacteridae	*Cormobates leucophaeus*	White-throated Treecreeper	OW	W		
Corvidae	*Corvus coronoides*	Australian Raven	OW		OW	O
Cuculidae	*Cacomantis flabelliformis*	Fan-tailed Cuckoo	-	W		
Dicruridae	*Rhipidura albiscapa*	Grey Fantail	OW	OW	OW	
	Rhipidura leucophrys	Willie Wagtail	O		OW	
Falconidae	*Falco cenchroides*	Nankeen Kestrel	O		O	

Family Name	Latin Name	Common Name	Current Survey		Recent Survey (2007)	Previous Survey (2005)
			Western section	Eastern section		
Halcyonidae	*Dacelo novaeguineae*	Laughing Kookaburra	OW	W		O
Hirundinidae	*Hirundo neoxena*	Welcome Swallow			OW	
Maluridae	*Malurus cyaneus*	Superb Fairy-wren			W	
	Malurus lamberti	Variegated Fairy-wren	OW			
Meliphagidae	*Acanthorhynchus tenuirostris*	Eastern Spinebill	OW	OW		
	Anthochaera carunculata	Red Wattlebird	OW	W		O
	Anthochaera chrysoptera	Little Wattlebird	OW	OW		O
	Lichenostomus chrysops	Yellow-faced Honeyeater		OW	OW	O
	Lichenostomus leucotis	White-eared Honeyeater				O
	Lichenostomus melanops	Yellow-tufted Honeyeater				O
	Manorina melanocephala	Noisy Miner	OW		OW	O
	Manorina melanophrys	Bell Miner	OW	OW	OW	O
	Phylidonyris novaehollandiae	New Holland Honeyeater		OW		O
Motacillidae	*Anthus novaeseelandiae*	Australian Pipit			O	
Pachycephalidae	*Colluricincla harmonica*	Grey Shrike-thrush	W		W	O
	Pachycephala pectoralis	Golden Whistler		W		O
Pardalotidae	*Acanthiza chrysorrhoa*	Yellow-rumped Thornbill			O	
	Acanthiza pusilla	Brown Thornbill		W	OW	O
	Gerygone mouki	Brown Gerygone		OW		
	Pardalotus punctatus	Spotted Pardalote	W	W	W	O
	Pardalotus striatus	Striated Pardalote			W	
Passeridae	*Neochmia temporalis*	Red-browed Finch				O
Petroicidae	*Eopsaltria australis*	Eastern Yellow Robin		W	W	
	Microeca fascinans	Jacky Winter			W	
	Petroica phoenicea	Flame Robin			O	
Phalacrocoracidae	*Phalacrocorax varius*	Pied Cormorant			O	
Podicipedidae	*Tachybaptus novaehollandiae*	Australasian Grebe			O	

Family Name	Latin Name	Common Name	Current Survey		Recent Survey (2007)	Previous Survey (2005)
			Western section	Eastern section		
Psittacidae	*Alisterus scapularis*	Australian King-Parrot			OW	
	Platycercus eximius	Eastern Rosella	OW	OW	OW	O
	Psephotus haematonotus	Red-rumped Parrot	OW		OW	
	Trichoglossus haematodus	Rainbow Lorikeet	OW			
Rallidae	*Fulica atra*	Eurasian Coot			O	
	Porphyrio porphyrio	Purple Swamphen	OW		O	
Sturnidae	*Acridotheres tristis*	Common Myna*	OW		OW	
	Sturnus vulgaris	Common Starling*	OW		OW	
Threskiornithidae	*Threskiornis spinicollis*	Straw-necked Ibis	O		O	
Zosteropidae	*Zosterops lateralis*	Silvereye	OW		OW	
Mammals						
Bovidae	*Bos taurus*	Cattle*	OW		O	
	Ovis aries	Sheep*	O			
Canidae	*Canis familiaris*	Dog*	OW			
	Vulpes vulpes	Fox*	I		O	
Equidae	*Equus caballus*	Horse*	O			
Felidae	*Felis catus*	Cat*	O			
Macropodidae	*Wallabia bicolor*	Swamp Wallaby	O			
Leporidae	*Oryctolagus cuniculus*	Rabbit*			O	
Macropodidae	*Macropod sp.*	Unidentified macropod			O	

Key: Observation Type: O = seen, W = heard, I = indirect evidence (*e.g.* scats)

Appendix 3
EP&A ACT SEVEN PART TESTS

The Seven Part Test is a statutory mechanism under Section 5A of the EP&A Act for assessing whether a proposed development activity may have a significant impact on threatened species, populations or ecological communities or their habitats as listed under the TSC Act. The results of this test are used to determine if a Species Impact Statement is required for each species potentially occurring within the Study Area.

When a threatened species known to occur within the vicinity of a Study Area is not recorded during a survey, the presence of potential habitat for this species is used to determine the need to undertake a Seven Part Test. 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 Seven Part Tests are not required for these species.

Flora

Section 5 discusses the potential impact of mine subsidence associated with the proposed works in regards to three EECs and ten threatened flora species as listed on the TSC Act. These included Cumberland Plain Woodland, Shale Sandstone Transition Forest, Moist Shale Woodland, *Acacia bynoeana*, *Callistemon linearifolius*, *Grevillea parviflora* ssp. *parviflora*, *Leucopogon exolasius*, *Persoonia bargoensis*, *Persoonia hirsuta*, *Pimelea spicata*, *Pomaderris brunnea*, *Pterostylis saxicola* and *Pultenaea pedunculata*.

It was concluded that Seven Part Tests were not required for any of the three EECs or for any of the ten threatened flora species as mine subsidence is not likely to impact on communities or species whose long term survival is independent of flowing water or swamp conditions.

Fauna

Seven Part Tests for fauna are in alphabetical order based on common names and describe the Giant Burrowing Frog, Large-footed Myotis, Littlejohn's Tree Frog and the Red-crowned Toadlet.

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, Grigg et al. 1995).

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 and 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 pools is likely to reduce the available breeding habitat for this species.

Based on the subsidence impact assessment provided by MSEC (MSEC 2007) it is considered unlikely that all pools within the Study Area would be disturbed by subsidence, if any.

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 pools 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 population would be placed at risk of extinction.

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 such that a viable local population of the species is likely to be placed at risk of extinction.

NA

In the case of a critically endangered or Endangered Ecological Community, whether the action proposed:

1. **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**

2. **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**

NA

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

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

2. **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**

3. **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.**

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 compared to the potential habitat within the region. It is therefore considered that a significant area of habitat for this species would not be modified or removed.

The subsidence impact assessment provided by MSEC (MSEC 2007) suggests that it is unlikely that all the pools within the Study Area would be 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.

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 (NPWS Threatened Species Unit).

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 24 Priority Actions to help recover this species. Those relevant to the Proposal include:

- Develop best practice management strategies that buffer and protect important 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 Giant Burrowing Frog; and

- Investigate methods of ameliorating or attenuating Chytrid action – appropriate gear and vehicle washdown procedures should be followed at all times.

There is currently no NSW threat abatement plan for the Giant Burrowing Frog, but the species is considered in the Commonwealth threat abatement plan 'Infection of amphibians with Chytrid Fungus resulting in chytridiomycosis'. The plan states that archived specimens of Giant Burrowing Frog have tested positive for Chytrid Fungus (DEH 2006). The aim of the threat abatement plan is to reduce the impacts of the KTP 'Infection of frogs by amphibian Chytrid causing the disease chytridiomycosis' to maximise the chances of the long-term survival of affected species, particularly listed threatened species.

The current Proposal is unlikely to exacerbate the infection or spread of Chytrid Fungus however, if the fungus is present in frog populations within the Study Area, these populations may be rendered more susceptible to other threatening processes such as loss and degradation of habitat (NSW Scientific Committee 2003a).

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 (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' (NSW Scientific Committee 2005a) – known and potential habitat for the Giant Burrowing Frog occurs within creek lines with sandy soils, which may be vulnerable to the effects of subsidence;
- 'Alteration to the natural flow regimes of rivers, streams, floodplains and wetlands' (NSW Scientific Committee 2002a) – 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; and
- 'Human-caused Climate Change' (NSW Scientific Committee 2000b) – anthropogenic global warming has the potential to change average temperature conditions and the frequency of occurrence of extreme events (e.g. fire). Such outcomes may alter the suitability of known and/or potential habitat for the Giant Burrowing Frog.

Conclusion

The proposed development is unlikely to have a significant impact on the Giant Burrowing Frog. A Species Impact Statement is not recommended.

Large-footed Myotis *Myotis macropus*

This species Listed as Vulnerable on Schedule 2 of the TSC Act.

The Large-footed Myotis 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 1998a). It is relatively common in tropical areas but uncommon further south (NPWS 1994). The Large-footed Myotis is regarded as having a primarily coastal distribution but may occur further inland along major rivers (Churchill 1998a).

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 1998a). 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 & Richards 1995; Menkhorst & Knight 1995; Churchill 1998). 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 & Knight 1995).

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, tunnels, stormwater drains and under bridges. Devines Tunnel crosses section of the SMP area and may provide breeding habitat for the Large-footed Myotis, however the MSEC report states that the tunnel is unlikely to be impacted by subsidence due to the proposed extraction of Longwalls 34-38. Therefore 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.

Based on the subsidence impact assessment provided by MSEC (MSEC 2007) it is considered unlikely that all pools within the Study Area would be disturbed by subsidence, if any. 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 population would be placed at risk of extinction.

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.

NA

In the case of a critically endangered or Endangered Ecological Community, whether the action proposed:

1. **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**

2. **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**

NA

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

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

2. **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**

3. **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.**

While there is marginal potential habitat for the Large-footed Myotis within the Study Area, the area of habitat that may be impacted by subsidence is small compared to the potential habitat within the region. It is therefore unlikely that a significant area of habitat for this species would be modified or removed.

The subsidence impact assessment provided by MSEC (MSEC 2007) suggests that it is unlikely that all pools within the Study Area would be disturbed by subsidence, if any. Given the mobility of this species it is unlikely that currently interconnecting or proximate habitat will be further isolated.

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 (NPWS Threatened Species Unit).

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

To date, there is no recovery plan or threat abatement plan for the Large-footed Myotis.

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

- 'Alteration of habitat following subsidence due to longwall mining' (NSW Scientific Committee 2005a) – the Large-footed Myotis may roost in caves and rock overhangs which may collapse as a result of subsidence (such impacts are predicted to occur over a small percentage of the Study Area and to be localised). It is also possible that foraging habitat for this species would be reduced by the effects of subsidence (e.g. loss of surface flow in creeks);

- 'Alteration to the natural flow regimes of rivers, streams, floodplains and wetlands' (NSW Scientific Committee 2002a) – the Large-footed Myotis forages almost exclusively at water sources such as rivers and streams. The possibility of watercourses being altered or the flow being reduced could result in a reduction of foraging habitat and important prey species for the Large-footed Myotis; and

- 'Human-caused Climate Change' (NSW Scientific Committee 2000b) – anthropogenic global warming has the potential to change average temperature conditions and the frequency of occurrence of extreme events (e.g. fire). Such outcomes may alter the suitability of known and/or potential habitat for the Large-footed Myotis.

Conclusion

The proposed activities are considered unlikely to have a significant impact on the Large-footed Myotis. 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.

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 temporary pools in forested areas, usually in high ridges away from the creeks or in deep permanent pools of slow creeks. One of the proposed impacts of subsidence is the potential short-term loss of pools within the creek habitat, which may reduce the available breeding habitat for this species. However, the subsidence impact assessment provided by the MSEC report suggests that it is unlikely that all the pools within the Study Area would be disturbed by subsidence.

This species has not been recorded within the Study Area. Given that further habitat for the Littlejohn's Tree Frog occurs within the vicinity of the Study Area and in the greater region, it is considered that the potential short-term loss of some pools 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 population would be placed at risk of extinction.

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.

NA

In the case of a critically endangered or Endangered Ecological Community, whether the action proposed:

1. **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**

2. **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**

NA

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

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

2. **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**

3. **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**

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. It is therefore considered that a significant area of habitat for this species would not be modified or removed.

The subsidence impact assessment provided by the MSEC report suggests that it is unlikely that all of the pools within the Study Area would be disturbed by subsidence. Since subsidence impacts on the 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.

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 (NPWS Threatened Species Unit).

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;

- Develop strategies for providing supplementary breeding habitat at selected locations throughout the species range – subsidence has the potential to impact known and potential breeding sites within the Study Area;

- 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;

- Investigate methods of ameliorating or attenuating Chytrid action – appropriate gear and vehicle washdown procedures should be followed at all times, and

- Undertake survey in some of the less surveyed parts of the species distribution.

There is currently no NSW threat abatement plan for Littlejohn's Tree Frog, but the species is considered in the Commonwealth threat abatement plan 'Infection of amphibians with Chytrid Fungus resulting in chytridiomycosis'. The plan states that there have been no reports of Chytrid Fungus in Littlejohn's Tree Frog, but that also no surveys have been performed to test for the pathogen in this species (DEH 2006). Therefore, Littlejohn's Tree Frog should be considered susceptible to infection by Chytrid Fungus. The aim of the threat abatement plan is to reduce the impacts of the KTP 'Infection of frogs by amphibian Chytrid causing the disease chytridiomycosis' (NSW Scientific Committee 2003a) to maximise the chances of the long-term survival of affected species, particularly listed threatened species.

The current Proposal is unlikely to exacerbate the infection or spread of Chytrid Fungus however, if the fungus is present in frog populations within the Study Area, these populations may be rendered more susceptible to other threatening processes such as loss and degradation of habitat (NSW Scientific Committee 2003a).

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'(NSW Scientific Committee 2005a) – known and potential habitat for Littlejohn's Tree Frog occurs within forest, woodland and Upland Swamp

habitat where permanent slow-flowing creeks, deep pools and fringing vegetation are present; all of which are known and/or may be vulnerable to the effects of subsidence;

- 'Alteration to the natural flow regimes of rivers, streams, floodplains & wetlands' (NSW Scientific Committee 2002a) – 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
- 'Human-caused Climate Change' (NSW Scientific Committee 2000b) – anthropogenic global warming has the potential to change average temperature conditions and the frequency of occurrence of extreme events (e.g. fire). Such outcomes may alter the suitability of known and/or potential habitat for Littlejohn's Tree Frog.

Conclusion

The proposed activity is considered unlikely to have a significant impact on Littlejohn's Tree Frog. 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 Mahony 1997).

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 these pools due to subsidence, although minimal, is likely to result in a reduction of breeding habitat for this species. However, the subsidence impact assessment provided by the MSEC report suggests that it is unlikely that all the pools within the Study Area would be disturbed by subsidence.

Given, the high numbers of this species that have been recorded along the Illawarra Escarpment (in Dharawal State Recreation Area and Heathcote

National Park), it is unlikely that the proposed activity will disrupt the lifecycle of the species such that a viable population would be placed at risk of extinction.

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.

NA

In the case of a critically endangered or Endangered Ecological Community, whether the action proposed:

1. **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**

2. **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**

NA

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

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

2. **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**

3. **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**

Locally this species is known to occur throughout the sandstone plateau and slopes. This species has been recorded 3 km north and east of Marhney's Hole, and in the Woronora, O'Hares Creek and Metropolitan Special Areas (Sydney Water, 1997) as well as Dharawal SRA (NPWS, 1998).

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. It is therefore considered that a significant area of habitat for this species would not be modified or removed.

The subsidence impact assessment provided by the MSEC report suggests that it is unlikely that all the pools 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.

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 (NPWS Threatened Species Unit).

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.

- Retain and protect habitat and buffers around habitat, particularly vegetation on upper slopes and ridges – subsidence may impact on potential habitat such as Upland Swamps and rocky slopes;
- 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; and
- Investigate methods of ameliorating or attenuating Chytrid action – appropriate gear and vehicle washdown procedures should be followed at all times.

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 (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' (NSW Scientific Committee 2005a) – known and potential habitat for the

Red-crowned Toadlet occurs within Upland Swamps, ephemeral creek lines and rocky slopes; all of which are known and/or may be vulnerable to the effects of subsidence;

- 'Alteration to the natural flow regimes of rivers, streams, floodplains and wetlands' (NSW Scientific Committee 2002a) – Red-crowned Toadlets prefer ephemeral creeks and drainage lines for breeding. Loss of water or changes to flow patterns could impact on the species; and
- 'Human-caused Climate Change' (NSW Scientific Committee 2000b) – anthropogenic global warming has the potential to change average temperature conditions and the frequency of occurrence of extreme events (e.g. fire). Such outcomes may alter the suitability of known and/or potential habitat for the Red-crowned Toadlet.

Conclusion

The proposed activities are considered unlikely to have a significant impact on the Red-crowned Toadlet. A Species Impact Statement is not recommended.

Appendix 4
EPBC ACT – SIGNIFICANT IMPACT CRITERIA

Under the EPBC Act, if the proposed development has the potential to have an adverse impact on Matters of National Environmental Significance (MNES) listed on the Act, the proposal must be referred to the Federal Minister for the Environment for further consideration. Such matters include threatened species, populations and ecological communities.

Significant Impact Criteria are carried out on MNES in order to determine if a referral is required.

Flora and EECs

Section 5 discusses the potential impact of mine subsidence associated with the proposed works in regards to two EECs and nine threatened flora species as listed on the EPBC Act. These included Cumberland Plain Woodland, Shale Sandstone Transition Forest, *Acacia bynoeana*, *Callistemon linearifolius*, *Grevillea parviflora* ssp. *parviflora*, *Leucopogon exolasius*, *Persoonia bargoensis*, *Persoonia hirsuta*, *Pimelea spicata*, *Pomaderris brunnea* and *Pterostylis saxicola*.

It was concluded that Significant Impact Criteria were not required for either of the two EECs or for any of the nine threatened flora species, as mine subsidence is not likely to impact on communities or species whose long term survival is independent of flowing water or swamp conditions.

Fauna

Vulnerable 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.

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 5 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. Loss of pools in creeks 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 the MSEC report, it is considered unlikely that all pools within the Study Area would be disturbed by subsidence, if any.

Given 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 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 creeks 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 the MSEC report it is considered unlikely that all pools within the Study Area would be disturbed by subsidence.

Given 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 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 would not disturb any vegetation within the Study Area. 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 interfere substantially with the recovery of the species?

Neither of these 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 (MSEC

2007). 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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