

# APPLICATION FOR FURTHER APPROVAL OF WEST CLIFF EMPLACEMENT STAGE 3

## VOLUME 3

## SPECIES IMPACT STATEMENT



bhpbilliton  
**ILLAWARRA COAL**



**BIOSIS**  
RESEARCH





**West Cliff Colliery - Stage 3  
Coal Wash Emplacement  
Application - Volume 3  
Species Impact Statement**

**June 2007**

**Biosis Research**

## Report for BHP Billiton Illawarra Coal

June 2007

Matthew Richardson  
Rhidian Harrington  
Nathan Smith  
Glenn Muir  
Brendan Smith  
Sian Wilkins  
Katie Cartner  
Jennifer Charlton  
Rachel Blakey

**Ballarat:**

449 Doveton Street North, Ballarat VIC 3354  
Ph: (03) 5331 7000 Fax: (03) 5331 7033  
email: [ballarat@biosisresearch.com.au](mailto:ballarat@biosisresearch.com.au)

**Melbourne:**

38 Bertie Street, Port Melbourne VIC 3207  
Ph: (03) 9646 9499 Fax: (03) 9646 9242  
email: [melbourne@biosisresearch.com.au](mailto:melbourne@biosisresearch.com.au)

**Queanbeyan:**

55 Lorn Road, Queanbeyan NSW 2620  
Ph: (02) 6284 4633 Fax: (02) 6284 4699  
email: [queanbeyan@biosisresearch.com.au](mailto:queanbeyan@biosisresearch.com.au)

**Sydney:**

15-17 Henrietta Street, Chippendale NSW 2008  
Ph: (02) 9690 2777 Fax: (02) 9690 2577  
email: [sydney@biosisresearch.com.au](mailto:sydney@biosisresearch.com.au)

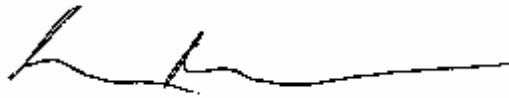
**Project no: s4200**

© Biosis Research Pty. Ltd.

This document is and shall remain the property of Biosis Research Pty. Ltd. The document may only be used for the purposes for which it was commissioned and in accordance with the Terms of the Engagement for the commission. Unauthorised use of this document in any form whatsoever is prohibited.

## DECLARATION

I, Bruce Blunden, of Illawarra Coal, PO Box 514, Unanderra NSW 2526, being the applicant for the development consent...[DA 60-03-2001, West Cliff Stage 3 Emplacement, Wedderburn Road, Appin, Wollondilly Shire Council] have read and understood this species impact statement. I understand the implications of the recommendations made in the statement and accept that they may be placed as conditions of consent or concurrence for the Proposal.



---

Environmental Approvals Manager, BHP Billiton Illawarra Coal



---

Matthew Richardson BSc (Hons), Biosis Research

## ACKNOWLEDGMENTS

Biosis Research acknowledges the contribution of the following people in preparing this report:

- Robert Suansri (Biosis Research)
- Terri English (Biosis Research)
- Mark Beale (BHP Billiton Illawarra Coal)
- Bruce Blunden (BHP Billiton Illawarra Coal)
- Andrew Gray (BHP Billiton Illawarra Coal)
- Lou Linqurovski (BHP Billiton Illawarra Coal)
- Ken Wilyman (Cardno Forbes Rigby)
- Chris McEvoy (Cardno Forbes Rigby)
- Mathew Carden (Cardno Forbes Rigby)
- Helen Jessup (Department of Environment and Climate Change NSW)
- Elizabeth Magarey (Department of Environment and Climate Change NSW)
- Kirk Newport (Sydney Catchment Authority)

## ABBREVIATIONS

|          |  |
|----------|--|
| BHPBIC   | BHP Billiton Illawarra Coal  |
| CAMBA    | China-Australia Migratory Bird Agreement                                 |
| CAVS     | Census of Australian Vertebrates   |
| CFR      | Cardno Forbes Rigby  |
| DEC      | Department of Environment and Conservation                               |
| DECC     | Department of Environment and Climate Change<br>(formerly DEC)           |
| DEH      | Department of the Environment and Heritage                               |
| DEW      | Department of Environment and Water Resources<br>(formerly DEH)          |
| DGR      | Director-General's Requirements  |
| DIPNR    | Department of Infrastructure Planning and Natural<br>Resources           |
| DNR      | Department of Natural Resources  |
| DOP      | Department of Planning   |
| DPI      | Department of Primary Industries (formerly                               |
| EIS      | Environmental Impact Statement   |
| EP&A Act | <i>Environmental Planning and Assessment Act 1979</i>                    |
| EPBC Act | <i>Environment Protection and Biodiversity Conservation<br/>Act 1999</i> |
| EVC      | Ecological Vegetation Classes  |
| FM Act   | <i>Fisheries Management Act 1994</i>                                     |
| GIS      | Geographic Information System  |
| GL       | Gigalitre (one billion litres)   |
| GPS      | Global Positioning System  |
| IUCN     | International Union for the Conservation of Nature                       |
| JAMBA    | Japan-Australia Migratory Bird Agreement                                 |
| LGA      | Local Government Authority   |
| MNES     | Matters of National Environmental Significance                           |
| NPWS     | National Parks and Wildlife Service (now DEC)                            |
| PER      | Public Environment Report  |
| RFI Act  | <i>Rivers and Foreshores Improvement Act 1948</i>                        |
| ROTAP    | Rare or Threatened Australian Plant                                      |
| SCA      | Sydney Catchment Authority   |
| SIS      | Species Impact Statement   |
| sp.      | Species (singular)   |
| spp.     | Species (plural)   |
| subsp.   | subspecies   |
| TSC Act  | <i>Threatened Species Conservation Act 1995</i>                          |
| var.     | variety  |
| VFMP     | Vegetation and Fauna Management Plan                                     |
| WM Act   | <i>Water Management Act 2000</i>   |

# CONTENTS

|   |           |
|---|-----------|
| <b>DECLARATION</b> .....  | <b>3</b>  |
| <b>ACKNOWLEDGMENTS</b> .....  | <b>4</b>  |
| <b>ABBREVIATIONS</b> .....  | <b>5</b>  |
| <b>SUMMARY</b> .....  | <b>9</b>  |
| <b>1.0 COMPLIANCE WITH THE REQUIREMENTS OF THE DIRECTOR GENERAL OF THE DECC</b> ..... | <b>14</b> |
| <b>1.1 Definitions</b> .....  | <b>14</b> |
| <b>1.2 Matters which have been limited or modified</b> .....                          | <b>15</b> |
| <b>1.3 Matters to be addressed</b> .....  | <b>15</b> |
| <b>2.0 FORM OF THE SPECIES IMPACT STATEMENT</b> .....                                 | <b>16</b> |
| <b>3.0 CONTEXTUAL INFORMATION</b> .....   | <b>17</b> |
| <b>3.1 Description of the Proposal, Subject Site and Study Area</b> .....             | <b>17</b> |
| 3.1.1 Background .....  | 17        |
| 3.1.2 Description of the Proposal.....  | 18        |
| 3.1.3 Description of Subject Site and Study Area .....                                | 18        |
| 3.1.4 Amelioration, Rehabilitation and Compensatory Measures.....                     | 21        |
| <b>3.2 Provision of Relevant Maps and Plans</b> .....                                 | <b>22</b> |
| <b>3.3 Land Tenure Information</b> .....  | <b>22</b> |
| <b>4.0 INITIAL ASSESSMENT</b> .....   | <b>24</b> |
| <b>4.1 Identifying Subject Species</b> .....  | <b>24</b> |
| 4.1.1 Assessment of available information .....                                       | 24        |
| 4.1.2 Nomenclature .....  | 26        |
| 4.1.3 Threatened Flora .....  | 26        |
| 4.1.4 Threatened Fauna .....  | 31        |
| 4.1.5 Endangered Populations .....  | 42        |
| 4.1.6 Endangered Ecological Communities .....   | 42        |
| <b>5.0 SURVEY</b> .....   | <b>43</b> |
| <b>5.1 Requirement to survey</b> .....  | <b>43</b> |
| <b>5.2 Documentation of survey effort and technique</b> .....                         | <b>43</b> |
| 5.2.1 Description of survey techniques and survey sites .....                         | 43        |
| 5.2.2 Documentation of survey effort .....  | 56        |
| <b>5.3 Specific survey requirements</b> .....   | <b>62</b> |
| 5.3.1 Specific Flora Survey Requirements.....   | 62        |
| 5.3.2 Specific fauna survey requirements.....   | 62        |
| <b>5.4 Survey Results</b> .....   | <b>64</b> |
| 5.4.1 Subject Species Survey Results .....  | 64        |
| 5.4.2 General protected animal and native plant species survey results.....           | 65        |
| <b>6.0 ASSESSMENT OF LIKELY IMPACTS ON THREATENED SPECIES AND POPULATIONS</b> .....   | <b>66</b> |
| <b>6.1 Assessment of Species Likely to be Affected</b> .....                          | <b>73</b> |
| 6.1.1 Affected Flora Species.....   | 73        |
| 6.1.2 Affected Fauna Species.....   | 77        |

|             |   |               |
|-------------|---|---------------|
| <b>6.2</b>  | <b>Assessment of Habitat</b> .....  | <b>84</b>     |
| 6.2.1       | Description of Vegetation.....  | 84            |
| 6.2.2       | Description of Fauna Habitat Values .....   | 89            |
| 6.2.3       | Discussion of Corridors.....  | 92            |
| <b>6.3</b>  | <b>Affected Subject Species Information</b> .....                                     | <b>96</b>     |
| 6.3.1       | Discussion Of Local And Regional Abundance.....                                       | 96            |
| 6.3.2       | Discussion Of Other Known Local Populations.....                                      | 96            |
| 6.3.3       | Discussion Of Habitat Utilisation.....  | 96            |
| 6.3.4       | Discussion Of Conservation Status .....   | 96            |
| 6.3.5       | Threatened Flora Species Profiles.....  | 96            |
| 6.3.6       | Threatened Fauna Species Profiles.....  | 133           |
| <b>6.4</b>  | <b>Description of feasible alternatives</b> .....                                     | <b>190</b>    |
| <b>7.0</b>  | <b>ASSESSMENT OF LIKELY IMPACTS ON ENDANGERED ECOLOGICAL COMMUNITIES</b> .....        | <b>192</b>    |
| <b>8.0</b>  | <b>DESCRIPTION OF AMELIORATIVE MEASURES</b> .....                                     | <b>193</b>    |
| 8.1         | Long Term Management Strategies .....   | 196           |
| 8.2         | Compensatory Strategies .....   | 196           |
| 8.3         | Ongoing Monitoring .....  | 197           |
| 8.4         | Translocation .....   | 197           |
| 8.5         | Informing Future Land Owners .....  | 197           |
| <b>9.0</b>  | <b>ASSESSMENT OF SIGNIFICANCE OF LIKELY EFFECT OF PROPOSED ACTION</b> .....           | <b>198</b>    |
| 9.1         | Assessments of Significance: Affected Flora Species.....                              | 198           |
| 9.2         | Assessments of Significance: Affected Animal Species.....                             | 263           |
| 9.3         | Comparison of Impact Assessment With Previous Studies.....                            | 328           |
| <b>10.0</b> | <b>ADDITIONAL INFORMATION</b> .....   | <b>330</b>    |
| 10.1        | Qualifications and experience .....   | 330           |
| 10.2        | Other approvals required for the development or activity .....                        | 330           |
| 10.2.1      | <i>Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act)</i> ..... | 330           |
| 10.3        | Licensing Matters Relating to the Survey.....   | 331           |
| 10.4        | Section 110 (5) reports .....   | 331           |
| <b>11.0</b> | <b>CONCLUSION</b> .....   | <b>332</b>    |
|             | <b>FIGURES</b> .....  | <b>334</b>    |
|             | <b>APPENDICES</b> .....   | <b>346</b>    |
|             | Appendix 1: The Director-General’s requirements for a species impact statement .      | 347           |
|             | Appendix 2: Completed Flora field survey proformas .....                              | 364           |
|             | Appendix 3: Flora species recorded in the Study Area .....                            | 476           |
|             | Appendix 4: Cumulative Fauna Species Lists.....                                       | 482           |
|             | Appendix 5: Completed proformas for the fauna surveys .....                           | 497           |
|             | Appendix 6: Curriculum vitae .....  | 539           |
|             | <b>REFERENCES</b> .....   | <b>DLXXIV</b> |



**TABLES**

|  |     |
|--|-----|
| Table 1: Comparison of significance assessment from 2001 SIS (Biosis Research 2001a) and this study (Biosis Research 2007b).....                                   | 11  |
| Table 2: Terrestrial flora listed on the TSC Act or EPBC Act that have the potential to occur in the local area. ....  | 26  |
| Table 3: Threatened animal species and/or their habitat listed on the TSC and/or EPBC Acts that have previously been recorded within 10 km of the Study Area ..... | 31  |
| Table 4. General Habitat Assessment / Survey Reference Points .....  | 57  |
| Table 5. Flora survey details: Quadrats .....  | 57  |
| Table 6. Flora survey details: Targeted Searches for threatened species.....   | 58  |
| Table 7. Flora survey details: Total Abundance Counts.....   | 58  |
| Table 8: Total Survey effort for Fauna surveys previously conducted by Biosis Research in the Study Area (Richardson <i>et al.</i> 2001).....                      | 60  |
| Table 9: Total Survey effort for current fauna surveys conducted by Biosis Research in the Study Area. ....  | 60  |
| Table 10: Results of total abundance counts for threatened flora .....   | 64  |
| Table 11. Determination of Affected Subject Species (Flora) from Subject Species .....   | 74  |
| Table 12: Determination of Affected Subject Species (Fauna) From Subject Species .....   | 77  |
| Table 13: Extant area of plant communities mapped within the Locality, Study Area, and Subject Site.....   | 84  |
| Table 14. Summary of Mitigation Measures Included in the VFMP.....   | 193 |
| Table 15: Comparison of significance assessment from 2001 SIS (Biosis Research 2001a) and this study (Biosis Research 2007b).....                                  | 329 |
| Table 16. Plant species recorded in the Study Area.....  | 477 |
| Table 17: Cumulative Fauna species lists.....  | 483 |

**FIGURES**

|  |     |
|--|-----|
| Figure 1: Location of the Study Area in a regional context.....  | 335 |
| Figure 2: Aerial photograph of the Locality showing the boundaries of the Study Area and Subject Site.....                       | 336 |
| Figure 3: Topographic map of the Study Area showing land use (at a scale of 1:250,000).....                                      | 337 |
| Figure 4: Locality map showing zoning, land tenure, parks and reserves and townships.....  | 338 |
| Figure 5: Plant communities within the Locality and Study Area.....  | 339 |
| Figure 6: Flora survey locations.....  | 340 |
| Figure 7: Fauna survey locations.....  | 341 |
| Figure 8: Threatened flora species recorded within 10 km of the Study Area as derived from DECC Atlas of NSW.....                | 342 |
| Figure 9: Threatened animal species recorded within 10 km of the Study Area, as derived from the DECC Atlas of NSW Wildlife..... | 343 |
| Figure 10: Threatened plant species recorded by Biosis Research from within the Study Area...344                                 |     |
| Figure 11: Threatened animal species recorded by Biosis Research from within the Study Area.345                                  |     |

## SUMMARY

Biosis Research was commissioned by BHPBIC to prepare a Species Impact Statement (SIS) for the proposed West Cliff Stage 3 Coal Wash Emplacement Area. The Proposal involves the clearing of approximately 60.5 ha of native vegetation.

The SIS examines the impacts of the Proposal on threatened flora and fauna as listed in the Director-General's Requirements (DEC 10 March 2006) and in accordance with the requirements of the *Conditions of Consent for the Dendrobium Underground Coal Mine*, DA60-03-2001 (Minister for Urban Affairs and Planning 2001).

### Assessment Methodology

Background information was collated and analysed from a variety of sources including previous relevant studies conducted by Biosis Research, scientific literature, species databases, aerial photography, maps and plans. Advice was sought from experts where necessary.

Field surveys for the current study were carried out in Spring and Summer 2006. Survey design and effort followed the *Threatened Species Assessment Guidelines* (DEC 2005) and the Director-General's Requirements.

Plants were surveyed using vegetation condition assessments, plot-based surveys, random meander transects and abundance counts.

Animals were surveyed using a variety of trapping techniques, bird surveys, frog and reptile surveys, spotlighting, call-playback, koala transects, echolocation for bats, habitat assessment and incidental observations.

Section 5.0 outlines in detail the survey design and effort for the current study.

### Threatened Plants

The Director General's requirements listed 27 threatened plant species to be considered in this SIS. An additional five threatened plant species listed on the *Threatened Species Conservation Act 1995* (TSC Act) and/or *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) that have been recorded or have potential habitat within 10 km of the Study Area were also considered. Of these, three threatened plant species, *Acacia bynoeana*, *Persoonia hirsuta* and *Pultenaea aristata*, were recorded within the Study Area. Potential habitat for a further 11 threatened species also occurs within the Study Area,

these are:

- *Acacia baueri* ssp. *aspera*
- *Astrotricha crassifolia*
- *Boronia deanei*
- *Cryptostylis hunteriana*
- *Darwinia peduncularis*
- *Eucalyptus camfieldii*
- *Epacris purpurascens* var. *purpurascens*
- *Grevillea parviflora* ssp. *parviflora*
- *Gyrostemon thesioides*
- *Leucopogon exolasius*
- *Pomaderris adnata*

Seven Part Tests concluded that the Proposal would have a significant impact on the local population of *Persoonia hirsuta*.

### **Threatened Animals**

The Director General's requirements listed 34 threatened animal species to be considered in this SIS. A further 23 threatened animal species listed on the TSC Act and/or EPBC Act that have been recorded or have potential habitat within 10 km of the Study Area were also considered. Of these, 39 animal species were determined to have potential habitat within the Study Area. Eight threatened animal species were recorded in the Study Area, either during this study or during previous studies conducted by Biosis Research, these are:

- Powerful Owl
- Gang-gang Cockatoo
- Common Bent-wing Bat
- Large-footed Myotis
- Grey-headed Flying-fox
- Koala
- Broad-headed Snake
- Rosenberg's Goanna

Seven Part Tests concluded that the Proposal would have a significant impact on local populations of the Broad-headed Snake, Eastern Pygmy-possum, Red-crowned Toadlet and Rosenberg's Goanna.

Although the proposed development may remove potential habitat for threatened animal species, the implementation of safeguards (two-staged clearing process, translocation of hollow-bearing limbs and rock outcrops, revegetation and rehabilitation of the Emplacement area) mean that impacts will be reduced. It is therefore considered unlikely that other threatened animal species known to, or

potentially occurring in the area, will suffer significant impacts from the proposed development.

### Endangered Populations and Endangered Ecological Communities

No Endangered Populations or Endangered Ecological Communities as listed under the TSC Act occur within the Study Area.

### Comparison of Impact Assessment with Previous Studies

The project has been previously assessed in the *Dendrobium Coal Project Species Impact Statement* (Biosis Research 2001a). This previous assessment included West Cliff, Dendrobium Areas 1-3, Nebo and Kemira Valley. The current study assesses potential impacts of the proposed West Cliff Stage 3 Coal Wash Emplacement Area only.

Changes in the assessment methodology since the original 2001 SIS have resulted in a shift in focus from the regional and species-wide level of the Eight Part Test, to the current Seven Part Test, where the focus is the impact on local populations (*Local population* and other definitions are included in Section 1.1). Table 1 below illustrates the implications of these changes with respect to the current study. *Persoonia hirsuta* and Rosenberg's Goanna have been assessed in the current SIS as *significantly impacted*, where, previously they were not. Importantly, the difference is a reflection of the changes in the assessment system between 2001 and 2007 and is not associated with any change in scale, process or design of the Proposal. A more detailed discussion of the changes in assessment methodology and its implications in terms of the Proposal is included in Section 9.3.

**Table 1: Comparison of significance assessment from 2001 SIS (Biosis Research 2001a) and this study (Biosis Research 2007b)**

| Species  | 2001 Impact Assessment Outcome   | 2007 Impact Assessment Outcome                              | Agreement |
|--|--|---|-----------|
| <b>Flora species assessed to be impacted significantly by the proposal</b> |  |   |           |
| <i>Persoonia hirsuta</i>   | DETECTED – Habitat and individuals removed but no significant impact on population | DETECTED – Significant impact on local population level     | No        |
| <b>Fauna species assessed to be impacted significantly by the proposal</b> |  |   |           |
| Red-crowned Toadlet  | NOT DETECTED – Significant impact on species and population level                  | NOT DETECTED – Significant impact on local population level | Yes       |
| Broad-headed Snake   | DETECTED – Significant impact on population level                                  | DETECTED – Significant impact on local population level     | Yes       |
| Eastern Pygmy-possum   | NOT DETECTED – Significant impact on species and population level                  | NOT DETECTED – Significant impact on local population level | Yes       |

|                    |   |   |    |
|--------------------|---|---|----|
| Rosenberg's Goanna | NOT DETECTED – Habitat present, but no impact based on large home range and high mobility | DETECTED – Significant impact on local population level | No |
|--------------------|---|---|----|

### Environmental Safeguards and Mitigation

A number of safeguards are recommended to minimise the impact of the Proposal on threatened species that occur within and adjacent to the Study Area:

- Minimise changes to off-site drainage patterns and water quality by using best-practice erosion and sedimentation control measures;
- Control drainage that may contain weed seeds or high levels of nutrients;
- Restrict the area of native vegetation disturbed during construction works through the use of highly visible temporary fencing;
- Restrict stockpiling to areas already cleared of vegetation;
- Implement an exclusion zone around the *Acacia bynoeana* population on the southern side of the Emplacement prior to any clearing or construction works;
- Employ a two-stage vegetation clearing process where non-habitat trees are cleared first, followed within 24 hours, by the clearing of hollow-bearing trees;
- Translocate fauna habitat features such as logs, tree hollows (>20 cm) and rock outcrops to adjacent habitat and rehabilitation areas;
- Prepare and implement a Vegetation and Fauna Management Plan (VFMP) for the whole of West Cliff Colliery. This includes details of Emplacement rehabilitation strategies, revegetation and weed management;
- Monitor and control weed populations that establish on disturbed areas, with particular attention to the eradication of perennial grasses and noxious weeds;
- On-going monitoring of the fauna mitigation, revegetation and weed control would be conducted in order to assess the effectiveness of the implemented ameliorative measures;
- Although not an ameliorative measure, compensatory habitat is provided at a ratio in excess of the 2:1 ratio required by the Dendrobium Mine Development Consent. A Compensatory Measures Assessment has been prepared (Research 2007); and,
- Translocation of *Persoonia hirsuta* individuals has not been proposed as an

ameliorative measure in the VFMP. However, if translocation of the species is adopted in the future, a translocation plan should be prepared to ensure the success of the operation.

# 1.0 COMPLIANCE WITH THE REQUIREMENTS OF THE DIRECTOR GENERAL OF THE DECC

## 1.1 Definitions

Definitions provided in the Director General's Requirement's are as follows:

- **development** has the same meaning as in the *Environmental Planning and Assessment Act 1979*.
- **activity** has the same meaning as in the EP&A Act.
- **Proposal** is the development, activity or action proposed.
- **Subject Site** means the area directly affected by the Proposal.
- **Study Area** is the Subject Site and any additional areas that are likely to be affected by the Proposal, either directly or indirectly.
- **Locality** is the area within a 5 km radius of the Subject Site.
- **subject species** means those threatened species that are known or considered likely to occur in the Study Area.

All other definitions are the same as those contained in the *Threatened Species Conservation Act 1995*. The following definitions are also utilised in this SIS:

- **abundance** means a quantification of the population of the species or community.
- **affected subject species** means subject species likely to be affected by the Proposal.
- **Director-General** means the Director-General of the NSW Department of Environment and Conservation.
- **regional** means the area defined with the applicable Bioregion, i.e. The Sydney Basin Bioregion.
- **population** (in reference to plants) means occurrences of plants are considered to be distinct populations if they are separated by discontinuities of at least 1 km (Keith 2000).
- **local population** is the population that occurs in the study area (DEC 2005%). In this case, the 500 metre buffer from the Stage 3 Emplacement Area.
- **Trap night** this refers to one trap being set for a period of one night. Thus ten traps set for one night would equal ten trap nights.

## 1.2 Matters which have been limited or modified

The following Section 110 matters do not need to be addressed by the SIS:

- Section 110(2) (e). This section is a replication of Section 110(2)(a);
- Section 110(2) (g) and 110(3) (d). The matters raised in these sections of the TSC Act have been clarified by the requirements below.

Section 110 matters in relation to any threat abatement plans or recovery plans need only be addressed where relevant. In relation to Key Threatening Processes, the following is relevant to this Proposal:

- Alteration to natural flow regimes of rivers and streams and their floodplains and wetlands;
- Bushrock removal;
- High frequency fire resulting in the disruption of life cycle processes in plants and animals and loss of vegetation structure and composition;
- Clearing of native vegetation (as defined and described in the final determination of the Scientific Committee to list the Key Threatening Process).

At the time of printing of the DGRs, the areas of declared critical habitat are not relevant to this Proposal.

Recovery plans may be approved, critical habitat may be declared and Key Threatening Processes may be listed between the issue of these requirements and the granting of consent. If this occurs, these additional matters will need to be addressed in the SIS and considered by the consent, determining or concurrence authority.

## 1.3 Matters to be addressed

The TSC Act provides that the SIS must meet all the matters specified in Sections 109 and 110 of the TSC Act with the exception of those matters limited above.



## 2.0 FORM OF THE SPECIES IMPACT STATEMENT

This Species Impact Statement (SIS) is in writing, in accordance with Section 109 (1) of the *Threatened Species Conservation Act 1995* and has been signed by the principle author and by the applicant (see “Declaration”), in accordance with Section 109 (2) of the TSC Act and as specified in the Requirements of the Director General of the Department of Environment and Climate Change.

Section 110 (1) of the TSC Act states that the applicant for development consent or the proponent of the activity must comply with the DGRs concerning the form and content of the SIS. Accordingly, the SIS is formatted to follow the sections and subsections provided in the DGRs.

## 3.0 CONTEXTUAL INFORMATION

### 3.1 Description of the Proposal, Subject Site and Study Area

#### 3.1.1 Background

BHP Billiton - Illawarra Coal's coal preparation plants at West Cliff Colliery (West Cliff) near Appin (Figure 1) and Port Kembla currently produce a combined total of approximately 2.5 Mt of coal wash per annum. Coal wash is the by-product of coal extraction and preparation and includes a variety of materials other than coal which cannot be used in steel production. Despite research to identify alternative uses for coal wash and efforts to market these uses (see section 6.4), the overall alternative reuse quantity to date of 0.28 Mt has not been able to significantly reduce the 2.5 Mtpa requiring disposal and the need still exists for the emplacement of coal wash, within an engineered and managed land exercise.

The existing coal wash emplacement facilities, Stage 1 and Stage 2 at West Cliff are nearing capacity and it is necessary to seek further approval to develop a Stage 3 emplacement area (referred to as the 'Proposal') required to provide further deposition of coal wash that will service all operations for an estimated 13 years.

As part of the development application for the coal wash emplacement, Dendrobium Coal Project in 2000-2001, approval to expand the existing operations into the Stage 3 emplacement area was sought. Consent for the Dendrobium Coal Project was granted by the then Minister for Urban Affairs and Planning in late 2001. However, a condition of the Dendrobium Mine development consent (hereafter referred to as the Consent) required that the West Cliff Stage 3 coal wash emplacement be subject to further approval. One component of the further approval was the need to develop a new SIS for the Proposal in accordance with the requirements of the NSW National Parks and Wildlife Service (NPWS), now the NSW Department of Environment and Climate Change (DECC).

In February 2006 BHPIC formerly requested the Director General of the DECC provide requirements to undertake a Species Impact Statement (SIS). The Director General issued the requirements (DGR's) for the Species Impact Statement in March 2006. This document has been prepared based on the assessment of the West Cliff Study Area and surrounding areas at West Cliff.

### 3.1.2 Description of the Proposal

The Proposal will continue Stage 2 coal wash emplacement operations into Stage 3. Coal wash from West Cliff and Port Kembla coal preparation plants will progressively fill benches across the emplacement area that will advance gradually down Brennans Creek Valley. In preparation for the deposition of coal wash all existing features including surface rock, logs and topsoil would be excavated and translocated to the surface of completed emplacement areas. At the completion of each phase of the active emplacement area, the area will be topsoiled and revegetated with native vegetation sourced from the site. A Vegetation and Fauna Management Plan has been developed for the entire West Cliff site and is provided in the application to seek further approval for the Stage 3 Emplacement Area.

The proposed Stage 3 emplacement area including all associated infrastructure covers 66.3 ha with a total capacity of approximately 33.5 Mt and a maximum design height of approximately 353 m AHD. Up to 60.5 ha of native vegetation will be required to be cleared. Associated infrastructure includes the proposed construction of haul roads, dams, dam construction roads, clean water diversion channels and dirty water management ponds (Figure 2). A detailed description of the Proposal including all associated infrastructure is provided by Cardno Forbes Rigby (2007a) and accompanies the submission of this SIS.

The Proposal includes alteration of existing drainage patterns across the Study Area including the construction of a number of new emplacement catch ponds and a new water storage/treatment pond on the pit top (P4A). This system will be entirely independent to the pit top water management system and this will result in a vast improvement in the quality of water being released from the emplacement catch ponds into Brennans Creek Dam. The Proposal also includes construction of two clean water diversion channels along the east and west perimeter of the emplacement area. Each diversion channel will collect run-off from areas upslope of the emplacement area to the east and west of the emplacement and divert that water into Brennans Creek Dam. The Proposal will be subject to the water quality requirements under existing EPA license conditions.

Proposal of the Stage 3 emplacement area will be compensated for by the transfer of a compensatory measure by BHPBIC to the NSW Government at a ratio of more than the required 2:1 (cleared land : vegetated land) ratio. An assessment of land proposed for compensatory habitat has been conducted by Biosis Research and BHP Billiton (2007) and is discussed in Section 8.2 of this SIS.

### 3.1.3 Description of Subject Site and Study Area

The **Subject Site** is located at West Cliff Colliery in the Wollondilly Shire, NSW and is incorporated in a single Coal Lease, CCL724. The Study Area is located on

the Woronora Plateau and is approximately 15 km south of Campbelltown and 5 km east of Appin. The Subject Site falls within the southern portion of the Sydney Basin Bioregion as defined by Thackway and Cresswell (Thackway and Cresswell 1995).

In accordance with the DGR's, the Subject Site includes all areas that will be directly impacted by the Proposal. The **Study Area** includes the Subject Site and an area of indirect impacts. In the current project, an indirect impact zone has been adopted for the reasons detailed below. In addition to this, the entire West Cliff lease area and selected off-site areas have been included in the study in order to provide contextual information.

A zone of 500 m from the area of direct impact is proposed on the basis of the possible indirect impacts (see below). Limited data is available on the appropriate distance that indirect impacts are likely to extend from a coal mine or its associated handling facilities. As there has been considerable research conducted on the indirect impacts (edge effects) of roads, and roads are likely to have similar indirect impacts to the Proposal, the size of the Study Area (i.e. distance that indirect impacts are likely to extend from the Proposal) is based on literature concerning roads.

A study by Bali (2000) on the edge effects of roads concluded that, for most habitats, 50 m was a reasonable estimate over which “we are confident that edge effects occur”. However, Bali (2000) also indicates that edge effects may not be confined to this 50 m zone and provides a body of evidence from three review papers that indicate a large variation in the extent of edge effects – from 15 to 50 m for “Abiotic” indicators, 4 to 500 m for “Direct Biological” indicators and 10 – 2800 m for “Indirect Biological” indicators.

Abiotic edge effects include changes to microclimatic or physical parameters such as air temperature, soil moisture or humidity. In the case of the Proposal, these may also include noise and vibration and the deposition of sediments. The measurement of abiotic factors is probably more accurate and easily replicated than biological indicators, but there is a lack of research on the distance that abiotic edge effects extend.

The dispersal of dust from the Proposal is also likely to cause abiotic edge effects. The effects of dust include elevated concentrations of chemicals and pollutants at distances from the dust source. These often include growth-limiting nutrients, which are likely to have direct impacts on plants. Although some studies have demonstrated that increased levels of chemicals from dust can be detected up to 500 m from the source (a road), in most studies dust was deposited within 50 m (Forman *et al.* 2003).

Abiotic factors are likely to impact directly on both plants and animals, and with

the exception of dust and noise, likely to be restricted to within 50 m of the edge. Noise levels decrease rapidly over 100 m from a busy road, but do not reach normal background levels until up to 800 m. Many animal species rely on sound for communication, navigation, to avoid predators and to find food. A number of studies have attributed reductions in bird abundance to road disturbance (noise, vibrations, light) up to a distance of 1,200 m, although in most studies the effects were not detectable above 400 m (Forman *et al.* 2003). Vibrations may affect reptiles particularly as they have poor eyesight and rely on vibrations to detect prey items. However, there is very little known about the impacts of vibrations on wildlife.

Direct biological edge effects include changes to abundance, density or species richness with increasing distance from an edge. There has been considerable research conducted on the effects of road edges on direct biological indicators, which indicates that impacts may extend up to 500 m. However, the data is often highly variable, which may be because estimates are not associated with edge effects, but rather with survey limitations, other environmental conditions and/or interactions amongst species (Bali 2000).

Indirect biological effects include weed invasion, seed dispersal, disturbance, predation, brood parasitism and herbivory. There has been considerable research conducted on the effects of road edges on indirect biological indicators and although this research indicates that effects extend up to 2,800 m from an edge, it is highly variable (Bali 2000).

Although Bali (2000) concluded that edge effects extend to a maximum of 50 m, based on the fact that abiotic effects were the most consistent indicator of edge effects, it is obvious from the literature that edge effects extend beyond 50 m, but that they cannot be measured in a consistent manner. For the purposes of this SIS the most conservative “Direct Biological” indicator is used (i.e. 500 m), because most studies indicate that any impacts to wildlife from roads are not detectable beyond 500 m. It should be noted that individual species will be impacted by different edge effects and that the distance from the Proposal that the impacts extend will vary between species. The value of 500 m has been chosen because it is supported by the literature, although it is probably a conservative estimate, and it is likely to capture all the different types of impacts on all species.

Flora and fauna values within the Study area are considered to be of high conservation significance. Three threatened plant species and four threatened animal species as listed on the TSC and/or EPBC Acts have been recorded within the Study Area. In addition to threatened species already recorded, the Study Area is also considered to provide potential habitat for a further nine threatened plant species and 31 threatened animal species.

Plant communities in the Study Area were considered to be in good condition with all structural layers intact and a high diversity of species present. Five plant communities were identified as occurring in the Study Area: Exposed Sandstone Scribbly Gum Woodland, Sandstone Gully Apple Peppermint Forest, Sandstone Gully Peppermint Forest, Upland Swamps and Upper Georges River Sandstone Woodland. None of these plant communities are listed as Endangered Ecological Communities on the TSC and/or EPBC Acts.

Fauna habitats within the Study Area are considered to be in good condition with flora containing a high number of indigenous species; ground, log and litter layers are largely intact and undisturbed; a large variety of habitat and resources for threatened species are present. The habitat also provides protection that would assist fauna movements to and from surrounding areas, including Dharawal State Conservation Area to the east and Sydney Catchment Authority Catchment Areas to the south-west and also forms part of a wildlife corridor.

### **3.1.4 Amelioration, Rehabilitation and Compensatory Measures**

This SIS assesses the impacts of the Proposal on threatened species at West Cliff of those species likely to utilise the Study Area. This SIS forms one component of the requirements for further approval for the Stage 3 Coal Wash Emplacement.

Three other components of the further approval include the requirement to prepare a Management Plan for the Broad-headed Snake, a plan to clear vegetation for Stage 3, and a compensatory measure package.

Following discussions with BHP Billiton the vegetation clearing plan has been replaced with a Vegetation and Fauna Management Plan (VFMP) for the whole of West Cliff's operations. This VFMP identifies best practice management activities in the following areas:

1. Soil translocation and hygiene
2. Weed Management
3. Vegetation clearing for fauna mitigations
4. Habitat re-instatement
5. Revegetation

Further, this VFMP formalises existing Study Area management protocols for other activities such as fire management.

The VFMP therefore exceeds the requirement of the consent to prepare a 'Vegetation Clearing Plan' simply for the Stage 3 emplacement area by

including various other management activities for the whole Study Area. The VFMP also identifies a raft of measures that will mitigate impacts of the Proposal on flora and fauna values.

Similarly, the Broad-headed Snake Management Plan and the Compensatory Measure Package are integral components of the Proposal.

The details of the VFMP, the Broad-headed Snake Management Plan and the Compensatory Measure Package have not been reproduced in detail in this SIS. It will however be important to read those documents in association with this SIS as they form a significant component of the mitigation measures that have been adopted by BHPBIC for the Proposal.

## 3.2 Provision of Relevant Maps and Plans

The location of the Study Area within a regional context is provided in Figure 1. An aerial photograph of the Locality, showing the boundary of the Study Area and Subject Site, is provided in Figure 2.

A topographic map of the Study Area (at a scale of 1:250,000) is provided in Figure 3, showing current land use (mining, agricultural and rural). Maps of the Locality showing zoning, land tenure, parks and reserves and townships, are provided in Figure 4.

A map of the plant communities within the Locality and Study Area is provided in Figure 5. Maps showing survey locations are provided in Figure 6 and Figure 7. Maps showing the location of database search results for threatened plant and animal species from the DECC Atlas of NSW Wildlife are provided in Figure 8 and Figure 9 respectively. Maps showing the location of threatened plant and animal species (including habitats) recorded by Biosis Research during surveys are provided in Figure 10 and Figure 11 respectively.

## 3.3 Land Tenure Information

All appropriate access permits were gained from the relevant landholders before surveys were undertaken. The Subject Site is located on Crown Land held by BHPBIC under Consolidation Coal Lease 724. Land tenure surrounding the Study Area includes Crown Land, Dharawal State Conservation Area, Sydney Catchment Authority freehold land and land owned by the Tharawal Local Aboriginal Land Council. A number of services run through the Study Area, these include a gas pipeline, water pipeline, and 66 kV electrical transmission lines.

The 66 kV electrical transmission lines are owned and operated by Integral Energy and used to supply power to operate West Cliff Colliery. Power is supplied from

the state grid via the overhead transmission line from Appin across Brennans Creek valley to the West Cliff mine Study Area. There is an existing 445 mm steel gas pipeline that crosses the Study Area that is owned and maintained by BHPBIC. The pipeline transfers mine gas generated at West Cliff to the adjacent BHPBIC Appin Colliery for power generation.

There is an existing 100 mm victaulic overland pipeline that crosses the Subject Site. The pipe is currently used to carry "Douglas" desalinated water and/or water from the Appin town supply to existing infrastructure of the north of the West Cliff Colliery Study Area. The Brennans Creek valley section of the pipeline is an asset currently owned and operated by BHPBIC.



## 4.0 INITIAL ASSESSMENT

### 4.1 Identifying Subject Species

#### 4.1.1 Assessment of available information

In order to identify threatened species, populations and/or ecological communities that may be affected by the Proposal, the following resources were used:

##### **Previous studies by Biosis Research**

Previous studies undertaken by Biosis Research within the Study Area and Locality including:

Dendrobium Coal Project Species Impact Statement (Biosis Research 2001a);

Dendrobium Coal Project: Terrestrial and Aquatic Habitat Assessment (Biosis Research 2001b);

Flora and Fauna Assessment: West Cliff Power Supply (Biosis Research 2006f);

Flora and Fauna Assessment: North Appin 66kV Switching Station and Feeder Lines (Biosis Research 2006e);

Flora and Fauna Assessment of Appin Colliery Longwall 219 (Biosis Research 2006b);

Flora and Fauna Assessment of Longwall 409, Appin Colliery (Biosis Research 2006c);

Flora and Fauna Assessment: East Appin 66kV Switching Station (Biosis Research 2006d);

West Cliff Colliery Area 5 - Longwalls 31-33 Impacts of Subsidence on Terrestrial Flora and Fauna (Biosis Research 2005);

West Cliff Colliery Proposed Coal Stockpile Extension (Biosis Research 2002c);

West Cliff Colliery PED Line Communications Project - Flora and Fauna Habitat Assessment (Biosis Research 2002b);

West Cliff Colliery Seismic Line J Terrestrial Flora and Fauna Assessment

(Biosis Research 2002d); and,

*Acacia baueri* ssp. *aspera* Targeted Surveys, West Cliff Colliery (Biosis Research 2002a).

### **Primary Literature and Previous Studies**

Minister for Urban Affairs and Planning 2001, *Environmental Planning and Assessment Act, 1979. Integrated State Significant Development. Determination of Development Application Pursuant to Sections 76(A)9 & 80. Proponent: BHP Billiton. Conditions of Consent for the Dendrobium Underground Coal Mine.*, PlanningNSW, Sydney.

NPWS' Primary Submission to the Commission of Inquiry into the Dendrobium Coal Project, (NPWS 2001b); and,

NPWS' Submission - In - Reply to the Commission of Inquiry into the Dendrobium Coal Project (NPWS 2001c).

### **Databases**

- DECC Atlas of NSW Wildlife (accessed January - June 2007);
- DEH's EPBC Act Protected Matters Search Tool (accessed January 2007);
- PlantNet;
- Bionet (accessed January – June 2007);
- DECC Threatened species profiles (accessed January – June 2007); and,
- Birds Australia's Atlas of Australian Birds (accessed January - June 2007).

### **Photographs, maps and plans**

- Aerial photographs of the Locality (supplied by BHP Billiton);
- Topographic maps (Appin 1:25 000 Map Sheet); and,
- NPWS vegetation mapping (NPWS 2003a).

### **Consultation/People**

- Dr David Keith (DECC Hurstville) regarding previously recorded locations of *Acacia bynoeana* in the Locality; and,
- Elizabeth Magarey (DECC) regarding results from fauna surveys conducted in Dharawal State Conservation Area.

#### 4.1.2 Nomenclature

Plant taxonomy (method of classification) used in this report follows (Harden 1990, 1991a, 1992, 1993); (Brooker and Kleinig 1999) or subsequent advice from the National Herbarium of NSW. Plant species are referred to using their scientific names in this report with all scientific and common names listed in Appendix 5.

Names of vertebrates (fauna) follow the Census of Australian Vertebrates (CAVs) maintained by DEH. 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 Appendix 4.

#### 4.1.3 Threatened Flora

Thirty-two significant plant species listed on the TSC Act and EPBC Act, or their habitat, have been previously recorded within 10km of the Study Area (DECC Atlas of NSW Wildlife and DEH Online EPBC Database) (Table 2).

*Acacia bynoeana*, *Persoonia hirsuta* and *Pultenaea aristata* were recorded in Exposed Sandstone Scribbly Gum Woodland and Sandstone Gully Peppermint Forest in the Study Area. Potential habitat for a further 11 threatened species also occurs in the Study Area, these are; *Acacia baueri* ssp. *aspera*, *Astrotricha crassifolia*, *Boronia deanei*, *Cryptostylis hunteriana*, *Darwinia peduncularis*, *Eucalyptus camfieldii*, *Epacris purpurascens* var. *purpurascens*, *Grevillea parviflora* ssp. *parviflora*, *Gyrostemon thesioides*, *Leucopogon exolasiu* and, *Pommaderris adnata* (Table 2). All threatened flora with known and potential habitat in the Study Area are considered further in Section 6.1.1 of this SIS.

**Table 2: Terrestrial flora listed on the TSC Act or EPBC Act that have the potential to occur in the local area.** Key: 1) Listed on the EPBC Act as Endangered (E) or Vulnerable (V); 2) Listed on the TSC Act as Endangered (E1), Extinct (E4) or Vulnerable (V)

| Scientific Name                         | EPBC Act | TSC Act | Habitat  | Potential habitat |
|---|----------|---------|--|-------------------|
| <i>Acacia baueri</i> ssp. <i>aspera</i> | -        | 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 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 (DEC 2005a). | Yes.              |

| Scientific Name                   | EPBC Act | TSC Act | Habitat  | Potential habitat                   |
|-----------------------------------|----------|---------|--|-------------------------------------|
| <i>Acacia bynoeana</i>            | V        | E1      | Bynoe's wattle is found in central eastern NSW, from the Hunter District (Morisset) south to the Southern Highlands and west to the Blue Mountains. It has recently been found in the Colymea and Parma Creek areas west of Nowra. Occurs in heath or dry sclerophyll forest on sandy soils. Seems to prefer open, sometimes slightly disturbed sites such as trail margins, edges of roadside spoil mounds and in recently burnt patches (DEC 2005c).   | Yes. <b>Recorded in Study Area.</b> |
| <i>Acacia rivalis</i>             | -        | E1      | In NSW this species has only been recorded from the Broken Hill district where it grows along ephemeral streams in River Red Gum communities (Harden 1991a).   | No                                  |
| <i>Astrotricha crassifolia</i>    | V        | V       | Found on sandstone in dry sclerophyll woodland. Previous records include the Royal NP and near Patonga (Harden 1992). Also occurs on the Woronora Plateau (Sutherland and Campbelltown LGAs). There is also a record from near Glen Davis (Lithgow LGA). Also found in Victoria. Flowers in Spring (DEC 2005d).  | Yes                                 |
| <i>Boronia deanei</i>             | V        | V       | Wet heath vegetation (Fairley and Moore 1995). There are scattered populations of <i>Boronia deanei</i> between the far south-east of NSW and the Blue Mountains (including the upper Kangaroo River near Carrington Falls, the Endrick River near Nerriga and Nalbaugh Plateau), mainly in conservation reserves. Grows in wet heath, often at the margins of open forest adjoining swamps or along streams (DEC 2005e).  | Yes.                                |
| <i>Caladenia tessellata</i>       | V        | E1      | Low open forest with heath or sometimes grass understorey this species only grows in very dense shrubbery in coastal areas (Bishop 1996). Currently known from two disjunct areas: Braidwood on southern tablelands and three populations in Wyong area on the Central Coast (DEC 2005f).  | No                                  |
| <i>Cryptostylis hunteriana</i>    | V        | V       | This species typically grows in swamp-heath on sandy soils chiefly in coastal districts (Harden 1993) but has also been recorded on steep bare hillsides (Bishop 1996).  | Yes                                 |
| <i>Cynanchum elegans</i>          | E        | E1      | Rainforest gullies scrub and scree slopes in Gloucester and Wollongong districts (Harden 1992). Occurs mainly at the ecotone between dry subtropical rainforest and sclerophyll forest/woodland communities (NPWS 2002a). Has been recorded in dry subtropical rainforest, littoral rainforest, <i>Leptospermum laevigatum</i> - <i>Banksia integrifolia</i> Coastal scrub, <i>Eucalyptus tereticornis</i> forest and woodland, <i>Corymbia maculata</i> forest and woodland and <i>Melaleuca armillaris</i> scrub to open scrub (NPWS 2002a). | No                                  |
| <i>Daphnandra sp. 'Illawarra'</i> | E        | E1      | Occupies the rocky hillsides and gullies of the Illawarra lowlands, occasionally extending onto the upper escarpment slopes. Associated vegetation includes rainforest and moist eucalypt forest (DEC 2005h).  | No                                  |
| <i>Darwinia peduncularis</i>      | -        | V       | Occurs from Hornsby to Hawkesbury River and west to near Glen Davis where it grows in dry sclerophyll forest on sandstone hillsides and ridges (Harden 2002). Usually grows on or near rocky outcrops on sandy, well drained, low nutrient soil over sandstone. Flowers in winter to early spring (DEC 2005i).   | Yes                                 |

| Scientific Name                                      | EPBC Act | TSC Act | Habitat  | Potential habitat |
|--|----------|---------|--|-------------------|
| <i>Epacris purpurascens</i> var. <i>purpurascens</i> | -        | V       | Sclerophyll forest, scrub and swamps from Gosford and Sydney districts (Harden 1992) specifically this species is thought to require wet heath vegetation (T. James pers. comm.). Characteristically found in a range of habitat types, most of which have a strong shale soil influence. These include ridge top 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 2005m).   | Yes               |
| <i>Eucalyptus camfieldii</i>                         | V        | V       | Restricted distribution in a narrow band from Waterfall in the south to Raymond Terrace in the north. Coastal heath in shallow sandy soils overlying exposed Hawkesbury sandstone. Population sizes are difficult to estimate because its extensive lignotubers may be 20 m across. A number of stems arise from these lignotubers giving the impression of individual plants. Flowering period is irregular, flowers recorded throughout the year (DEC 2005n).  | Yes               |
| <i>Grevillea obtusiflora</i>                         | E        | E1      | <i>Grevillea obtusiflora</i> has two subspecies, <i>G. obtusiflora</i> ssp. <i>obtusiflora</i> and <i>G. obtusiflora</i> ssp. <i>fecunda</i> . <i>G. obtusiflora</i> ssp. <i>obtusiflora</i> occurs near Rylstone, occurs as scattered groups in the understorey of low open eucalypt forest at an altitude of 730 m above sea level and flowers sparsely in Winter and Spring with peak flowering in October. <i>G. obtusiflora</i> ssp. <i>fecunda</i> is found in the Capertee Valley, north-west of Lithgow, and in the Gardens of Stone National Park, it occurs in clusters within low, open scrub beneath open, dry sclerophyll forest, on orange, sandy loam soils with sandstone boulders, at an altitude of 570 m and flowers abundantly in spring. It appears to respond favourably to mechanical soil disturbance and is known to quickly recolonise roadside scrapes (DEC 2005q). | No                |
| <i>Grevillea parviflora</i> ssp. <i>parviflora</i>   | 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 2005r).   | Yes               |
| <i>Gyostemon thesioides</i>                          | -        | E1      | Within NSW, has only ever been recorded at three sites, to the west and south of Sydney, near the Colo, Georges and Nepean Rivers. The most recent sighting was of a single male plant near the Colo River within Wollemi National Park. The species has not been recorded from the Nepean and Georges Rivers for 90 and 30 years respectively, despite searches. Also occurs also in Western Australia, South Australia, Victoria and Tasmania. Grows on hillsides and riverbanks and may be restricted to fine sandy soils (DEC 2005t).  | Yes               |

| Scientific Name               | EPBC Act | TSC Act | Habitat   | Potential habitat                   |
|-------------------------------|----------|---------|---|-------------------------------------|
| <i>Leucopogon exolasius</i>   | V        | V       | Woodland on sandstone, restricted to the Woronora and Grose Rivers (Harden 1991a). The plant occurs in woodland on sandstone and prefers rocky hillsides along creek banks (DEC 2005§). Flowering occurs in August and September.   | Yes                                 |
| <i>Melaleuca deanei</i>       | V        | V       | Grows in wet heath on sandstone (Harden 1991a). 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 2005w). 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.   | No                                  |
| <i>Persoonia bargoensis</i>   | V        | E1      | Restricted to a small area south-west of Sydney on the western edge of the Woronora Plateau. Its entire range falls between Picton, Douglas Park, Yanderra, Cataract River and Thirlmere. Occurs in woodland or dry sclerophyll forest on sandstone and on heavier, well drained, loamy, gravelly soils typical of Shale Sandstone Transition Forest. Like most Geebung this species seems to benefit from the reduced competition and increased light available on disturbance margins including roadsides (DEC 2005{).  | No                                  |
| <i>Persoonia glaucescens</i>  | V        | E1      | Woodland to dry sclerophyll forest on sandstone from Picton to Bargo (Harden 1991a). More specifically this species prefers clayey and gravelly laterites with ridge tops, plateaus and upper slopes being preferred topography (NPWS 2000d).   | No                                  |
| <i>Persoonia hirsuta</i>      | E        | E1      | Occurs from Gosford to Royal NP and in the Putty district from Hill Top to Glen Davis where it grows in woodland to dry sclerophyll forest on sandstone (Harden 2002) or rarely on shale (NSW Scientific Committee 1998). Two subspecies are recognised, <i>P. hirsuta</i> ssp. <i>hirsuta</i> (Gosford to Berowra and Manly to Royal NP) and <i>P. hirsuta</i> ssp. <i>evoluta</i> (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 2005l). | Yes. <b>Recorded in Study Area.</b> |
| <i>Persoonia nutans</i>       | E        | E1      | Grows in Woodland to dry sclerophyll forest on clay soils and old alluviums on the Cumberland Plain (Robinson 1994, Harden 2002). It is restricted to Castlereagh Scribbly Gum Woodlands, Agnes Banks Woodland, Shale Gravel Transition Forest and Cooks River Castlereagh Ironbark Forest (NPWS 2003c).  | No                                  |
| <i>Pimelea spicata</i>        | E        | E1      | In western Sydney, <i>P. spicata</i> is restricted to areas supporting, or that previously supported, Cumberland Plain Woodland. <i>Pimelea spicata</i> has been recorded from both shale hills and shale plains woodland. <i>Pimelea spicata</i> has also been recorded from highly degraded areas that no longer support native vegetation, but that would have supported CPW previously (DEC 2004a).   | No                                  |
| <i>Plinthanthesis rodwayi</i> | V        | E1      | Montane woodland (Harden 1993). The species appears to be restricted to two peaks in Budawang NP (Mt Budawang, Mt Currockbilly). <i>Plinthanthesis rodwayi</i> has been recorded in open heathland on shallow soils (DEC 2005}).  | No                                  |
| <i>Pomaderris adnata</i>      | -        | E1      | Ridge top vegetation often with <i>Eucalyptus sieberi</i> and <i>Corymbia gummifera</i> (NSW Scientific Committee 2001b). Occurs near the edge of the plateau behind the Illawarra escarpment. Known only from one Study Area at Sublime Point, north of Wollongong (DEC 2005-).  | Yes                                 |

| Scientific Name              | EPBC Act | TSC Act | Habitat  | Potential habitat                   |
|------------------------------|----------|---------|--|-------------------------------------|
| <i>Pomaderris brunnea</i>    | 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 2005□).   | No                                  |
| <i>Pterostylis pulchella</i> | V        | V       | Restricted to several waterfalls on the Illawarra escarpment and the Southern Highlands. Usually favours creek banks and mossy rocks very close to running water (Bishop 1996). Flowers appear from February to May.   | No                                  |
| <i>Pterostylis saxicola</i>  | E        | E1      | Most commonly found growing in small pockets of shallow soil in depressions on sandstone rock shelves above cliff lines (NSW Scientific Committee 1997). The plant communities that occur above the shelves are either shale/sandstone transition or shale communities. Often occurs near streams. Picnic Point to Picton (Harden 1993). Currently known from only 5 localities (NSW Scientific Committee 1997).   | No                                  |
| <i>Pultenaea aristata</i>    | 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 2005€).   | Yes. <b>Recorded in Study Area.</b> |
| <i>Pultenaea pedunculata</i> | -        | E1      | Restricted to the Cumberland Plain and near Merimbula where it grows in dry sclerophyll forest and disturbed sites (Harden 2002). In western Sydney it occurs in three locations: within industrial and residential areas at Villawood and Prestons, and north-west of Appin between the Nepean River and Devines Tunnel No. 2 (DEC 2005□). 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 2005□). At all sites there is a lateritic influence in the soil with characteristic ironstone gravels present (DEC 2005□). This species is known to occur in remnants of Cooks River Clay Plain Scrub Forest (James <i>et al.</i> 1999). | No                                  |
| <i>Senna acclinis</i>        | -        | E1      | Found in coastal districts and adjacent tablelands of NSW from the Illawarra in NSW to Queensland. Grows in or on the edges of subtropical and dry rainforest (DEC 2005f).   | No                                  |
| <i>Syzygium paniculatum</i>  | V        | V       | Subtropical and littoral rainforest on sandy soils or stabilised dunes near the sea (Harden 1991a). Found only in NSW, in a narrow, linear coastal strip from Bulahdelah to Conjola State Forest. On the south coast the Magenta Lilly Pilly occurs on grey soils over sandstone, restricted mainly to remnant stands of littoral (coastal) rainforest. On the central coast Magenta Lilly Pilly occurs on gravels, sands, silts and clays in riverside gallery rainforests and remnant littoral rainforest communities (DEC 2005†).   | No                                  |
| <i>Thesium australe</i>      | V        | V       | Clay soils in grassy woodlands or coastal headlands (James <i>et al.</i> 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 Kangaroo Grass ( <i>Themeda australis</i> ). A root parasite that takes water and some nutrient from other plants, especially Kangaroo Grass (DEC 2005*).   | No                                  |

#### 4.1.4 Threatened Fauna

In total, 57 threatened animal species are considered in the SIS (Table 3).

These records are from the following sources:

- Atlas of NSW Wildlife (ref) – A total of 30 threatened animal species listed on the TSC Act have been previously recorded within 10 km of the Subject Site (Figure 9 and Figure 11).
- The Director General’s Requirements – necessitate the consideration of an additional nine threatened animal species that are listed on the TSC Act.
- The Orange-bellied Parrot is also considered as a result of the EPBC Act Protected Matters Online Database search.
- The Little Tern is considered due to its presence in the Birds Australia Atlas.
- Sixteen additional threatened animal species as listed on the TSC Act are considered due to recordings from previous assessments within the locality.

The study area is considered to have potential habitat for 39 of these threatened species. These 39 species are hereafter referred to as subject species. A description of the distribution and habitat of each species is provided in Section 6.3.6.

**Table 3: Threatened animal species and/or their habitat listed on the TSC and/or EPBC Acts that have previously been recorded within 10 km of the Subject Site and/or are required for consideration in the Director-General’s Requirements.**

| Scientific Name      | Common Name                | EPBC Act <sup>a</sup> | TSC Act <sup>b</sup> | Habitat   | Potential Habitat / Subject Species | Comments   |
|----------------------|----------------------------|-----------------------|----------------------|---|-------------------------------------|--|
| <b>Amphibians</b>    |                            |                       |                      |   |                                     |  |
| <i>Litoria aurea</i> | Green and Golden Bell Frog | V                     | E1                   | Found in marshes, dams and stream sides, particularly those containing bullrushes or spikerushes (NPWS 1999e). Preferred habitat contains water bodies that are unshaded, are free of predatory fish, have a grassy area nearby and have diurnal sheltering sites nearby such as vegetation or rocks (White and Pyke 1996, NPWS 1999e). | No                                  | The species has been recorded within a 10 km radius of the Subject Site (DECC Atlas of NSW Wildlife), but not within the Study Area. |



| Scientific Name                 | Common Name            | EPBC Act <sup>a</sup> | TSC Act <sup>b</sup> | Habitat   | Potential Habitat / Subject Species   | Comments   |
|---------------------------------|------------------------|-----------------------|----------------------|---|---------------------------------------|--|
| <i>Litoria littlejohni</i>      | 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 <i>et al.</i> 1995). Prefers rock flowing streams, but individuals have also been collected from semi-permanent dams with some emergent vegetation (Barker <i>et al.</i> 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, but suboptimal potential habitat | The species has been recorded within a 10 km radius of the Subject Site (DECC Atlas of NSW Wildlife) including the adjacent Dharawal State Conservation Area and/or Nature Reserve, but not within the Study Area. |
| <i>Heleioporus australiacus</i> | 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 <i>et al.</i> 1995). | Yes                                   | The species has been recorded within a 10 km radius of the Subject Site (DECC Atlas of NSW Wildlife) including the adjacent Dharawal State Conservation Area and/or Nature Reserve, but not within the Study Area. |
| <i>Mixophyes balbus</i>         | Stuttering Frog        | V                     | E1                   | This species is usually associated with mountain streams, wet mountain forests and rainforests (Barker <i>et al.</i> 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 <i>et al.</i> 1995).   | No                                    | The species has been recorded within a 10 km radius of the Subject Site (in the adjacent Dharawal State Conservation Area and/or Nature Reserve), but not within the Study Area.                                   |
| <i>Mixophyes iteratus</i>       | Giant Barred Frog      | E                     | E1                   | Usually found in coastal riverine rainforest and upland areas such as the Border Ranges (Barker <i>et al.</i> 1995).  | No                                    | The species has been recorded within a 10 km radius of the Subject Site (in the adjacent Dharawal State Conservation Area and/or Nature Reserve), but not within the Study Area.                                   |
| <i>Pseudophryne australis</i>   | 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 Mahony 1997).  | Yes                                   | The species has been recorded within a 10 km radius of the Subject Site (DECC Atlas of NSW Wildlife) including the adjacent Dharawal State Conservation Area and/or Nature Reserve, but not within the Study Area. |

| Scientific Name                       | Common Name                            | EPBC Act <sup>a</sup> | TSC Act <sup>b</sup> | Habitat  | Potential Habitat / Subject Species   | Comments   |
|---------------------------------------|--|-----------------------|----------------------|--|---------------------------------------|--|
| <b>Birds</b>                          |  |                       |                      |  |                                       |  |
| <i>Botaurus poiciloptilus</i>         | Australasian Bittern                   | -                     | V                    | Inhabits terrestrial and estuarine wetlands, generally where there is permanent water. Prefers wetlands with dense vegetation including rushes and reeds (NPWS 1999a).   | No                                    | The species has not been recorded within a 10 km radius of the Subject Site.   |
| <i>Ixobrychus flavicollis</i>         | Black Bittern                          | -                     | V                    | Usually found on coastal plains below 200 m. Often found along timbered watercourses, in wetlands with fringing trees and shrub vegetation. The sites where they occur are characterized by dense waterside vegetation (NPWS 1999b).   | No                                    | The species has not been recorded within a 10 km radius of the Subject Site.   |
| <i>Burhinus grallarius</i>            | Bush Stone-curlew                      | -                     | E1                   | Lightly timbered open forest and woodland, or partly cleared farmland with remnants of woodland, with a ground cover of short sparse grass and few or no shrubs where fallen branches and leaf litter are present (Marchant and Higgins 1993).   | Yes                                   | The species has been recorded within a 10 km radius of the Subject Site (DECC Atlas of NSW Wildlife), but not within the Study Area.   |
| <i>Callocephalon fimbriatum</i>       | 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 sub-alpine Snow Gum woodland and occasionally in temperate or regenerating forest (Forshaw and Cooper 1981). In winter, occurs at lower altitudes in drier, more open eucalypt forests and woodlands, particularly in box-ironbark assemblages, or in dry forest in coastal areas (Shields and Crome 1992). It requires tree hollows in which to breed (Gibbons and Lindenmayer 1997). | Yes                                   | The species has been recorded within a 10 km radius of the Subject Site (DECC Atlas of NSW Wildlife), and within the Study Area (Biosis Research).   |
| <i>Calyptorhynchus lathamii</i>       | Glossy Black-cockatoo                  | -                     | V                    | Inhabits forest with low nutrients, characteristically with key Allocasuarina species. Tends to prefer drier forest types (NPWS 1999d) with a middle stratum of Allocasuarina below Eucalyptus or Angophora. Often confined to remnant patches in hills and gullies (Higgins 1999). Breed in hollows stumps or limbs, either living or dead (Higgins 1999).  | Yes                                   | The species has been recorded within a 10 km radius of the Subject Site (DECC Atlas of NSW Wildlife) including the adjacent Dharawal State Conservation Area and/or Nature Reserve, but not within the Study Area. |
| <i>Climacteris picumnus victoriae</i> | Brown Treecreeper (eastern subspecies) | -                     | V                    | Live in eucalypt woodlands, especially areas of relatively flat open woodland typically lacking a dense shrub layer, with short grass or bare ground and with fallen logs or dead trees present (Traill and Duncan 2000).  | Yes                                   | The species has been recorded within a 10 km radius of the Subject Site (DECC Atlas of NSW Wildlife) including the adjacent Dharawal State Conservation Area and/or Nature Reserve, but not within the Study Area. |
| <i>Coracina lineata</i>               | Barred Cuckoo-shrike                   | -                     | V                    | Found in rainforests, vine thickets and their margins. Also found in eucalypt forests and clearing in secondary growth forests (Pizzey and Knight 1997).   | Yes, but suboptimal potential habitat | The species has not been recorded within a 10 km radius of the Subject Site.   |

| Scientific Name                     | Common Name                                   | EPBC Act <sup>a</sup> | TSC Act <sup>b</sup> | Habitat  | Potential Habitat / Subject Species | Comments   |
|-------------------------------------|---|-----------------------|----------------------|--|-------------------------------------|--|
| <i>Ptilinopus superbus</i>          | Superb Fruit-Dove                             | -                     | V                    | Mostly closed forests, including monsoon rainforests and mesophyll vine forests (Higgins and Davies 1996).   | No                                  | The species has not been recorded within a 10 km radius of the Subject Site.   |
| <i>Grantiella picta</i>             | Painted Honeyeater                            | -                     | V                    | Found mainly in dry open woodlands and forests, where it is strongly associated with mistletoe (Higgins <i>et al.</i> 2001). Often found on plains with scattered eucalypts and remnant trees on farmlands.  | Yes                                 | The species has not been recorded within a 10 km radius of the Subject Site.   |
| <i>Melithreptus gularis gularis</i> | Black-chinned Honeyeater (eastern subspecies) | -                     | V                    | Found mostly in open forests and woodlands dominated by box and ironbark eucalypts (Higgins <i>et al.</i> 2001). It is rarely recorded east of the Great Dividing Range (Higgins <i>et al.</i> 2001).  | Yes                                 | The species has not been recorded within a 10 km radius of the Subject Site.   |
| <i>Xanthomyza phrygia</i>           | 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 (Pizzey 1983, NPWS 1999g).   | Yes                                 | The species has been recorded within a 10 km radius of the Subject Site (DECC Atlas of NSW Wildlife) including the adjacent Dharawal State Conservation Area and/or Nature Reserve, but not within the Study Area. |
| <i>Pachycephala olivacea</i>        | Olive Whistler                                | -                     | V                    | Found in a range of habitats including alpine thickets, wetter rainforest/woodlands, riparian vegetation and heaths (Pizzey and Knight 1997).  | Yes                                 | The species has not been recorded within a 10 km radius of the Subject Site.   |
| <i>Pyrrholaemus sagittata</i>       | 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 <i>et al.</i> 1984, NSW Scientific Committee 2001c). The species is sedentary, living in pairs or trios and nests on the ground in grass tussocks, dense litter and fallen branches. They forage on the ground and in the understorey for arthropods and seeds (Blakers <i>et al.</i> 1984, NSW Scientific Committee 2001c). Home ranges vary from 6-12 hectares (NSW Scientific Committee 2001c). | Yes                                 | The species has not been recorded within a 10 km radius of the Subject Site.   |
| <i>Stagonopleura guttata</i>        | Diamond Firetail                              | -                     | V                    | Found in a range of habitat types including open Eucalypt forest, mallee and acacia scrubs (Pizzey and Knight 1997).   | Yes                                 | The species has been recorded within a 10 km radius of the Subject Site (DECC Atlas of NSW Wildlife), but not within the Study Area.   |

| Scientific Name                        | Common Name                       | EPBC Act <sup>a</sup> | TSC Act <sup>b</sup> | Habitat  | Potential Habitat / Subject Species | Comments   |
|--|-----------------------------------|-----------------------|----------------------|--|-------------------------------------|--|
| <i>Lathamus discolor</i>               | Swift Parrot                      | EM                    | E1                   | The Swift Parrot occurs in woodlands and forests of NSW from May to August, where it feeds on eucalypt nectar, pollen and associated insects (Forshaw and Cooper 1981). The Swift Parrot is dependent on flowering resources across a wide range of habitats in its wintering grounds in NSW (Shields and Crome 1992). This species is migratory, breeding in Tasmania and also nomadic, moving about in response to changing food availability (Pizzey 1983). | Yes                                 | The species has been recorded within a 10 km radius of the Subject Site (DECC Atlas of NSW Wildlife), but not within the Study Area.   |
| <i>Neophema chrysogaster</i>           | Orange-bellied Parrot             | E                     | E1                   | Mostly found within 3km of the coast, mostly in sheltered coastal areas such as lagoon and estuaries (Higgins 1999). The species can be found foraging in weedy areas associated with these coastal habitats or even in totally modified landscapes such as pastures, seed crops and golf courses (DEC 2005z).   | No                                  | The species has not been recorded within a 10 km radius of the Subject Site.   |
| <i>Neophema pulchella</i>              | 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).                                 | Yes                                 | The species has been recorded within a 10 km radius of the Subject Site (DECC Atlas of NSW Wildlife) including the adjacent Dharawal State Conservation Area and/or Nature Reserve, but not within the Study Area. |
| <i>Pezoporus wallicus wallicus</i>     | Eastern Ground Parrot             | -                     | V                    | Mainly found in heathland, sedgeland or buttongrass plains providing medium to dense cover (Higgins 1999).   | No                                  | The species has been recorded within a 10 km radius of the Subject Site (in the adjacent Dharawal State Conservation Area and/or Nature Reserve), but not within the Study Area.                                   |
| <i>Dasyornis brachypterus</i>          | Eastern Bristlebird               | E                     | E1                   | Found in coastal woodlands, dense scrub and heathlands, particularly where it borders taller woodlands (Pizzey and Knight 1997).   | No                                  | The species has been recorded within a 10 km radius of the Subject Site (in the adjacent Dharawal State Conservation Area and/or Nature Reserve), but not within the Study Area.                                   |
| <i>Melanodryas cucullata cucullata</i> | Hooded Robin (south-eastern form) | -                     | V                    | This species lives in a wide range of temperate woodland habitats, and a range of woodlands and shrublands in semi-arid areas (Traill and Duncan 2000).  | Yes                                 | The species has not been recorded within a 10 km radius of the Subject Site.   |
| <i>Petroica rodinogaster</i>           | Pink Robin                        | -                     | V                    | Found in dense, dank forest/treefern gullies and disperses in autumn-winter to open forests, woodlands and scrublands (Pizzey and Knight 1997).  | Yes                                 | The species has not been recorded within a 10 km radius of the Subject Site.   |

| Scientific Name             | Common Name              | EPBC Act <sup>a</sup> | TSC Act <sup>b</sup> | Habitat   | Potential Habitat / Subject Species | Comments  |
|-----------------------------|--------------------------|-----------------------|----------------------|---|-------------------------------------|---|
| <i>Rostratula australis</i> | Australian Painted Snipe | V                     | E1                   | Usually found in shallow inland wetlands including farm dams, lakes, rice crops, swamps and waterlogged grassland. They prefer freshwater wetlands, ephemeral or permanent, although they have been recorded in brackish waters (Marchant & Higgins 1993).  | No                                  | The species has not been recorded within a 10 km radius of the Subject Site.  |
| <i>Sterna albifrons</i>     | Little Tern              | M                     | E1                   | Found in sheltered coastal environments including lagoons, estuaries, river mouths and deltas, lakes, bays, harbours and inlets (Higgins and Davies 1996).  | No                                  | The species has been recorded within a 10 km radius of the Subject Site (Birds Australia's Atlas of Australian Birds), but not within the Study Area.   |
| <i>Oxyura australis</i>     | Blue-billed Duck         | M                     | V                    | Almost wholly aquatic, preferring deep water in large, permanent wetlands with an abundant aquatic flora (Marchant and Higgins 1990).   | No                                  | The species has not been recorded within a 10 km radius of the Subject Site.  |
| <i>Stictonetta naevosa</i>  | Freckled Duck            | M                     | V                    | The freckled duck breeds in permanent fresh swamps that are heavily vegetated. Found in fresh or salty permanent open lakes, especially during drought. Often seen in groups on fallen trees and sand spits (Simpson and Day 1996).   | No                                  | The species has not been recorded within a 10 km radius of the Subject Site.  |
| <i>Ninox connivens</i>      | Barking Owl              | -                     | V                    | Generally found in open forests, woodlands, swamp woodlands and dense scrub. Can also be found in the foothills and timber along watercourses in otherwise open country (Pizzey 1983).  | Yes                                 | The species has been recorded within a 10 km radius of the Subject Site (in the adjacent Dharawal State Conservation Area and/or Nature Reserve), but not within the Study Area.  |
| <i>Ninox strenua</i>        | Powerful Owl             | -                     | V                    | Occupies wet and dry eucalypt forests and rainforests. Can occupy both unlogged 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). | Yes                                 | The species has been recorded within a 10 km radius of the Subject Site (DECC Atlas of NSW Wildlife) including the adjacent Dharawal State Conservation Area and/or Nature Reserve, and within the Study Area (DECC Atlas of NSW Wildlife and Biosis Research). |

| Scientific Name              | Common Name               | EPBC Act <sup>a</sup> | TSC Act <sup>b</sup> | Habitat   | Potential Habitat / Subject Species | Comments   |
|------------------------------|---------------------------|-----------------------|----------------------|---|-------------------------------------|--|
| <i>Tyto novaehollandiae</i>  | Masked Owl                | -                     | V                    | Inhabits a diverse range of wooded habitat that provide tall or dense mature trees with hollows suitable for nesting and roosting (Higgins 1999). Mostly recorded in open forest and woodlands adjacent to cleared lands. Nest in hollows, in trunks and in near vertical spouts or large trees, usually living but sometimes dead (Higgins 1999). Nest hollows are usually located within dense forests or woodlands (Gibbons and Lindenmayer 1997). Masked owls do prey upon hollow-dependent arboreal marsupials, but terrestrial mammals make up the largest proportion of the diet (Gibbons and Lindenmayer 1997, Higgins 1999). | Yes                                 | The species has been recorded within a 10 km radius of the Subject Site (DECC Atlas of NSW Wildlife) including the adjacent Dharawal State Conservation Area and/or Nature Reserve, but not within the Study Area. |
| <i>Tyto tenebricosa</i>      | Sooty Owl                 | -                     | V                    | Often found in tall old-growth forests, including temperate and subtropical rainforests. In NSW mostly found on escarpments with a mean altitude <500 m. Nests and roosts in hollows of tall emergent trees, mainly eucalypts (Higgins 1999) often located in gullies (Gibbons and Lindenmayer 1997). Nests have been located in trees 125 to 161 cm in diameter (Gibbons and Lindenmayer 1997).  | Yes                                 | The species has been recorded within a 10 km radius of the Subject Site (DECC Atlas of NSW Wildlife) including the adjacent Dharawal State Conservation Area and/or Nature Reserve, but not within the Study Area. |
| <b>Mammals</b>               |                           |                       |                      |   |                                     |  |
| <i>Cercartetus nanus</i>     | Eastern Pygmy-possum      | -                     | V                    | Inhabits rainforest through to sclerophyll forest and tree heath. Banksias and myrtaceous shrubs and trees are a favoured food source. Will often nest in tree hollows, but can also construct its own nest (Turner and Ward 1995). Because of its small size it is able to utilise a range of hollow sizes including very small hollows (Gibbons and Lindenmayer 1997). Individuals will use a number of different hollows and an individual has been recorded using up to 9 nest sites within a 0.5 ha area over a 5 month period (Ward 1990).  | Yes                                 | The species has been recorded within a 10 km radius of the Subject Site (DECC Atlas of NSW Wildlife) including the adjacent Dharawal State Conservation Area and/or Nature Reserve, but not within the Study Area. |
| <i>Dasyurus maculatus</i>    | 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).   | Yes                                 | The species has been recorded within a 10 km radius of the Subject Site (DECC Atlas of NSW Wildlife) including the adjacent Dharawal State Conservation Area and/or Nature Reserve, but not within the Study Area. |
| <i>Petrogale penicillata</i> | Brush-tailed Rock-Wallaby | V                     | EI                   | Found in rocky areas in a wide variety of habitats including rainforest gullies, wet and dry sclerophyll forest, open woodland and rocky outcrops in semi-arid country. Commonly sites have a northerly aspect with numerous ledges, caves and crevices (Eldridge and Close 1995).  | Yes                                 | The species has been recorded within a 10 km radius of the Subject Site (in the adjacent Dharawal State Conservation Area and/or Nature Reserve), but not within the Study Area.                                   |

| Scientific Name                 | Common Name              | EPBC Act <sup>a</sup> | TSC Act <sup>b</sup> | Habitat  | Potential Habitat / Subject Species | Comments   |
|---------------------------------|--------------------------|-----------------------|----------------------|--|-------------------------------------|--|
| <i>Macropus parma</i>           | Parma Wallaby            | -                     | V                    | Occurs in wet and dry sclerophyll forest with a thick, shrubby understorey associated with grassy patches. They may also occur in rainforest but prefer the wet sclerophyll forest (Strahan 1995). This species feeds on grasses and herbs (Strahan 1995).   | No                                  | The species has been recorded within a 10 km radius of the Subject Site (in the adjacent Dharawal State Conservation Area and/or Nature Reserve), but not within the Study Area.                                   |
| <i>Mormopterus norfolkensis</i> | 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 Hoyer 1995, Churchill 1998).  | Yes                                 | The species has been recorded within a 10 km radius of the Subject Site (DECC Atlas of NSW Wildlife) including the adjacent Dharawal State Conservation Area and/or Nature Reserve, but not within the Study Area. |
| <i>Isodon obesulus</i>          | Southern Brown Bandicoot | E                     | E1                   | Prefers sandy soils with scrubby vegetation and/or areas with low ground cover that are burnt from time to time (Braithwaite 1995). A mosaic of post fire vegetation is important for this species (Maxwell <i>et al.</i> 1996).   | Yes                                 | The species has been recorded within a 10 km radius of the Subject Site (in the adjacent Dharawal State Conservation Area and/or Nature Reserve), but not within the Study Area.                                   |
| <i>Petaurus australis</i>       | 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-trees, winter flowering eucalypts, mature trees suitable for den sites and a mosaic of different forest types (NPWS 1999k).   | No                                  | The species has been recorded within a 10 km radius of the Subject Site (DECC Atlas of NSW Wildlife) including the adjacent Dharawal State Conservation Area and/or Nature Reserve, but not within the Study Area. |
| <i>Petaurus norfolcensis</i>    | Squirrel Glider          | -                     | V                    | Generally occurs in dry sclerophyll forests and woodlands but is absent from dense coastal ranges in the southern part of its range (Suckling 1995). Requires abundant hollow bearing trees and a mix of eucalypts, banksias and acacias (Quin 1995). There is only limited information available on den tree use by Squirrel Gliders, but it has been observed using both living and dead trees as well as hollow stumps (Gibbons and Lindenmayer 1997). Within a suitable plant community at least one species should flower heavily in winter and one species of eucalypt should be smooth barked (Menkhorst <i>et al.</i> 1988). | Yes                                 | The species has been recorded within a 10 km radius of the Subject Site (DECC Atlas of NSW Wildlife) including the adjacent Dharawal State Conservation Area and/or Nature Reserve, but not within the Study Area. |

| Scientific Name                            | Common Name            | EPBC Act <sup>a</sup> | TSC Act <sup>b</sup> | Habitat   | Potential Habitat / Subject Species | Comments  |
|--|------------------------|-----------------------|----------------------|---|-------------------------------------|---|
| <i>Phascolarctos cinereus</i>              | Koala                  | -                     | V                    | Inhabits eucalypt forests and woodlands. The suitability of these forests for habitation depends on the size and species of trees present, soil nutrients, climate and rainfall (Reed and Lunney 1990, Reed <i>et al.</i> 1990).  | Yes                                 | The species has been recorded within a 10 km radius of the Subject Site (DECC Atlas of NSW Wildlife) including the adjacent Dharawal State Conservation Area and/or Nature Reserve, and within the Study Area (DECC Atlas of NSW Wildlife and Biosis Research). |
| <i>Potorous tridactylus</i>                | Long-nosed Potoroo     | V                     | V                    | Inhabits coastal heath and wet and dry sclerophyll forests. Generally found in areas with rainfall greater than 760 mm. Requires relatively thick ground cover where the soil is light and sandy (Johnston 1995).   | Yes                                 | The species has been recorded within a 10 km radius of the Subject Site (in the adjacent Dharawal State Conservation Area and/or Nature Reserve), but not within the Study Area.  |
| <i>Pteropus poliocephalus</i>              | Grey-headed Flying-fox | V                     | V                    | This species is a canopy-feeding frugivore and nectarivore of rainforests, open forests, woodlands, Melaleuca swamps and Banksia woodlands. Bats commute daily to foraging areas, usually within 15 km of the day roost (Tidemann 1995) although some individuals may travel up to 70 km (Augee and Ford 1999).   | Yes                                 | The species has been recorded within a 10 km radius of the Subject Site (DECC Atlas of NSW Wildlife) including the adjacent Dharawal State Conservation Area and/or Nature Reserve, and within the Study Area (DECC Atlas of NSW Wildlife and Biosis Research). |
| <i>Miniopterus schreibersii oceanensis</i> | Eastern Bent-wing Bat  | -                     | V                    | This species uses a broad range of habitat including rainforest, wet and dry sclerophyll forest, paper bark forest and open woodland and grassland (Churchill 1998). The species is a cave dweller (although some individuals occasionally roost in human constructed tunnels and buildings) (Strahan 1995, Churchill 1998).  | Yes                                 | The species has been recorded within a 10 km radius of the Subject Site (DECC Atlas of NSW Wildlife) including the adjacent Dharawal State Conservation Area and/or Nature Reserve, and within the Study Area (DECC Atlas of NSW Wildlife and Biosis Research). |
| <i>Chalinolobus dwyeri</i>                 | Large-eared Pied Bat   | V                     | V                    | Located in a variety of drier habitats, including the dry sclerophyll forests and woodlands to the east and west of the Great Dividing Range (Hoye and Dwyer 1995). Can also be found on the edges of rainforests and in wet sclerophyll forests (Churchill 1998). This species roosts in caves and mines in groups of between 3 and 37 individuals (Churchill 1998). | Yes                                 | The species has been recorded within a 10 km radius of the Subject Site (DECC Atlas of NSW Wildlife) including the adjacent Dharawal State Conservation Area and/or Nature Reserve, but not within the Study Area.  |



| Scientific Name                        | Common Name                         | EPBC Act <sup>a</sup> | TSC Act <sup>b</sup> | Habitat   | Potential Habitat / Subject Species | Comments  |
|--|-------------------------------------|-----------------------|----------------------|---|-------------------------------------|---|
| <i>Falsistrellus tasmaniensis</i>      | Eastern False Pipistrelle           | -                     | V                    | Inhabit sclerophyll forests, preferring wet habitats where trees are more than 20 m high (Churchill 1998). Two observations have been made of roosts in stem holes of living eucalypts (Phillips 1995). There is debate about whether or not this species moves to lower altitudes during winter, or whether they remain sedentary but enter torpor (Menkhorst and Lumsden 1995). This species also appears to be highly mobile with records showing movements of up to 12 km between roosting and foraging sites (Menkhorst and Lumsden 1995). | Yes                                 | The species has been recorded within a 10 km radius of the Subject Site (DECC Atlas of NSW Wildlife) including the adjacent Dharawal State Conservation Area and/or Nature Reserve. This species was 'possibly' recorded within the Study Area <sup>i</sup> (Biosis Research).                  |
| <i>Kerivoula papuensis</i>             | Golden-tipped Bat                   | -                     | V                    | Occurs in rainforest and along rainforest gullies in wet sclerophyll forest. Have been found roosting in the abandoned nests of gerygones and scrubwrens (Churchill 1998).  | No                                  | The species has been recorded within a 10 km radius of the Subject Site (in the adjacent Dharawal State Conservation Area and/or Nature Reserve), but not within the Study Area.  |
| <i>Myotis adversus/Myotis macropus</i> | Large-footed Myotis/Southern Myotis | -                     | V                    | Occurs in most habitat types as long as they are near permanent water bodies, including streams, lakes and reservoirs. Commonly roost in caves, but can also roost in tree hollows, under bridges and in mines (Richards 1995, Churchill 1998).   | Yes                                 | The species has been recorded within a 10 km radius of the Subject Site (DECC Atlas of NSW Wildlife) including the adjacent Dharawal State Conservation Area and/or Nature Reserve. This species was recorded within the Study Area with 'probable' confidence <sup>ii</sup> (Biosis Research). |
| <i>Saccolaimus flaviventris</i>        | Yellow-bellied Sheath-tail Bat      | -                     | V                    | Reported from a wide range of habitats throughout eastern and northern Australia, including wet and dry sclerophyll forest, open woodland, Acacia shrubland, mallee, grasslands and desert (Churchill 1998). They roost in tree hollows and have also been observed roosting in animal burrows, abandoned Sugar Glider nests, cracks in dry clay, hanging from buildings and under slabs of rock (Churchill 1998). The species flies high and fast and forages above the canopy (Churchill 1998).   | Yes                                 | The species has been recorded within a 10 km radius of the Subject Site (in the adjacent Dharawal State Conservation Area and/or Nature Reserve), but not within the Study Area.  |
| <i>Scoteanax rueppellii</i>            | Greater Broad-nosed Bat             | -                     | V                    | Prefer moist gullies in mature coastal forests and rainforests, between the Great Dividing Range and the coast. They are only found at low altitudes below 500 m (Churchill 1998). In dense environments they utilise natural and human-made openings in the forest for flight paths. Creeks and small rivers are favoured foraging habitat (Hoye and Richards 1995). This species roosts in hollow tree trunks and branches (Churchill 1998).  | Yes                                 | The species has been recorded within a 10 km radius of the Subject Site (DECC Atlas of NSW Wildlife) including the adjacent Dharawal State Conservation Area and/or Nature Reserve, but not within the Study Area.  |

| Scientific Name                  | Common Name                 | EPBC Act <sup>a</sup> | TSC Act <sup>b</sup> | Habitat   | Potential Habitat / Subject Species | Comments  |
|----------------------------------|-----------------------------|-----------------------|----------------------|---|-------------------------------------|---|
| <b>Reptiles</b>                  |                             |                       |                      |   |                                     |   |
| <i>Hoplocephalus bungaroides</i> | 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, NPWS 1999c). | Yes                                 | The species has been recorded within a 10 km radius of the Subject Site (DECC Atlas of NSW Wildlife) including the adjacent Dharawal State Conservation Area and/or Nature Reserve, and within the Study Area (DECC Atlas of NSW Wildlife and Biosis Research). |
| <i>Varanus rosenbergi</i>        | Rosenberg's Goanna          | -                     | V                    | This species is a Hawkesbury/Narrabeen sandstone outcrop specialist (Wellington and Wells 1985). Occurs in coastal heaths, humid woodlands and both wet and dry sclerophyll forests (Cogger 1992).  | Yes                                 | The species has been recorded within a 10 km radius of the Subject Site (DECC Atlas of NSW Wildlife) including the adjacent Dharawal State Conservation Area and/or Nature Reserve, and within the Study Area (DECC Atlas of NSW Wildlife and Biosis Research). |
| <b>Invertebrates</b>             |                             |                       |                      |   |                                     |   |
| <i>Meridolum corneovirens</i>    | 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 2000b).  | No                                  | The species has been recorded within a 10 km radius of the Subject Site (DECC Atlas of NSW Wildlife), but not within the Study Area.  |
| <i>Petalura gigantea</i>         | Giant Dragonfly             | -                     | E1                   | Live in permanent swamps and bogs with some free water and open vegetation. Adults spend most of their time settled on low vegetation on or adjacent to the swamp (DEC 2005p).  | No                                  | The species has not been recorded within a 10 km radius of the Subject Site.  |

**Key:** a: V = Vulnerable, E = Endangered, C = Conservation Concern, M = Migratory.

b: V = Vulnerable, E1 = Endangered.

i: Possible = Anabat recording was 'possible' this species however its call is likely to be confused with other species with similar calls.

ii: Probable = Anabat recording was 'probable' this species however there is the possibility of some confusion with other species.

#### 4.1.5 Endangered Populations

Endangered Populations are listed on Schedule 1 (Part 2) of the TSC Act. There are currently no Endangered Populations listed within the Locality.

#### 4.1.6 Endangered Ecological Communities

None of the native vegetation types in the Study Area are listed as Endangered Ecological Communities on the TSC and/or EPBC Acts. Based on DECC vegetation mapping (NPWS 2003a) three Endangered Ecological Communities listed on the TSC and/or EPBC Acts are known to occur within the Locality (5 km radius). These are; Shale Sandstone Transition Forest, Cumberland Plain Woodland and O'Hares Creek Shale Forest; these communities do not occur within the Study Area.

The Study Area does not contain habitat for any Endangered Ecological Communities listed on the TSC Act and/or EPBC Acts, however, Upland Swamps present in the Study Area are both structurally and floristically similar to the definition of "Temperate Highland Peat Swamps on Sandstone" (DEH 2005) which is listed under the EPBC Act. The extant distribution of Temperate Highland Peat Swamps on Sandstone has been mapped (DEH 2005) and does not incorporate any upland swamps within the Locality on the Woronora Plateau. The nearest swamps that are listed as Temperate Highland Peat Swamps on Sandstone are located in the Southern Highlands to the south-west of the Locality. On this basis, upland swamps within the Study Area have not been considered as EEC's under the EPBC Act.

## 5.0 SURVEY

### 5.1 Requirement to survey

Flora and fauna surveys were conducted in accordance with the Director-General's Requirements, including targeted surveys for species identified in Section 4.0 above.

### 5.2 Documentation of survey effort and technique

The following section describes all survey effort and techniques employed across the Study Area.

#### 5.2.1 Description of survey techniques and survey sites

##### 5.2.1.1 Flora Survey

The location of flora survey sites is shown on Figure 6.

Site specific surveys of the areas to be affected by the Proposal were assessed during current and previous surveys (see Section 4.1.1). The primary aim of the current study was to conduct targeted searches for subject species (including potential habitat) and determine the likely impacts on affected subject species. In order to determine the Affected Subject Species, survey effort for threatened flora was concentrated immediately within and adjacent to the Subject Site. The broader 'Study Area' was surveyed with less intensity.

Where a threatened plant species was identified, its abundance was then determined. Targeted surveys for all threatened flora species were carried out across the Study Area in order to determine the extent of the species in the Study Area. Limited targeted surveys for threatened plant species were undertaken outside of the Study Area but in proximity to it in the attempt to determine the distribution and abundance of local populations. Techniques used during flora surveys of the Study Area are described below.

#### **Vegetation Mapping and General Habitat Assessment (Survey Reference Points)**

***Targeted Species: O' Hares Creek Shale Forest, Shale Sandstone Transition Forest, Cumberland Plain Woodland, All potential habitats for threatened***

## flora

The Study Area falls in a gap between the mapped extent of the Cumberland Plain vegetation mapping (NPWS 2002b) and the vegetation mapping of the Woronora, O'Hares and Metropolitan Catchments (NPWS 2003a). The vegetation of the Study Area was mapped by Biosis Research (2001). That vegetation mapping was updated in the current assessment.

Initially, high resolution aerial photography was used to delineate likely boundaries between plant communities within the Study Area. The plant communities of the Study Area were then digitised (mapped as polygons) in 'Map Info 8.5' using visually perceived boundaries and features including soil type, topography and aspect. Proposed survey reference sites were located within each polygon of each vegetation unit mapped in the Study Area. This enabled all areas to be ground truthed accurately during the field survey.

Field surveys incorporated a general habitat assessment and recorded the following data at each survey reference point:

- Location: geographic coordinates and location description;
- Topographical features: slope, aspect, outcropping, surface rock and soil type;
- Vegetation structure: height, projective foliage cover, condition and dominant species present in each vegetation strata (layer)
- Habitat description: fire history, vegetation condition, tree age and regeneration, understorey characteristics, presence of introduced species, adjacent land uses and disturbances.

The condition of the vegetation was assessed according to the degree to which it resembled relatively natural, undisturbed vegetation using the following criteria:

- species composition (species richness, degree of weed invasion),
- vegetation structure (representation of each of the original layers of vegetation).

The vegetation condition was classed as Good, Moderate or Poor according to the following criteria:

**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;

**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,

**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.

The vegetation mapping of the Study Area (Figure 5) is based on the data collected at each survey reference site and plant community boundaries recorded by Global Positioning Systems (GPS). The location of each survey reference site is included in Figure 6.

Plant communities identified within the Study Area were classified and named according to the descriptions in NPWS (2003a). In support of the general habitat assessment (including survey reference sites), successive surveys incorporated plot based surveys (quadrats) which were used to describe the different vegetation types (see below). All data from the general habitat assessment and plot based surveys was compared with the regional vegetation mapping (NPWS 2003a) in order to verify the presence/absence of EECs and areas of potential habitat for threatened species.

### **Plot Based Surveys (Quadrats)**

***Targeted Species: All Plant Communities (see Section 6.2) and Subject Plant Species (see Section 6.1.1).***

Flora data from 20 m x 20 m (400 m<sup>2</sup>) (DEC 2004b) quadrats was recorded from vegetation that was considered to accurately represent each vegetation type within the Study Area. The methodology for data collection follows DEC (2004b). In general, quadrats were located within vegetation that was relatively undisturbed and hence were located in areas of relatively high species diversity and low weed abundance. That is, quadrats were not placed in vegetation directly adjacent to access tracks or other disturbances including past clearing.

From each of the quadrats, the estimated abundance of all identifiable plant species was recorded using a modified 7 point Braun-Blanquet (Braun-Blanquet 1928) cover abundance scale. A similar 7 point scale has been used in other vegetation mapping studies (NPWS 2003a) and as follows; <5% - 3 or less individuals, <5% - more than 3 sparsely scattered, <5% - common throughout plot, 5% - 25%, 25% - 50%, 50% - 75% and 75% - 100%.

Species not conclusively identifiable in the field were pressed and later identified using a standard flora reference library. Data from a total of 12 vegetation quadrats were recorded, the location of which is shown in Figure 6. A general

habitat assessment (see above) was also undertaken at each quadrat location.

### **Targeted Searches (Random Meander Transects)**

**Targeted Species: All Subject Plant Species (see Table 2).**

Targeted searches were undertaken and involved survey of all preferred or potential habitat as identified in the general habitat assessment. Targeted searches included random meanders (Cropper 1993) which were undertaken in pairs traversing the development footprint and surrounding areas. This technique was used during targeted searches to provide a greater coverage of the Study Area (DEC 2004b). Global Positioning Systems (GPS) were used to delineate the development footprint in combination with associated maps. This ensured a more complete coverage of the areas that may be impacted by the Proposal. A record of GPS tracking for these surveys is included in Figure 6.

### **Total Abundance Counts**

**Targeted Species: *Acacia bynoeana*, *Persoonia hirsuta* and *Pultenaea aristata***

Where threatened species were observed, each specimen was individually counted and the size and geographic location of each patch recorded using GPS. Where a threatened plant species was found in large numbers within a discrete area, the area covered by the population was established by conducting parallel line searches. Once the boundaries of an identified population were delineated, all individuals were temporarily tagged with coloured ribbon, before the ribbon was collected and counted.

## **5.2.1.2 Fauna Survey**

The current survey effort follows that of the 2001 SIS and other surveys at the Study Area. Only the survey techniques and effort used in the current assessment have been described here. For other survey techniques, see reports Study Area in Section 4.1.1. The locations of fauna survey sites are shown in Figure 7.

### **Tree Mounted Elliott Traps**

**Targeted Species: *Squirrel Glider***

Tree mounted size B Elliott traps (460 x 160 x 150 mm) were used to survey for arboreal mammal species within potential habitat in the Study Area. Potential habitat within ridge and gully vegetation was targeted. The location of potential habitat was based on vegetation mapping, the dominant canopy species present in

each vegetation community and where signs and or evidence of arboreal fauna occurred (e.g. glider notches on tree trunks and limbs).

Sixteen traps were set in ridge habitat over four locations for a minimum of four nights and a maximum of seven nights, totalling 73 trap nights. Within each ridge Study Area, traps were located approximately 50 m apart. Six traps were set in gully habitat over two locations for a minimum of four nights and a maximum of six nights, totalling 27 trap nights. Within each gully Study Area, traps were located approximately 40 m apart. Locations of the traps are shown in Figure 7.

Traps were set on tree trunks or on major branches at heights between eight and twelve metres using a wooden platform and an elasticised strap. The wooden shelves were attached using a hand-held magnetic drill and screws. The traps were baited with a mixture of rolled oats, peanut butter and honey and a diluted honey mixture was sprayed on trees around the traps. Traps were checked each morning and any captured animal was identified to species and released at the Study Area of capture.

Trained and qualified Biosis Research staff and Total Height Safety sub-contractors erected the arboreal Elliott traps using a rope-ascension and lowering system. The same Biosis Research staff members checked and removed the arboreal Elliott traps.

### **Tree Mounted Hair Tubes**

#### ***Targeted species: Eastern Pygmy-possum and Squirrel Glider***

Arboreal hair tubes (entrance diameter 110 x 70 mm) were used to survey for arboreal mammal species within potential habitat in the Study Area. Potential habitat within ridge and gully vegetation was targeted. The location of potential habitat was based on vegetation mapping, the dominant canopy species present in each vegetation community and where signs and or evidence of arboreal fauna occurred (e.g. glider notches on tree trunks and limbs).

Three hair tubes were erected at each tree containing an arboreal Elliott trap. Therefore, 48 hair tubes were placed in ridge habitat and 18 were placed in gully habitat. The hair tubes were employed for a minimum of four nights and a maximum of ten nights, totalling 255 trap nights in ridge habitat and 153 trap nights in gully habitat. Locations of the hair tubes are shown in Figure 7.

Hair tubes were placed on or near each tree that contained an arboreal Elliott trap. At each tree, hair tubes were placed at a low, medium and high position on the tree or, one low and two high (where low equals up to 1 m, medium equals 2 – 5 m and high equals 7 – 15 m). The hair tubes were taped (using fabric tape) to the tree trunk or branches of the same tree containing an arboreal Elliott trap,



or close to such a tree, on nearby trees. The hair tubes were baited with a mixture of rolled oats, peanut butter and honey and a diluted honey mixture was sprayed on trees around the hair tubes.

Trained and qualified Biosis Research staff and Total Height Safety sub-contractors erected the arboreal hair tubes using a rope-ascension and lowering system. The same Biosis Research staff members removed the arboreal hair tubes.

### **Elliott Traps (ground)**

***Targeted species: Eastern Pygmy-possum, Southern Brown Bandicoot and Long-nosed Potoroo***

Small ground-dwelling mammals were surveyed using Elliott A and B traps (A = 330 x 100 x 90 mm; B = 460 x 160 x 150 mm) in areas of potential habitat within the Study Area. Potential habitat within ridge and gully vegetation was targeted.

Three transects of 25 Elliott A's and 25 Elliott B's were placed within ridge habitat for four nights, totalling 300 trap nights for Elliott A's and 300 trap nights for Elliott B's within ridge habitat. One transect of 25 Elliott A's and 25 Elliott B's was placed within gully habitat for four nights, totalling 100 trap nights for Elliott A's and 100 trap nights for Elliott B's within gully habitat.

Within a transect, each pair of Elliott traps (size A and B) were placed within a couple of metres of each other, and each pair were located approximately 10 m apart giving a 250 m long transect. The traps were baited with a mixture of rolled oats, peanut butter and honey. Traps were checked each morning and any captured animal was identified to species and released at the Study Area of capture.

Locations of the traps are shown in Figure 7.

### **Hair Tubes (ground)**

***Targeted species: Eastern Pygmy-possum, Southern Brown Bandicoot, Long-nosed Potoroo and Brush-tailed Rock-Wallaby***

Small ground-dwelling mammals were surveyed using hair tubes (small and large) in areas of potential habitat within the Study Area. The entrance diameter of the hair tubes was 50 mm and 140 x 90 mm for the small and large sizes respectively. Potential habitat within ridge and gully vegetation was targeted.

Three transects of 10 small and 10 large hair tubes were placed within ridge habitat for a minimum of eight nights and a maximum of nine nights,

totalling 250 trap nights for small hair tubes and 250 trap nights for large hair tubes within ridge habitat. One transect of 10 small and 10 large hair tubes was placed within gully habitat for eight nights, totalling 80 trap nights for small hair tubes and 80 trap nights for large hair tubes.

Hair tubes were placed on the ground and secured with either tent pegs or string. Within each transect, each pair of hair tubes (small and large) were placed within 1 m of each other, and each pair were located approximately 25 – 30 m apart, with transects 250 – 300 m long. The hair tubes were baited with a mixture of rolled oats, peanut butter and honey.

Locations of the hair tubes are shown in Figure 7.

### **Cage Traps (ground)**

***Targeted species: Spotted-tailed Quoll, Southern Brown Bandicoot, Long-nosed Potoroo and Rosenberg's Goanna***

Ground-dwelling mammals and reptiles were surveyed using double-ended metal/wire cage traps (800 x 300 x 300 mm) in areas of potential habitat within the Study Area. Potential habitat within ridge and gully vegetation was targeted.

Four transects of four to six cage traps were set in ridge habitat for a minimum of three nights and a maximum of six nights, totalling 72 trap nights in ridge habitat. Two transects of two and six cage traps were set in gully habitat for three nights, totalling 24 trap nights in gully habitat.

Cage traps were placed on the ground at intervals between 25 and 50 m within each transect. The traps were baited with chicken wings and/or a mixture of rolled oats, peanut butter and honey. Traps were checked each morning and any captured animal was identified to species and released at the Study Area of capture.

Locations of the traps are shown in Figure 7.

### **Diurnal Bird Surveys**

***Targeted species: Gang-gang Cockatoo, Glossy Black-cockatoo, Bush Stone-curlew, Brown Treecreeper (eastern subspecies), Barred Cuckoo-shrike, Painted Honeyeater, Black-chinned Honeyeater (eastern subspecies), Regent Honeyeater, Olive Whistler, Speckled Warbler, Diamond Firetail, Swift Parrot, Turquoise Parrot, Hooded Robin (south-eastern form) and Pink Robin.***

Diurnal bird species were surveyed by a zoologist either by direct observation using 10 x 42 field binoculars or by their calls. Surveys were carried out at

different times of day including dusk and dawn over the entire Study Area. Potential habitat within ridge, gully and upland swamp vegetation was targeted. Surveys were conducted during early summer. Incidental bird lists were also compiled in winter and late spring to increase the chance of detection of species present at different times of the year.

Bird surveys were conducted as either a point census for 20 minutes, or as an area search (100 x 200 m) for 20 – 30 minutes. 1.3 person hours of diurnal bird surveys were carried out in ridge habitat, 1.8 person hours were conducted in gully habitat and 0.3 person hours performed in upland swamp habitat.

Survey locations are shown in Figure 7.

### **Diurnal Herpetological Surveys**

***Targeted species: Broad-headed Snake, Rosenberg’s Goanna, Red-crowned Toadlet, Littlejohn’s Tree Frog and Giant Burrowing Frog***

One to two zoologists conducted diurnal herpetological searches within areas of potential habitat within the Study Area. Potential habitat within ridge and gully vegetation was targeted. Surveys were conducted in winter and summer to increase the chances of detecting species active at these times of year.

Searches consisted of an area search (generally 1 to 2 ha) and were concentrated at water courses, dams and rocky outcrops. Searches involved examining ground litter, turning over logs and rocks, examining rock cavities and crevices (with a head torch) and examining tree trunks and limbs. Any captured animals were identified to species and then released at the Study Area of capture.

Diurnal herpetological surveys were conducted for 14.5 person hours within ridge habitat in winter. The surveys were conducted for one person hour within ridge habitat and two person hours within gully habitat in summer.

Survey locations are shown in Figure 7.

### **Spotlighting (mammals, birds, reptiles)**

***Targeted species: Eastern Pygmy-possum, Grey-headed Flying-fox, Koala, Squirrel Glider, Spotted-tailed Quoll, Brush-tailed Rock-Wallaby, Southern Brown Bandicoot, Long-nosed Potoroo, Barking Owl, Masked Owl, Powerful Owl, Sooty Owl, Bush Stone-curlew and Broad-headed Snake***

Spotlighting was carried out in potential habitat within the Study Area to detect arboreal mammals, owls and the Broad-headed Snake, ground-dwelling mammals and the Bush Stone-curlew. Potential habitat within ridge and

gully vegetation was targeted. Surveys were conducted in summer (with some spotlighting for owls conducted in winter as part of the nocturnal call-playback surveys; see below).

Spotlighting generally took place on foot, with some transects completed from a slow moving vehicle, by two zoologists using handheld 50-w spotlights. The speed of survey was 1 km per hour on foot or 5 km per hour in a vehicle. Within ridge habitat 3.9 person hours of spotlighting were conducted, and five person hours were performed within gully habitat. Any animals encountered were identified by direct observation using 10 x 42 field binoculars or by their calls.

Survey locations are shown in Figure 7.

### **Spotlighting (frogs)**

***Targeted species: Littlejohn's Tree Frog, Giant Burrowing Frog and Red-crowned Toadlet***

Two different survey techniques were used to spotlight for frogs within the Study Area: nocturnal watercourse searches and nocturnal habitat searches. Potential habitat within gully vegetation was targeted for both techniques. Surveys were conducted during early summer. Incidental frog lists were also compiled in winter and late spring to increase the chance of detection of species active at different times of the year.

Nocturnal watercourse searches consisted of an initial five minute listening period followed by two person hours of active spotlight searching of 200 m of watercourse. Four nocturnal watercourse transects were conducted in gully habitat. Nocturnal habitat searches consisted of an initial five minute listening period followed by half a person hour of active spotlight searching of a large water body that was not a creek line. One large pool was surveyed twice using this method. Surveys were conducted over a minimum of two nights. Any animals encountered were identified by direct observation or by their calls.

Survey locations are shown in Figure 7.

### **Nocturnal call-playback (birds and mammals)**

***Targeted species: Barking Owl, Masked Owl, Powerful Owl, Sooty Owl, Bush Stone-curlew, Koala and Squirrel Glider***

Nocturnal species with large home ranges (Barking Owl, Masked Owl, Powerful Owl and Sooty Owl) or those that are particularly cryptic (Koala, Squirrel Glider and Bush Stone-curlew) are generally difficult to locate during nocturnal

spotlighting but may be detected using call-playback. This technique relies on behavioural responses associated with territory and threat, whereby emitted calls may induce a defending response (either call or display) from individuals of the same species.

Potential habitat within ridge and gully vegetation was targeted. Surveys were conducted in winter for owls and summer for mammals and the Bush Stone-curlew to increase the chances of detecting species active at these times of year. A JNC MP3 player connected to a TOA megaphone was used to emit the calls. Each session began with a 5-10 minute listening period to detect any species already present in the area. The first species' call was played for five minutes, followed by five minutes of listening. Each subsequent species' call was played for five minutes followed by a five minute listening period until all species calls had been emitted. A final 10 minute spotlight of the area was conducted following the call-playback. Any animals encountered were identified by direct observation using 10 x 42 field binoculars or by their calls.

Owl call-playback was conducted at four sites (three in ridge and one in gully habitat), separated by at least 1 km. Call-playback for the Masked Owl was repeated at each Study Area on eight different nights. The Sooty Owl's call was repeated at each Study Area on seven different nights. Call-playback for the Powerful and Barking Owls was conducted at each Study Area on eight different nights, with only 30 seconds of call emitted on the eighth night.

Mammal call-playback was conducted at five sites (three in ridge and two in gully habitat), separated by at least 1 km. Call playback for the Koala and Squirrel Glider was conducted at these sites over a minimum of two nights.

Bush Stone-curlew call-playback was conducted at two sites within ridge habitat.

Survey locations are shown in Figure 7.

### **Nocturnal call-playback (frogs)**

***Targeted species: Littlejohn's Tree Frog, Giant Burrowing Frog and Red-crowned Toadlet***

Species that are particularly cryptic, such as frogs, may be detected using call-playback. This technique relies on behavioural responses associated with territory and threat, whereby emitted calls may induce a defending response (either call or display) from individuals of the same species.

Potential habitat within gully and upland swamp vegetation was targeted. Surveys were conducted in summer however incidental frog lists were also compiled in winter and late spring to increase the chance of detection of species

active at different times of the year. A JNC MP3 player connected to a TOA megaphone was used to emit the calls. Each session began with a 5 minute listening period to detect any species already present in the area. The first species' call was played for five minutes, followed by five minutes of listening. Each subsequent species' call was played for five minutes followed by a five minute listening period until all species calls had been emitted. Any animals encountered were identified by direct observation or by their calls.

Nocturnal frog call-playback was conducted at two sites, one in gully and one in upland swamp vegetation, over two separate nights.

Survey locations are shown in Figure 7.

### **Diurnal Call-playback (frogs)**

#### ***Targeted species: Red-crowned Toadlet***

Species that are particularly cryptic, such as frogs, may be detected using call-playback. This technique relies on behavioural responses associated with territory and threat, whereby emitted calls may induce a defending response (either call or display) from individuals of the same species.

Potential habitat within gully and upland swamp vegetation was targeted. Surveys were conducted in summer. A JNC MP3 player connected to a TOA megaphone was used to emit the calls. Each session began with a 5 minute listening period to detect any species already present in the area. A recording of the Red-crowned Toadlet was emitted for five minutes, followed by five minutes of listening. Any animals encountered were identified by direct observation or by their calls.

Diurnal frog call-playback was conducted at four sites, three in gully and one in upland swamp vegetation, over two different days.

Survey locations are shown in Figure 7.

### **Koala Transects**

#### ***Targeted species: Koala***

The aim of the targeted surveys for Koalas was to gather information on habitat usage and the status of populations in the Study Area, to map Koala habitat and to determine the location of Koala movement corridors. Information on Koalas in the area was collected using a range of methods.

In areas of potential Koala habitat (determined during habitat assessments

performed by Biosis Research), field surveys included opportunistic diurnal scat, scratch and sighting searches, diurnal call-playback, spotlighting and nocturnal call-playback surveys.

### **Harp Traps**

***Targeted species: Eastern Freetail Bat, Eastern Bent-wing Bat, Large-eared Pied Bat, Eastern False Pipistrelle, Golden-tipped Bat, Large-footed Myotis/Southern Myotis, Yellow-bellied Sheathtail Bat and Greater Broad-nosed Bat***

Harp traps were used to trap foraging bat species within potential habitat in the Study Area. Potential habitat within ridge and gully vegetation was targeted. The surveys were conducted during summer.

Two harp traps were used to trap bats at seven sites (four sites in ridge habitat and three sites in gully habitat), for one or two consecutive nights. Seven trap nights were conducted in ridge habitat and three trap nights were conducted in gully habitat. Harp traps were set across suspected bat flyways which included areas above dams, over creeks and paths, as well as across gaps within forest and woodland. The harp traps were set before dusk and checked the following morning. Any captured animals were identified to species and then released at the Study Area of capture after dusk the following night where possible.

Locations of the traps are shown in Figure 7.

### **Bat Call Detection (Echolocation Analysis)**

***Targeted species: Eastern Freetail Bat, Eastern Bent-wing Bat, Large-eared Pied Bat, Eastern False Pipistrelle, Golden-tipped Bat, Large-footed Myotis/Southern Myotis, Yellow-bellied Sheathtail Bat and Greater Broad-nosed Bat***

Two Anabat II detectors with digital ZCAIM recording devices (Titley Electronics) were used to record microchiropteran bat calls (echolocation) within the Study Area. Calls can provide information on frequency and call sequence, thus allowing species identification. Potential habitat within ridge and gully vegetation was targeted.

The detectors were set before dusk within or near a suspected bat flyway, and left to record over night. Detectors were set above dams, near creeks and paths and within gaps or along edges of forest/woodland vegetation. This positioning was designed to cover the foraging areas of the targeted bat species.

The Anabat detectors were placed at 12 sites (eight within ridge habitat and four within gully habitat), for one or two consecutive nights. After accounting for failed nights (due to equipment failure) eight nights of recording were successful in ridge habitat and five nights were successful in gully habitat.

Recorded calls were analysed by Bat Call Analyst Ray Williams.

Locations of the Anabat detectors are shown in Figure 7.

### **Fauna Habitat Assessment**

Three categories were used to evaluate fauna habitat of the Study Area - Good, Moderate or Poor - and are 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 as the value of the Study Area as a habitat corridor, was also used to assess habitat quality.

Using the above methods, Biosis Research conducted seven habitat assessments in the Study Area (two within ridge, four within gully, and one within upland swamp habitat).

Survey locations are shown in Figure 7.

### **Incidental Observations**

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



identified from predator scats.

During the surveys conducted by Biosis Research, the zoologists and botanists made incidental observations each day as part of their respective surveys. The habitat in which species were observed was recorded (e.g. ridge, gully or upland swamp). A waypoint was marked at the location of any threatened species encountered.

### **Off Site Surveys**

Fauna surveys were also carried out in three areas surrounding the Study Area: Tharawal Local Aboriginal Land Council land (located to the immediate north of West Cliff), Dharawal State Conservation Area (located to the immediate east of West Cliff), and Metropolitan Water Catchment – Cataract Catchment (located to the south of West Cliff), to gain knowledge of any local populations of threatened species occurring in the Locality.

The off site surveys consisted of habitat assessments, diurnal herpetological searches, diurnal bird surveys, diurnal call-playback for frogs, spotlighting for mammals and frogs, and nocturnal call-playback for frogs. Refer to above sections for methodology.

## **5.2.2 Documentation of survey effort**

Copies of completed field data sheets have been included in Appendix 7. Documentation summarising all survey effort for each survey technique used is included below. It should also be noted that the survey effort for the numerous previous surveys of the Study Area (see Section 4.1.1) have not been included in the following tables. The results of previous surveys have been included in this report where appropriate.

### 5.2.2.1 Flora survey effort

**Table 4. General Habitat Assessment / Survey Reference Points**

| Task  | Details   |
|---|---|
| <b>Flora: Survey to determine extant plant communities and areas of potential habitat for threatened flora.</b> |   |
| Targeted subject species  | N/A   |
| Survey technique  | General habitat assessment, ground truthing aerial photo mapping  |
| Time invested in each survey technique (# person hours)   | Included as part of the Targeted Surveys (See Table 6)  |
| Dates of survey   | 11 – 12 July, 2006<br>27, 28 and 29 November 2006<br>1, 12, 13 and 14 December 2006<br>18 January 2007<br>9 February 2007<br>1 May 2007 |
| Survey point marked on a map  | As shown in <b>Figure 6</b> (AMG coordinates available on request)  |
| Size, orientation and dimensions of quadrat or length of transect for each survey technique                     | N/A   |
| Survey start times and finish times   | 8.30 am 4.30pm  |
| Surveyor name and phone number  | Mathew Richardson, Nathan Smith, Sian Wilkins and Brendan Smith, Botanists with Biosis Research, 9690 2777                              |
| Name of person undertaking identification   | As above  |

\* Time invested is actual survey time and excludes all vehicle movements and associated on Study Area survey planning.

**Table 5. Flora survey details: Quadrats**

| Task  | Details  |
|---|--|
| <b>Flora: Survey to determine composition of plant communities</b>                          |  |
| Targeted subject species  | N/A  |
| Survey technique  | Quadrats   |
| Time invested in each survey technique (# person hours)                                     | *26.5 hours  |
| Date of survey  | 27, 28 and 29 November 2006  |
| Quadrat locations (AMG Coordinates)   | As shown in <b>Figure 6</b> (Full AMG coordinates available on request)                                    |
| Survey point marked on a map  | As shown in <b>Figure 6</b>  |
| Size, orientation and dimensions of quadrat or length of transect for each survey technique | Quadrats measured 20 x 20 m (400 m <sup>2</sup> ) and were conducted at 12 locations.                      |
| Survey start times and finish times   | 8.30 am 4.30pm   |
| Surveyor name and phone number  | Mathew Richardson, Nathan Smith, Sian Wilkins and Brendan Smith, Botanists with Biosis Research, 9690 2777 |
| Name of person undertaking identification   | As above   |

\* Time invested is actual survey time and excludes all vehicle movements and associated on Study Area survey planning.

**Table 6. Flora survey details: Targeted Searches for threatened species**

| Task  | Details  |
|---|--|
| <b>Flora: Survey to determine presence of all subject plant species.</b>                    |  |
| Targeted subject species  | All subject species (see Table 2).   |
| Survey technique  | Targeted surveys (Random Meanders) in areas of potential habitat within the Study Area.  |
| Time invested in each survey technique (# person hours)                                     | *228 hours   |
| Dates of surveys  | 11 – 12 July, 2006<br>27, 28 and 29 November 2006<br>1, 12, 13 and 14 December 2006<br>18 January 2007<br>9 February 2007<br>1 May 2007  |
| Survey point or transect marked on a map  | As shown in <b>Figure 6</b>  |
| Size, orientation and dimensions of quadrat or length of transect for each survey technique | Targeted searches (random meanders) carried out within the Study Area. This included two persons walking in parallel lines approximately 20 m apart and traversing the development footprint and areas of potential habitat within Study Area. |
| Survey start times and finish times   | 8.00 am 4.30pm each day  |
| Surveyor name and phone number  | Mathew Richardson, Nathan Smith, Sian Wilkins and Brendan Smith, Botanists with Biosis Research, 9690 2777   |
| Name of person undertaking identification   | Nathan Smith, Botanist with Biosis Research.   |

\* Time invested is actual survey time and excludes all vehicle movements and associated on Study Area survey planning.

**Table 7. Flora survey details: Total Abundance Counts**

| Task  | Details   |
|---|---|
| <b>Flora: Survey to determine the numbers of threatened plants</b>                          |   |
| Targeted subject species  | <i>Acacia bynoeana</i> , <i>Persoonia hirsuta</i> and <i>Pultenaea aristata</i>   |
| Survey technique  | Total abundance counts  |
| Time invested in each survey technique (# person hours)                                     | Included as part of the Targeted Surveys (Table 6).   |
| Date of survey  | 11 – 12 July, 2006<br>27, 28 and 29 November 2006<br>1, 12, 13 and 14 December 2006<br>18 January 2007<br>9 February 2007<br>1 May 2007 |
| Description of Study Area location  | Exposed Sandstone Scribbly Gum Woodland and Sandstone Gully Peppermint Forest   |
| Survey point marked on a map  | As per locations of threatened species (Figure 6).  |
| Size, orientation and dimensions of quadrat or length of transect for each survey technique | Dependent on size and density of population.  |
| Survey start times and finish times   | 8.30 am to 4.30pm   |
| Surveyor name and phone number  | Mathew Richardson, Nathan Smith, Sian Wilkins and Brendan Smith, Botanists with Biosis Research, 9690 2777                              |
| Name of person undertaking identification   | Mathew Richardson, Nathan Smith, Sian Wilkins and Brendan Smith, Botanists with Biosis Research   |

### 5.2.2.2 Fauna Survey Effort

The terrestrial fauna survey effort is summarised in Table 5, Table 6, and Table 7. Table 8 shows the total effort during the fauna surveys conducted during previous work by Biosis Research (2001). Table 9 shows the survey effort for the surveys conducted most recently by Biosis Research. In addition to the tabulated survey effort, numerous habitat based assessments have been conducted by Biosis Research within or nearby the Study Area (Richardson 2001, Harrington 2002, Richardson 2002d, c, a, e, f, b, Richardson *et al.* 2003, Richardson and Hardy 2003, Richardson and English 2004, Harrington 2005, Smith 2005, Smith *et al.* 2005, English and Gorrod 2006, English and Wilkins 2006b, a, Harrington and Smith 2006, Harrington *et al.* 2006, Moody 2006).

Many of these habitat-based surveys included active searching and listening for incidental fauna or fauna traces (Harrington 2002, Richardson and English 2002, Richardson *et al.* 2003, Smith *et al.* 2005, English and Gorrod 2006, English and Wilkins 2006a).

**Table 8: Total Survey effort for Fauna surveys previously conducted by Biosis Research in the Study Area (Richardson *et al.* 2001).**

| Method   | Survey Effort          |               | Dates of Surveys          | Surveys & species ID performed by  |
|--|------------------------|---------------|---------------------------|--|
|  | Number of Survey sites | Survey effort |                           |  |
| Tree-mounted Elliot traps  | 1                      | 288 TN/D*     | 20-26 May, 2001           | Martin Predavec & James Smith c/o Biosis Research (02) 9690 2777                               |
| Cage Traps (meat)  | 2                      | 40 TN/D       | 20-24 May, 2001           |  |
| Cage Traps (Peanut butter)   | 2                      | 80 TN/D       | 20-24 May, 2001           |  |
| Hair tubes (meat)  | 2                      | 200 TN/D      | 19-29 May, 2001           | Ray Williams, Ecotone Ecological Consultants (Anabat Call Analysis 22-23/05/03) (02) 4968 4901 |
| Hair tubes (Peanut butter)   | 2                      | 200 TN/D      | 19-29 May, 2001           |  |
| Spotlighting   | 1                      | 5.5 hrs       | 21 May, 2001              |  |
| Harp Trap Nights   | 3                      | 4 TN/D        | 21-25 May, 2001           | Barbara Triggs (Hair analysis) (03) 5158 0445  |
| Anabat   |                        | 1 TN/D        | 22-23 May, 2001           |  |
| Call Playback (Powerful Owl, Barking Owl, Masked Owl, Sooty Owl, Yellow-bellied Glider, Sugar Glider, Squirrel Glider, Giant Burrowing frog, Stuttering frog, Red-crowned toadlet) | 4                      | 5 hrs         | 20, 22, 23 & 25 May, 2001 |  |
| Diurnal Herpetofauna Survey  | 2                      | 13 hrs        | 21 and 23 May, 2001       |  |
| Nocturnal Herpetofauna Survey  | 3                      | 8.5 hrs       | 23 & 25 May, 2001         |  |
| Diurnal Bird Survey  |                        | 11.3 hrs      | 21 & 27 May, 2001         |  |
| Habitat based surveys  | Many                   | ~15 days      | 7 – 28 November, 2000     |  |
| Incidental observations  |                        | 8 days        | All field days            |  |

\* TN/D = Trap Nights/Days.

**Table 9: Total Survey effort for current fauna surveys conducted by Biosis Research in the Study Area.**

| Site Name                    | Survey Effort     |               | Dates of Surveys   | Surveys & Species ID Performed by   |
|------------------------------|-------------------|---------------|--|---|
|                              | No. Survey Points | Survey Effort |  |   |
| Arboreal Elliot B Traps      | 22                | 100 TN        | 27 November - 1 December; 4 - 7 & 11 - 15 December 2006. | Glenn Muir, Jennifer Charlton, Katie Cartner & Rachel Blakey. Biosis Research. (02) 9690 2777 |
| Arboreal Hair Tubes (Large)* | 66                | 408 TN/D      | 27 November - 1 December; 4 - 7 & 11 - 15 December 2006. | Glenn Muir, Jennifer Charlton, Katie Cartner & Rachel Blakey. Biosis Research. (02) 9690 2777 |

| Site Name  | Survey Effort     |               | Dates of Surveys   | Surveys & Species ID Performed by  |
|--|-------------------|---------------|--|--|
|  | No. Survey Points | Survey Effort |  |  |
| Ground Elliot A Traps  | 100               | 400 TN/D      | 4 - 8 December 2006  | Glenn Muir, Jennifer Charlton, Katie Cartner & Rachel Blakey. Biosis Research. (02) 9690 2777  |
| Ground Elliot B Traps  | 100               | 400 TN/D      | 4 - 8 December 2006  | Glenn Muir, Jennifer Charlton, Katie Cartner & Rachel Blakey. Biosis Research. (02) 9690 2777  |
| Ground Hair Tubes (Small)  | 40                | 330 TN/D      | 28 November - 7 December 2006.                             | Glenn Muir, Jennifer Charlton, Katie Cartner & Rachel Blakey. Biosis Research. (02) 9690 2777  |
| Ground Hair Tubes (Large)  | 40                | 330 TN/D      | 28 November - 7 December 2006.                             | Glenn Muir, Jennifer Charlton, Katie Cartner & Rachel Blakey. Biosis Research. (02) 9690 2777  |
| Ground Cage Traps  | 28                | 96 TN/D       | 28 November - 1 December 2006 & 4 - 7 December 2006.       | Glenn Muir, Jennifer Charlton, Katie Cartner & Rachel Blakey. Biosis Research. (02) 9690 2777  |
| Bat Call Detection   | 9                 | 13 TN         | 29 November - 1 December; 4 - 8 & 11 - 15 December 2006.   | Glenn Muir, Jennifer Charlton, Katie Cartner & Rachel Blakey. Biosis Research. (02) 9690 2777  |
| Harp Trap Nights   | 7                 | 10 TN         | 29 November - 1st December & 4 - 8 December 2006.          | Glenn Muir, Jennifer Charlton, Katie Cartner & Rachel Blakey. Biosis Research. (02) 9690 2777  |
| Diurnal Call Playback (Giant Burrowing Frog, Littlejohn's Tree Frog and Red-crowned Toadlet)   | 6                 | 2.23 hrs      | 5 - 7 December 2006  | Jennifer Charlton & Rachel Blakey. Biosis Research. (02) 9690 2777   |
| Nocturnal Call Playback (Giant Burrowing Frog, Littlejohn's Tree Frog and Red-crowned Toadlet) | 2                 | 1.17          | 5 - 6 December 2006  | Jennifer Charlton & Rachel Blakey. Biosis Research. (02) 9690 2777   |
| Nocturnal Call Playback (Mammals)  | 6                 | 4.43 hrs      | 29 - 30 November & 5 - 8 December 2006.                    | Jennifer Charlton & Rachel Blakey. Biosis Research. (02) 9690 2778   |
| Nocturnal Call Playback (Powerful Owl, Sooty Owl, Masked Owl & Barking Owl)                    | 4                 | 32.22 hrs     | 17 - 20 & 24 - 27 July 2006                                | Rhidian Harrington, Jennifer Charlton & Katie Cartner. Biosis Research. (02) 9690 2777.  |
| Spotlighting (Mammals)   | 7                 | 8.9 hrs       | 29 - 30 November & 5 - 7 December 2006.                    | Glenn Muir, Jennifer Charlton, Katie Cartner & Rachel Blakey. Biosis Research. (02) 9690 2777  |
| Spotlighting (Frogs)   | 7                 | 8 hrs         | 4 - 8 December 2006  | Jennifer Charlton & Rachel Blakey. Biosis Research. (02) 9690 2777   |
| Diurnal Herpetofauna Survey  | 13                | 17 hrs        | 17 - 20 & 24 - 27 July 2006; 27 November - 8 December 2006 | Rhidian Harrington, Jennifer Charlton & Katie Cartner (Winter Surveys). Glenn Muir, Jennifer Charlton, Katie Cartner & Rachel Blakey (Summer Surveys). Biosis Research. (02) 9690 2777 |
| Diurnal Bird Survey  | 8                 | 3.49 hrs      | 6 & 13 - 14 December 2006                                  | Glenn Muir, Jennifer Charlton & Katie Cartner. Biosis Research. (02) 9690 2777   |

| Site Name               | Survey Effort         |               | Dates of Surveys | Surveys & Species ID Performed by  |
|-------------------------|-----------------------|---------------|------------------|--|
|                         | No. Survey Points     | Survey Effort |                  |  |
| Incidental Observations | Throughout Study Area | -             | All field days   | Rhidian Harrington, Mathew Richardson, Glenn Muir, Jennifer Charlton, Katie Cartner, Rachel Blakey, Nathan Smith, Brendan Smith, Terri English & Sian Wilkins. Biosis Research. (02) 9690 2777 |

## 5.3 Specific survey requirements

### 5.3.1 Specific Flora Survey Requirements

Flora surveys were undertaken during Winter, early Summer and Autumn. This allowed for improved detectability of threatened plants during their respective flowering seasons.

Survey results for subject flora species that were not recorded in the current or previous surveys may be the result of survey limitations. Detectability of species with potential habitat in the Study Area is an important limitation requiring consideration. Threatened species may occur in areas of suitable potential habitat within the Study Area and were not detected.

Large portions of the Study Area have previously been burnt (December 2001 – January 2002) which is likely to reduce the detectability of some threatened species. Consequently, further assessment has been conducted for these species as affected subject species on the basis of potential habitat within the Study Area only. Subject species that were not identified during the current survey but have potential habitat within the Study Area have been considered further in this SIS.

In addition to subject species not detected during surveys, on Study Area records of the affected subject species, *Persoonia hirsuta* included two small seedlings as opposed to the numerous adults which were recorded from the unburnt portions of the Study Area. This further supports the notion that time since fire may reduce the detectability of some subject flora species.

### 5.3.2 Specific fauna survey requirements

Performing targeted surveys for the subject species of this study involved taking into account specific survey requirements which may influence the species detectability, including seasonal and environmental variables.

The targeted surveys were conducted over two survey periods, during both

Winter and Summer of 2006. During the winter period the Broad-headed Snake and the large forest owls (Powerful Owl, Sooty Owl, Masked Owl and Barking Owl) were surveyed. This season is appropriate to survey the Broad-headed snake because it is much more easily detected in its winter habitat (within crevices in west-facing sandstone rocky outcrops) than their cryptic summer habitat within the canopy. Although Owls may be surveyed year round, the targeted surveys were performed during winter, which is their breeding season, to maximise the chance of detecting owls as they are more active during this period (e.g. territorial and breeding interaction). Any harmful impacts of call-playback surveys on nesting owls during this period were minimised by avoiding call playback near known nest sites as per the DECC Threatened Biodiversity Survey and Assessment draft guidelines (DEC 2004c). The Swift Parrot was also opportunistically targeted during winter reptile surveys as this species migrates to Tasmania during Spring and Summer (DEC 2005...). Similarly the Regent Honeyeater was also targeted during the winter reptile surveys as they forage on winter-flowering tree species and are visible during this period.

Targeted surveys for all amphibians (Littlejohn's Tree Frog, Giant Burrowing Frog and Red-crowned Toadlet) were conducted during the summer survey period. Warmer summer months are a time of greater activity due to breeding for many frogs and indeed this falls within the Giant Burrowing Frog breeding season (August-March) (DEC 2005o). The Red-crowned Toadlet is an opportunistic breeder dependant on suitable rainfall. While the Littlejohn's Tree-frog's breeding season is reported to occur in winter, this species has been recorded year-round by Biosis Research during nearby monitoring programs (Biosis Research, unpublished data) and thus it is considered appropriate to survey for them during the summer period. The optimal weather conditions of heavy rains were not encountered during the field surveys, thus reducing the likelihood of recording Red-crowned Toadlet and Giant Burrowing Frog, for which rainfall of 5 mm has been found to increase likelihood of detection (Penman *et al.* 2006).

Diurnal bird surveys were conducted during the summer survey period. All diurnal bird subject species targeted in the survey are detectable year round except the Swift Parrot, as previously discussed. Care was taken to maximise use of peak activity periods (dawn and dusk) as far as possible during the survey. In addition, the Bush-stone Curlew, a nocturnal bird, was surveyed diurnally as per the DECC Threatened Biodiversity Survey and Assessment draft guidelines (DEC 2004c).

All bat surveys were conducted in the summer survey period as this is the period of greatest activity in microchiropteran and megachiropteran bats as recommended by the DECC Threatened Biodiversity Survey and Assessment



draft guidelines (DEC 2004c).

Rosenberg's Goanna was also surveyed during the summer period as this is its period of greatest activity (King and Green 1993).

## 5.4 Survey Results

### 5.4.1 Subject Species Survey Results

#### 5.4.1.1 Subject Flora Species

Of the 32 subject flora species (Table 2), three species were recorded in the Study Area, these are *Acacia bynoeana*, *Persoonia hirsuta* and *Pultenaea aristata*. Survey results discussing conservation status, habitat utilisation and local and regional abundance are included in section 6.3.5. The location of subject plant species recorded during the surveys is shown on **Error! Reference source not found.**

The abundance of subject species that were detected during the surveys is included in Table 10 below.

**Table 10: Results of total abundance counts for threatened flora**

| Plant Species             | *Total Number Within Locality (5 km) | Total Number Within Study Area (500 m) | Total Number Within Subject Site |
|---------------------------|--------------------------------------|--|----------------------------------|
| <i>Acacia bynoeana</i>    | >1942                                | 282                                    | 11                               |
| <i>Persoonia hirsuta</i>  | >178                                 | 156                                    | 47                               |
| <i>Pultenaea aristata</i> | >2231                                | 50                                     | 25                               |

\* Includes DECC records and off site records collected during the current assessment.

### 5.4.1.2 Subject Fauna Species

Of the 45 fauna subject species listed in Section 4.1.4, eight species were recorded in the Study Area, either during this study or during previous studies conducted by Biosis Research. These are Powerful Owl, Gang Gang Cockatoo, Common Bent-wing Bat, Large-footed Myotis, Grey-headed Flying-fox, Koala, Broad-headed Snake and Rosenberg's Goanna. Survey results discussing habitat utilisation and local and regional abundance are included in Section 6.3.6. The locations of subject fauna species recorded during the surveys are shown on Figure 11. Detailed assessments of the subject fauna species are presented in Section 6.3.6 and survey proformas for targeted species surveys are presented in Appendix 7.

## 5.4.2 General protected animal and native plant species survey results

### 5.4.2.1 Native Flora

A total of 156 species of vascular plant were recorded from quadrat surveys in the study area (Appendix 3). Common weed species included *Andropogon virginicus*, *Eragrostis curvula*, *Chloris gayana*, *Cynodon dactylon*, *Ageratina adenophora* and *Juncus acutus*.

### 5.4.2.2 Native Fauna

A total of 111 animal species were recorded within the Study Area during the current survey, comprising 105 (95 %) native species and six (5%) introduced species (Appendix 6). In addition, a total of 230 animal species were found including previous work done by Biosis Research, off site surveys and records from the Birds Australia Atlas Database. A list of all animal species recorded during the current and previous surveys is included in Appendix 6.

## 6.0 ASSESSMENT OF LIKELY IMPACTS ON THREATENED SPECIES AND POPULATIONS

The primary impact on subject species and communities will be through the removal of vegetation and associated habitat loss. A number of indirect impacts may result from the Proposal including changes in surface water flows and water quality, habitat removal and fragmentation, weed invasion, erosion and siltation, deposition of dust, increased noise and vibrations, increased traffic and alteration of natural fire regimes. All of these indirect impacts occur on the Study Area presently. It is judged that the Proposal may alter the way these indirect impacts occur on the Study Area. Further discussion of impacts that are considered relevant to the Proposal have been included below. Impacts that are considered specific to affected subject species are included in the Assessment of Significance (see Section 9).

### Clearing of Vegetation and Associated Habitat Loss

‘Clearing of native vegetation’ is listed as a Key Threatening Process under Schedule 3 of the TSC Act, ‘Land clearance’ is listed as a Key Threatening Process under the EPBC Act. None of the vegetation communities within the Subject Site and Study Area are listed as EEC’s under the TSC or EPBC Acts.

Native vegetation serves a number of different functions including:

- Provision of habitat, food and other resources for native biota;
- Maintenance of interactions between species (e.g. pollination, dispersal, mutualism, competition);
- Nutrient cycling and filtering and retention of nutrients;
- Carbon storage;
- Maintenance of soil processes;
- Maintenance of catchment scale hydrological and geochemical processes,
- Maintenance of landscape scale ecological processes.

Vegetation clearing would be associated with the Proposal for the construction of the emplacement area, installation of utilities, any auxiliary infrastructure (including drainage channels and settlement dams) and access and egress haulage roads. A total of 60.5 ha of vegetation will be cleared.

The Final Determination in the TSC Act for this Key Threatening Process lists some of the impacts of the clearing of native vegetation on biological diversity as:

- Destruction of habitat resulting in the loss of local populations of individual

species;

- Fragmentation;
- Expansion of dryland salinity (unlikely to result from the current Proposal);
- Riparian zone degradation;
- Increased habitat for invasive species;
- Loss of leaf litter layer;
- Loss or disruption of ecological function,
- Changes to soil biota.

Vegetation clearing associated with the Proposal will impact on a number of subject species and will also have negative local impacts on non-subject species. For fauna species, the degree of impact will depend upon the extent of clearing and the ability, or inability, of individuals to emigrate to suitable local habitats. For instance, sedentary species, such as the Red-crowned Toadlet, or species utilising the Subject Site during Vulnerable stages of their lives (e.g. juveniles) are unlikely to evade this impact. In addition, species with specific habitats for nesting, breeding and/or roosting, such as rocky outcrops or hollow-bearing trees, are Vulnerable where these habitats are disturbed or removed. The impacts of clearing of native vegetation and associated habitat loss are considered for each of the affected flora and fauna species in Section 6.3.6.

Vegetation clearing will result in the removal of individual plants and remove habitat features associated with that vegetation. The Proposal will clear viable components of native vegetation and create, and widen, gaps within forest remnants, which may influence the movement of and interaction between local fauna populations.

Removal of vegetation for track construction and upgrade will, apart from the direct effect of vegetation/habitat loss, tend to increase gaps between vegetation/habitats either side of the access track, which may exacerbate existing impediments, albeit minor, for fauna movement.

Implicit with vegetation loss at West Cliff is the diminution and removal of a range of fauna habitat features including:

- replacement of a diverse forest gully system to one that is comparatively simplistic and homogenous;
- nest and foraging resources – such as understorey vegetation, tree hollows, foliage, flowering and seed material and associated arthropod densities,

- microhabitats contained within ground covers and leaf litter that sustain a range of vascular and non-vascular plants and vertebrate and invertebrate fauna.

The upper section of Brennans Creek catchment (Stage 1 of the emplacement area) has been altered by past emplacement. The Stage 1 emplacement area has been capped and rehabilitated with vegetation. The Stage 2 emplacement is currently an active valley fill operation within Brennans Creek. The southern end of the Stage 2 emplacement has been capped and rehabilitated with native vegetation. Brennans Creek is currently diverted around the Stage 1 & 2 of the emplacement. Brennans Creek below the Stage 2 emplacement (within the Subject Site) is subject to extensive siltation; however, riparian habitats are presently in good condition.

### **Bushrock Removal**

Sections of exposed rocky outcrop, including overhang rock on rock formations, will be removed by the Stage 3 West Cliff emplacement area. This action is likely to have important consequences for a number of extant species, and for threatened species such as the Red-crowned Toadlet, Rosenberg's Monitor and Broad-headed Snake.

Bushrock removal is listed as a Key Threatening Process under Schedule 3 of the TSC Act and is defined as the removal of natural surface deposits of rock from rocky outcrops or from areas of native vegetation. Bushrock Removal removes and/or disturbs habitat of native species, which may find shelter in or under rocks, may use rocks for basking, or which grow in rocky areas. Species listed under the Key Threatening Process which may be impacted by the Proposal, and for which habitat is present at West Cliff include the Spotted-tailed Quoll, Broad-headed Snake, Red-crowned Toadlet, *Persoonia hirsuta*, *Acacia bynoeana*, and *Acacia baueri* ssp. *aspera*.

### **Changes in Drainage Patterns and Water Quality**

Under current provisions BHPBIC is permitted to discharge from Brennans Creek Dam into the lower stage of Brennans Creek which flows to the Georges River. Discharges from Brennans Creek Dam are managed to comply with the requirements of an Environment Protection Licence (Ecoengineers 2007).

As part of the approved Stage 1 and 2 emplacement operations, a clean water diversion channel was constructed to collect clean runoff from the west of the Study Area and return it to Brennans Creek upstream of the Subject Site. These channels are designed to collect and redirect clean runoff and are not an attempt to reconstruct habitat. The current Proposal includes an extension to the existing Brennans Creek clean water diversion channel along the western and eastern

perimeter of the Subject Site before discharging into Brennans Creek, just above the full supply level of Brennans Creek Dam impoundment. The Proposal will attempt to construct a more meaningful aquatic environment within the clean water bypass channels, including pools and riffles, rock bars and other structures.

At present, wet weather overflow enters Brennans Creek from a sedimentation pond (Pond 4) at the northern end of the Stage 2 emplacement. It is proposed that a two pond water management system will be installed and operated for the Stage 3 emplacement, thereby providing a considerable improvement in the quality of water discharged to Brennans Creek downstream of the active emplacement area.

Alteration to the natural flow regimes of rivers, streams, floodplains and wetlands is a Key Threatening Process listed under Schedule 3 of the TSC Act. The Final Determination for this Key Threatening Process states that alteration to natural flow regimes can occur through reducing or increasing flows, altering seasonality of flows, changing the frequency, duration, magnitude, timing, predictability and variability of flow events, altering surface and sub-surface water levels and changing the rate of rise or fall of water levels.

Consideration of affected subject species that may be impacted by changes in drainage patterns and water quality is included in Sections 6 and 9.

### **Edge Effects and Habitat Fragmentation**

Edge effects are zones of altered environmental conditions (i.e. altered light levels, wind speed, temperature) occurring along the edges of habitat fragments. These new environmental conditions along the edges can promote the growth of different vegetation types (including weeds) and allow invasion by pest animals specialising in edge habitats. Edge zones can be subject to higher levels of predation by introduced mammalian predators and native avian predators (Berry 2002). This new zone of habitat inside the edge of a fragment can also exacerbate barrier effects.

Bali (2000) noted that there are limitations to edge effect studies, with a study by Murcia (1995) noting that it is unrealistic to expect all variables to vary equally with distance from the edge. As edge effects varied between community types and abiotic effects were the most consistent indicator of edge effects (measuring less than or equal to 50 m in most studies), Bali (2000) concluded that average edge effects generally occur up to 50 m away from the road edge. However, although Bali (2000) concluded that edge effects extend to a maximum of 50 m, based on the fact that abiotic effects were the most consistent indicator of edge effects, it is obvious from the literature that edge effects extend beyond 50 m, but that they can't be measured in a consistent

manner (see Section 3.1.3). Although edge effects have been recorded beyond 500 m, for the purposes of this SIS the Study Area has been defined as a 500 m buffer of the Subject Site because most studies indicate that any impacts (edge effects) to wildlife from roads are not detectable beyond 500 m (Forman *et al.* 2003).

Edge effects associated with the Proposal may include the degradation of adjacent habitat through:

- Changes in microclimate (e.g. temperature, wind, light humidity);
- Increase in noise and vibrations;
- Changes in floristics (i.e. species composition and abundance);
- Alteration to the pattern and frequency of fire. The main issues in relation to fire regime at West Cliff Colliery is a reduction in fire frequency due to the fire exclusion policy. Fire suppression can be as detrimental to sandstone woodland as over-burning;
- Invasion by exotic plant and animal species;
- A potential increase in sedimentation. The Water Quality Management Plan (Ecoengineers 2007) anticipates a net reduction in total suspended solids discharged to Brennans Creek;
- Increase in tree death (e.g. dieback, impact on root zone);
- Improved access for predators (Bali 2000).

Safeguards relating to edge effects relate generally to reducing impacts outside of the direct development zone, controlling possible impacts at their source within the emplacement area and reducing the hardness of the edge between the extent of earthworks and native vegetation. A summary of the important edge effects and the management of these issues at West Cliff are provided below.

### **Weed Invasion**

Weed invasion has the potential to occur in all areas cleared for the Proposal. Weeds were more common along access tracks, revegetated areas (e.g. Stage 1) and disturbed forest edges of the West Cliff Study Area but were absent within core bushland areas. The dominant weed species present in the Study Area were exotic perennial grasses.

Invasion of native plant communities by exotic perennial grasses is listed as a Key Threatening Process under Schedule 3 of the TSC Act Exotic perennial grasses are those that are not native to NSW and have a life-span of more than one growing season (DEC 2005v). A relatively small number of these perennial grasses threaten native plant communities, and it is these species which are of concern (DEC 2005v). Two grass species listed as being of a specific concern

under this Key Threatening Process are present at West Cliff; these are *Eragrostis curvula* (African Lovegrass) and *Cortaderia selloana* (Pampas Grass). Further exotic perennial grass species recorded in the Study Area include *Andropogon virginicus* (Whisky Grass), *Chloris gayana* (Roads Grass) and *Cynodon dactylon* (Common Couch).

Weed propagules may be transported into comparatively weed free areas by construction and service vehicles and have the potential to replace native understoreys along the margins of access tracks. Apart from altering local flora assemblages and competitively displacing native plant species, weed invasion also has the potential to modify important habitat features for local fauna species. The vegetation and fauna management plan identifies strategies and activities for the onsite management of weeds. The Proposal is unlikely to significantly increase the prevalence of weeds at West Cliff.

### **Erosion and Siltation**

Erosion and siltation can result from vegetation clearing, track upgrade and widening, physical effects of frequent vehicle movements and soil disturbance from construction. The potential impact of erosion and subsequent sedimentation within small drainages is expected to be greater in cleared and unstable areas as a result of increased run off.

Any attempt to control erosion or contamination will be limited by the efficacy of mitigation strategies and will depend on the type of structure(s) used and the level of maintenance throughout the construction and operation phases of the project.

### **Dust**

No studies are known to have investigated the cumulative, long-term impacts of mining generated dust on flora and fauna. Dust may be generated at coal mine sites during Study Area preparation, excavation, transportation, coal processing and truck movements. General observations of vegetation surrounding West Cliff Colliery include visible deposition of coal dust immediately adjacent to site roads, coal processing areas and the existing emplacement.

Feasible impacts of this may include a possible decrease in photosynthesis of dust covered plants and reduced pollination and dispersal (i.e. through direct interaction with floral organs and or the reduction in pollinators and dispersal vectors) of dust covered plants. These often include growth-limiting nutrients, which are likely to have direct impacts on plants. Although some studies have demonstrated that increased levels of some chemicals from dust can be detected up to 500 m from the source (a road), in most studies dust was deposited within 50 m (Forman *et al.* 2003). The effects of dust from numerous sources on



human health have been well documented and these adverse effects would be relevant to fauna as well.

### **Noise**

Noise and vibration will result from recurrent truck and heavy plant movements. This may startle some fauna species and may cause disruption and emigration from vegetated areas adjacent to the Subject Site.

### **Traffic and Vehicle Movements**

Construction and usage of access and egress haul roads are an essential component of the Proposal. Truck, heavy plant and light vehicles (4WD) will be utilised on the Subject Site.

Fauna that is displaced by the Proposal or that is moving between or occupying habitats on either side of the Subject Site will be exposed to risks of road injury (or death) during construction and operation. While this risk is generally considered to be low, some species, such as frogs, may be a greater risk where access roads traverse drainage lines and other suitable fauna habitats. There is also a slight risk to ground-dwelling mammals and reptiles, particularly if vehicle speeds are uncontrolled or if movement is conducted at night (including dawn and dusk).

The use of vehicles and heavy plant may also result in a significant increase in the introduction of weed propagules into areas that are comparatively weed free.

### **Alteration of Natural Fire Regimes**

The Proposal is unlikely to increase or decrease fire frequency in the Study Area.

The Proposal is likely to result in reduced fire frequencies within remnant vegetation immediately surrounding the Subject Site. This alteration in natural fire regimes may have long term implications for the survival of native species within remnants of the Study Area. Fire is considered a natural feature of the environment in the area and is essential to the survival of some plant species and communities. A significant body of research has involved identifying the “optimum” fire frequency that will maintain biodiversity within and between different plant communities and species populations. In plant communities such as those of the Study Area, a variation in inter-fire intervals within any one area is generally suggested for species conservation (Morrison *et al.* 1995).

## Increased Shading

The Proposal is likely to result in increased shading and changes to the natural photoperiod (period of sunlight exposure) within flora and fauna habitats immediately adjacent to the Subject Site. Photoperiod is known to be an important mechanism for numerous ecological processes including triggers for plant flowering and seed germination, thermoregulation (temperature control) in reptiles, nest and shelter site selection in reptiles (Webb 1997) and reproductive cues in mammals (McCallan 2006) and reptiles.

Threatened species known to occur within the Study Area including the Broad Headed Snake and Rosenberg's Goanna may be impacted by increased shade conditions resulting from the Proposal.

## Existing Site Condition

None of the indirect impacts discussed in this Section are new to West Cliff. They have already been associated with Stages 1 and 2 of the emplacement as well as with existing roads and traffic. The Proposal that makes up Stage 3 will extend or alter the distribution of indirect impacts at the Subject Site, but will not introduce any new indirect impacts to the area.

## 6.1 Assessment of Species Likely to be Affected

Based on the current surveys, habitat assessment, previous surveys within the Locality (Section 5.2), review of literature and consideration of likely impacts, the list of subject species identified in Section 4.1 has been refined to a list of Affected Subject Species. Affected subject Species are those considered likely to be affected by the Proposal.

### 6.1.1 Affected Flora Species

Based on database interrogation, literature review and information gathered during field surveys within the Locality, 17 of the 32 subject flora species listed in Table 2 have been excluded from consideration as Affected Subject Species (Table 11). The key criteria used as a basis to exclude these species from further consideration as Affected Subject Species includes the following:

1. There is no habitat (including potential habitat) that will be affected by the Proposal;
2. Known vegetation associations are absent from the Study Area;
3. The Study Area is not within the species' normal range;

4. There appear to be no other reasons why the species should warrant further consideration.

**Table 11. Determination of Affected Subject Species (Flora) from Subject Species**

| Scientific Name                                      | Comments / Potential habitat within Study Area   | Affected Species / Considered further in SIS |
|--|--|--|
| <i>Acacia baueri</i> subsp. <i>aspera</i>            | This species has not been recorded within the Study Area despite extensive targeted surveys. Potential habitat in the Study Area is considered to be within Upland Swamps and rocky outcrops within Exposed Sandstone Scribbly Gum Woodland.   | Yes  |
| <i>Acacia bynoeana</i>                               | <b>Recorded in Study Area.</b><br><i>Acacia bynoeana</i> was recorded within ESSW located within the Subject Site, various locations within the Study Area, Dharawal State Conservation Area and Sydney Metropolitan Catchment Area.   | Yes  |
| <i>Acacia rivalis</i>                                | This species has not been recorded within the Study Area despite extensive targeted surveys. Habitat for this species is within River Red Gum communities bordering ephemeral streams - Broken Hill District (Harden 1991). Although the Study Area for this species is not within known distribution for this species, a single and probably spurious record of this species is known from within a 10 km radius of the Study Area. | No   |
| <i>Astrotricha crassifolia</i>                       | This species has not been recorded within the Study Area despite extensive targeted surveys. Potential habitat in the Study Area is considered to be within ESSW and Upper Georges River Sandstone Woodland (UGRSW).   | Yes  |
| <i>Boronia deanei</i>                                | This species has not been recorded within the Study Area despite extensive targeted surveys. Potential habitat in the Study Area is considered to be within Upland Swamps and Sandstone Gully Peppermint Forest (SGPF).  | Yes  |
| <i>Caladenia tessellata</i>                          | This species has not been recorded within the Study Area despite extensive targeted surveys. No known records of this species occur within the Locality or within a 10 km radius of the Study Area. Potential habitat for this species is not considered to be present within the Study Area.  | No   |
| <i>Cryptostylis hunteriana</i>                       | This species has not been recorded within the Study Area despite extensive targeted surveys. All plant communities present in the Study Area are considered to be potential habitat for this species.  | Yes  |
| <i>Cynanchum elegans</i>                             | This species has not been recorded within the Study Area despite extensive targeted surveys. Potential habitat for this species is not considered to be present within the Study Area.   | No   |
| <i>Daphnandra</i> sp. 'Illawarra'                    | This species has not been recorded within the Study Area despite extensive targeted surveys. Potential habitat for this species is associated with rainforest communities that are not present within the Study Area.  | No   |
| <i>Darwinia peduncularis</i>                         | This species has not been recorded within the Study Area despite extensive targeted surveys. Potential habitat in the Study Area is considered to be within ESSW. The species has not been previously recorded within the Locality and the nearest known records are near Picton, more than 10 km outside the Study Area.  | Yes  |
| <i>Epacris purpurascens</i> var. <i>purpurascens</i> | This species has not been recorded within the Study Area despite extensive targeted surveys. Potential habitat for this species is considered to be within Upland Swamps, SGPF and Sandstone Gully Apple Peppermint Forest (SGAPF) present within the Study Area.  | Yes  |
| <i>Eucalyptus camfieldii</i>                         | This species has not been recorded within the Study Area despite extensive targeted surveys. Potential habitat in the Study Area is considered to be within ESSW. The species has not been previously recorded within the Locality and the nearest known records are near Waterfall, more than 10 km outside the Study Area.   | Yes  |

| Scientific Name                                      | Comments / Potential habitat within Study Area  | Affected Species / Considered further in SIS |
|--|---|--|
| <i>Grevillea obtusiflora</i>                         | This species has not been recorded within the Study Area despite extensive targeted surveys. The species has not been previously recorded within the Locality and the nearest known records are near Capertree (Lithgow), more than 50 km outside the Study Area. Potential habitat and known vegetation associations for this species are not considered to be present within the Study Area.  | No   |
| <i>Grevillea parviflora</i> subsp. <i>parviflora</i> | This species has not been recorded within the Study Area despite extensive targeted surveys. Potential habitat for this species is considered to be within UGRSW.   | Yes  |
| <i>Gyrostemon thesioides</i>                         | This species has not been recorded within the Study Area despite extensive targeted surveys. Potential habitat for this species is considered to be within SGAPF and SGPF.  | Yes  |
| <i>Leucopogon exolasius</i>                          | This species has not been recorded within the Study Area despite extensive targeted surveys. Potential habitat for this species is considered to be within SGAPF, SGPF present within the Study Area.   | Yes  |
| <i>Melaleuca deanei</i>                              | This species has not been recorded within the Study Area despite extensive targeted surveys. Potential habitat for this species is considered to be within UGRSW present within the Study Area.   | Yes  |
| <i>Persoonia bargoensis</i>                          | This species has not been recorded within the Study Area despite extensive targeted surveys. The species does occur within the Locality on heavier shale/sandstone derived soils near Appin which are not present within the Study Area. Potential habitat for this species is not considered to be present within the Study Area.  | No   |
| <i>Persoonia glaucescens</i>                         | This species has not been recorded within the Study Area despite extensive targeted surveys. The species has not been previously recorded within the Locality and the nearest known records are near Thirlmere and Tahmoor on heavier shale/sandstone derived soils. Potential habitat for this species is not considered to be present within the Study Area.  | No   |
| <i>Persoonia hirsuta</i>                             | <b>Recorded in Study Area.</b><br>Known and potential habitat for this species is considered to be present within ESSW and SGPF.  | Yes  |
| <i>Persoonia nutans</i>                              | This species has not been recorded within the Study Area despite extensive targeted surveys. The species has not been previously recorded within the Locality and the nearest known records are to the north of the Holsworthy Military Area. Known vegetation associations for this species are not present within the Study Area. The species is known to occur on heavier shale/sandstone derived soils (NPWS 2003c) which are not present within the Study Area. Potential habitat for this species is not considered to be present within the Study Area.                            | No   |
| <i>Pimelea spicata</i>                               | This species has not been recorded within the Study Area despite extensive targeted surveys. The species has not been previously recorded within the Locality and the nearest known records are greater than 20 km to the north-west of the Locality, near Mount Annan. Known vegetation associations for this species are not present within the Study Area. The species is known to occur on heavier Wiannamatta shale derived soils (NPWS 2004) which are not present within the Study Area. Potential habitat for this species is not considered to be present within the Study Area. | No   |
| <i>Plinthanthesis rodwayi</i>                        | This species has not been recorded within the Study Area despite extensive targeted surveys. The species has not been previously recorded within the Locality and the nearest known records are on two peaks in Budawang NP (Mt Budawang, Mt Currockbilly) (DEC 2005) more than 50 km outside the Study Area. Potential habitat and known vegetation associations for this species are not considered to be present within the Study Area.  | No   |

| Scientific Name              | Comments / Potential habitat within Study Area  | Affected Species / Considered further in SIS |
|------------------------------|---|--|
| <i>Pomaderris adnata</i>     | This species has not been recorded within the Study Area despite extensive targeted surveys. Potential habitat in the Study Area is considered to be within ESSW. No known records of this species occur within the Locality, although the species has been recorded at Sublime Point just north of Wollongong and approximately 12 km east of the Study Area.  | Yes  |
| <i>Pomaderris brunnea</i>    | This species has not been recorded within the Study Area despite extensive targeted surveys. The species has not previously recorded within the Locality and the nearest known records are near Douglas Park, approximately 10 km from the Study Area. The species is known to occur on clay and alluvial soils (DEC 2005□) which are not a feature present in the Study Area. Potential habitat for this species is not considered to be present within the Study Area.  | No   |
| <i>Pterostylis pulchella</i> | This species has not been recorded within the Study Area despite extensive targeted surveys. The species has not previously recorded within the Locality and the nearest known records are near Robertson, approximately 25 km from the Study Area. Potential habitat for this species is not considered to be present within the Study Area.   | No   |
| <i>Pterostylis saxicola</i>  | This species has not been recorded within the Study Area despite extensive targeted surveys. The species has not been previously recorded within the Locality and the nearest known records are near Douglas Park, approximately 10 km from the Study Area. The species is known to occur on transitional shale/sandstone and shale derived soils (DEC 2005◁) which are not present within the Study Area. Potential habitat for this species is not considered to be present within the Study Area.  | No   |
| <i>Pultenaea aristata</i>    | <b>Recorded in Study Area.</b><br>This species was recorded within ESSW, SGPF and Upland Swamps located within the Subject Site.  | Yes  |
| <i>Pultenaea pedunculata</i> | This species has not been recorded within the Study Area despite extensive targeted surveys. The species has not been previously recorded within the Locality and the nearest known records are north-west of Appin, approximately 8 km from the Study Area. Known vegetation associations for this species are not present within the Study Area. The species is known to occur on heavier soils including Wiannamatta shale, tertiary alluvium and transitional shale/sandstone soils (NPWS 2002b) which are not present within the Study Area. Potential habitat for this species is not considered to be present within the Study Area. | No   |
| <i>Senna acclinis</i>        | This species has not been recorded within the Study Area despite extensive targeted surveys. Potential habitat for this species is associated with rainforest communities that are not present within the Study Area.   | No   |
| <i>Syzygium paniculatum</i>  | This species has not been recorded within the Study Area despite extensive targeted surveys. Potential habitat for this species is associated with rainforest communities that are not present within the Study Area.   | No   |
| <i>Thesium australe</i>      | This species has not been recorded within the Study Area despite extensive targeted surveys. The species has not been previously recorded within the Locality and the nearest known records are near Camden, approximately 20 km from the Study Area. Known vegetation associations for this species are not present within the Study Area. Potential habitat for this species is not considered to be present within the Study Area.   | No   |

## 6.1.2 Affected Fauna Species

Based on database interrogation, literature review and information gathered during field surveys within the Locality, 7 of the 39 subject fauna species listed in Table 3 have been excluded from consideration as Affected Subject Species (Table 12). The key criteria used as a basis to exclude these species from further consideration as Affected Subject Species includes the following:

1. There is no habitat (including potential habitat) that will be affected by the Proposal;
2. The Study Area is not within the species' normal range;
3. The species has not been recorded recently within the Locality and is thought to be locally extinct;
4. There appear to be no other reasons why the species should warrant further consideration.

Thirty-two Affected Subject Species are considered in Table 12.

**Table 12: Determination of Affected Subject Species (Fauna) From Subject Species**

| Scientific Name                 | Common Name            | Comments   | Affected Species/ Considered further in SIS | Reasoning  |
|---------------------------------|------------------------|--|---|--|
| <b>Amphibians</b>               |                        |  |   |  |
| <i>Litoria littlejohni</i>      | Littlejohn's Tree Frog | Suboptimal potential habitat for this species may exist within creek lines and upland swamps within the Locality. Whilst the species has not been recorded within the Study Area, it is known to occur in the adjacent Dharawal State Conservation Area (DEC 2006a), and approximately 7 km south-east of the Subject Site (DECC Atlas of NSW Wildlife). | Yes   | Direct impacts on the species are possible. Indirect impacts caused by dust movement and noise are also possible, but unlikely to exceed current indirect impacts. Another potential impact is the restriction of movement between local populations, if they occur. |
| <i>Heleioporus australiacus</i> | Giant Burrowing Frog   | Potential habitat may exist for this species within upland swamps, ridgelines, and wet and dry forests of the Study Area. Whilst the species has not been recorded within the Study Area, it is known to occur in the adjacent Dharawal State Conservation Area (DEC 2006a) and within the Locality (DECC Atlas of NSW Wildlife).                        | Yes   | Direct impacts on the species are possible. Indirect impacts caused by dust movement and noise are also possible, but unlikely to exceed current indirect impacts. Another potential impact is the restriction of movement between local populations, if they occur. |

| Scientific Name                       | Common Name                            | Comments   | Affected Species/<br>Considered further in SIS | Reasoning  |
|---------------------------------------|--|--|--|--|
| <i>Pseudophryne australis</i>         | Red-crowned Toadlet                    | Dry open forests and heaths on wet ridge tops, and ephemeral creeks provide potential habitat for the Red-crowned Toadlet within the Study Area and Locality. There are a number of previous records within the Locality (DECC Atlas of NSW Wildlife), including Dharawal SCA (DECC 2006).   | Yes  | The Red-crowned Toadlet has the potential to be impacted directly by the Proposal.   |
| <b>Birds</b>                          |  |  |  |  |
| <i>Burhinus grallarius</i>            | Bush Stone-curlew                      | Potential habitat for this species occurs within the areas of woodland that are open and have a ground cover of short grass, leaf litter and fallen branches. The species has been previously recorded once within the Locality in 1981 (DECC Atlas of NSW Wildlife).  | No   | The Bush Stone-curlew has the potential to be impacted directly by the Proposal although, it is unlikely as the species is presumed to be locally extinct within the region (DEC 2005‡).   |
| <i>Callocephalon fimbriatum</i>       | Gang-gang Cockatoo*                    | The forests and woodlands of the Study Area provide potential habitat for the Gang-gang Cockatoo. The species has been previously recorded within the Study Area during the current surveys.   | Yes  | The Proposal has the potential to directly impact potential breeding and foraging resources for this species.  |
| <i>Calyptrorhynchus lathamii</i>      | Glossy Black-cockatoo                  | <i>Allocasuarina torulosa</i> and <i>A. littoralis</i> were both recorded within the Study Area and provide potential foraging habitat for this species. Hollow-bearing trees provide potential breeding resources. The species has not been recorded within the Study Area however, it is known to occur in the adjacent Dharawal State Conservation Area to the east (DEC 2006a), as well as north and south of the Study Area (DECC Atlas of NSW Wildlife). | Yes  | The Proposal has the potential to directly impact potential breeding and foraging resources for this species.  |
| <i>Climacteris picumnus victoriae</i> | Brown Treecreeper (eastern subspecies) | Eucalypt woodlands may provide potential habitat for this species within the Study Area. The species has not been recorded within the Study Area however, it is known to occur in the adjacent Dharawal State Conservation Area to the east (DEC 2006a), as well as north of the Study Area within 10 km (DECC Atlas of NSW Wildlife).   | Yes  | The Brown Treecreeper (eastern subspecies) has the potential to be directly impacted by the Proposal.  |
| <i>Coracina lineata</i>               | Barred Cuckoo-shrike                   | Eucalypt forests within the Study Area may provide potential habitat for this species however, only limited potential habitat occurs within the Subject Site. The Study Area lies further south than the bulk of southern records, however one lone record occurs approximately 21 km south-east of the Subject Site from 1998 (BioNet).   | No   | Direct or indirect impacts are unlikely for this species as only limited potential habitat exists within the Subject Site and the species has not been recorded within 21 km of the Subject Site. Furthermore, DECC (DEC 2005‡) did not consider the species to be of conservation concern for the region. |
| <i>Grantiella picta</i>               | Painted Honeyeater                     | Open woodlands with mistletoe and remnant trees on farmlands can provide potential habitat for the Painted Honeyeater. The species has not been previously recorded within the Study Area, and the closest record occurs near Windsor, approximately 64 km to the north (BioNet).  | No   | Direct or indirect impacts are unlikely due to the species' mobility, and because the species has not been recorded within 64 km of the Subject Site. Furthermore, DECC (DEC 2005‡) consider the species to be locally extinct.  |

| Scientific Name                     | Common Name                                   | Comments   | Affected Species/<br>Considered further in SIS | Reasoning   |
|-------------------------------------|---|--|--|---|
| <i>Melithreptus gularis gularis</i> | Black-chinned Honeyeater (eastern subspecies) | Open forests and woodlands dominated by box and ironbark eucalypts within the Locality provide potential habitat for this species. However, these tree species were not present within the Subject Site. This species has not been previously recorded within the Study Area and the closest record is approximately 14.5 km west of the Subject Site (BioNet).                                      | No   | Direct or indirect impacts are unlikely due to the species' mobility, lack of potential habitat within the Subject Site, and because the species has not been previously recorded within 14 km of the Subject Site.   |
| <i>Xanthomyza phrygia</i>           | Regent Honeyeater                             | Eucalypt woodlands and open forests may provide potential habitat for this species within the Study Area. The species has not been recorded within the Study Area however, it is known to occur in the adjacent Dharawal State Conservation Area to the east (DEC 2006a). In addition, 70 individuals were recorded approximately 1 km north of the Study Area in 1934 (DECC Atlas of NSW Wildlife). | Yes  | The Regent Honeyeater has the potential to be impacted by the Proposal however it is unlikely as the species is considered to be a rare winter visitor to the area (DEC 2005‡), and the preferred habitat of box-ironbark eucalypt forest was not present within the Subject Site.    |
| <i>Pachycephala olivacea</i>        | Olive Whistler                                | Eucalypt and riparian forest within the Study Area may provide potential habitat for this species. The species has not been previously recorded within the Study Area and the nearest records occur approximately 20 km south-east of the Subject Site (BioNet).   | No   | Direct or indirect impacts are unlikely due to the species' mobility, and because the species has not been recorded within 20 km of the Subject Site. Furthermore, DECC (DEC 2005‡) consider the species to be an extremely rare visitor to the region.                               |
| <i>Pyrrholaemus sagittata</i>       | Speckled Warbler                              | Potential habitat for this species occurs within the eucalypt woodlands of the Study Area, either on the ridges or in the gullies. The species has not been recorded within the Study Area and the closest record lies approximately 26 km north-west of the Subject Site, recorded in 2002 (BioNet).  | Yes  | Whilst the species has not been previously recorded within the Study Area, it is sedentary and has the potential to be impacted by the Proposal if present.   |
| <i>Stagonopleura guttata</i>        | Diamond Firetail                              | Open eucalypt forest within the Study Area may provide potential habitat for this species. The species has not been recorded within the Study Area previously. The closest records lie approximately 8.5 to 9 km west and south-west of the Subject Site (DECC Atlas of NSW Wildlife).   | Yes  | The Diamond Firetail appears to be sedentary and therefore, if present, may be impacted by the Proposal. However, the species is usually encountered in large flocks and is reasonably conspicuous. Therefore, the lack of records may suggest the species is unlikely to be present. |
| <i>Lathamus discolor</i>            | Swift Parrot                                  | Eucalypt woodlands and open forests may provide potential habitat for this species within the Study Area. The Swift Parrot has been previously recorded within the Locality, approximately 2.5 km north-west of the Subject Site (DECC Atlas of NSW Wildlife).   | Yes  | The Proposal has the potential to impact on potential foraging habitat for this species, a rare winter visitor to the area. The species breeds in Tasmania.   |



| Scientific Name                        | Common Name                       | Comments   | Affected Species/<br>Considered further in SIS | Reasoning  |
|--|-----------------------------------|--|--|--|
| <i>Neophema pulchella</i>              | Turquoise Parrot                  | Eucalypt forests and open woodlands with a ground cover of grasses may provide potential habitat for this species within the Study Area. The species has been previously recorded within the Locality (DECC Atlas of NSW Wildlife).  | Yes  | The Proposal has the potential to impact on potential foraging and breeding habitat for this species.  |
| <i>Melanodryas cucullata cucullata</i> | Hooded Robin (south-eastern form) | Woodland within the Study Area may provide potential habitat for this species. The species has not been previously recorded within the Study Area. The nearest record is approximately 13 km west of the Subject Site (DECC Atlas of NSW Wildlife).  | Yes  | Although rare and not previously recorded within the Study Area, the species is sedentary and if present, may be impacted by the Proposal.   |
| <i>Petroica rodinogaster</i>           | Pink Robin                        | Rainforest, open forests and woodlands within the Study Area may provide potential habitat for this species. The species has not been previously recorded within the Study Area. The closest records occur approximately 15.5 km south-east of the Subject Site, recorded in 1988 (BioNet).  | No   | Direct or indirect impacts are unlikely due to the species' mobility, and because the species has not been recorded within 15 km of the Subject Site. Furthermore, DECC (DEC 2005 <sup>‡</sup> ) consider the species to be an extremely rare visitor to the region. |
| <i>Ninox connivens</i>                 | Barking Owl                       | Open forests, woodlands and swamp woodlands within the Study Area may provide potential habitat for this species. The species has not been previously recorded within the Study Area. The closest records of the species are from Dharawal SCA however, the species is not thought to occur there any longer (DEC 2006a). The next closest records lie approximately 15 km east and west of the Subject Site (BioNet). | Yes  | Potential breeding and foraging habitat would be directly impacted by the Proposal.  |
| <i>Ninox strenua</i>                   | Powerful Owl*                     | Eucalypt forests within the Study Area provide potential habitat for the Powerful Owl. The species has been previously recorded within the Study Area, including the Subject Site (DECC Atlas of NSW Wildlife and Biosis Research).  | Yes  | Potential breeding and foraging habitat would be directly impacted by the Proposal.  |
| <i>Tyto novaehollandiae</i>            | Masked Owl                        | Open forest and woodland provide potential habitat for this species within the Study Area. The species has not been previously recorded within the Study Area. The closest records of the species are from Dharawal SCA however, the species is not thought to occur there any longer (DEC 2006a).   | Yes  | Potential breeding and foraging habitat would be directly impacted by the Proposal.  |
| <i>Tyto tenebricosa</i>                | Sooty Owl                         | Rainforest and old-growth forests within the Locality may provide potential habitat for this species. The species has not been previously recorded within the Study Area. The closest records of the species are from Dharawal SCA however, the species is not thought to occur there any longer (DEC 2006a).  | Yes  | Potential breeding and foraging habitat would be directly impacted by the Proposal.  |

| <b>Mammals</b>                  |                           |   |     |  |
|---------------------------------|---------------------------|---|-----|--|
| <i>Cercartetus nanus</i>        | Eastern Pygmy-possum      | Rainforests, sclerophyll forests, tree heath and Banksias provide potential habitat for this species within the Study Area and Locality. The species has not been previously recorded within the Study Area however, a number of records exist within a 10 km radius of the Subject Site (DECC Atlas of NSW Wildlife) including within Dharawal SCA (DEC 2006a).  | Yes | Direct impacts on the species are possible. Indirect impacts caused by dust movement are also possible. Another potential impact is the restriction of movement between local populations, if they occur.                            |
| <i>Dasyurus maculatus</i>       | Spotted-tailed Quoll      | Rainforests, sclerophyll forests and woodlands supporting rock crevices and caves provide potential habitat for this species within the Study Area. The Spotted-tailed Quoll has been previously recorded within the Locality (DECC Atlas of NSW Wildlife).   | Yes | Potential breeding and foraging habitat would be directly impacted by the Proposal.  |
| <i>Petrogale penicillata</i>    | Brush-tailed Rock-Wallaby | Rainforest gullies, sclerophyll forests and open woodlands supporting rocky outcrops may provide potential habitat for this species within the Study Area and Locality. The species has not been previously recorded within the Study Area. The closest records of the species are from Dharawal SCA however, the species is not thought to occur there any longer (DEC 2006a). The next closest record is approximately 20 km south-west of the Subject Site, recorded in 1960 (BioNet).     | Yes | Potential breeding and foraging habitat would be directly impacted by the Proposal.  |
| <i>Mormopterus norfolkensis</i> | Eastern Freetail Bat      | Dry eucalypt forests and woodlands within the Study Area provide potential habitat for this species. The species has been previously recorded within the Locality (DECC Atlas of NSW Wildlife) including within Dharawal SCA (DEC 2006a).   | Yes | Potential breeding and foraging habitat would be directly impacted by the Proposal.  |
| <i>Isodon obesulus</i>          | Southern Brown Bandicoot  | Scrubby vegetation on sandy soil may provide potential habitat for this species within the Study Area. The species has not been previously recorded within the Study Area. The closest records of the species are from Dharawal SCA however, the species is not thought to occur there any longer (DEC 2006a). The next closest record lies approximately 21 km south-west of the Subject Site, recorded in 1997 (BioNet).  | No  | Potential breeding and foraging habitat would be directly impacted by the Proposal although, it is unlikely as the species has not been sighted for many years after being recorded several decades ago in Dharawal SCA (DEC 2006a). |
| <i>Petaurus norfolcensis</i>    | Squirrel Glider           | Dry sclerophyll forests and woodlands supporting abundant hollow-bearing trees provide potential habitat for this species within the Study Area and Locality. The species has not been previously recorded within the Study Area. The closest records of the species are from Dharawal SCA however, the species is not thought to occur there any longer (DEC 2006a). The Squirrel Glider has also been recorded approximately 8.5 km north of the Subject Site (DECC Atlas of NSW Wildlife). | Yes | Potential breeding and foraging habitat would be directly impacted by the Proposal.  |

|  |                            |   |     |  |
|--|----------------------------|---|-----|--|
| <i>Phascolarctos cinereus</i>              | Koala*                     | Eucalypt forests and woodlands within the Study Area may provide potential habitat for this species. The species has been previously recorded within the Study Area (DECC Atlas of NSW Wildlife and <i>pers.comm.</i> ) including Dharawal SCA (DEC 2006a). The largest and most significant population of Koalas on the southern outskirts of Sydney occurs at Wedderburn, approximately 8 km north of the Subject Site (DEC 2006a).   | Yes | Direct impacts on the species are possible. Indirect impacts caused by dust movement are also possible. Another potential impact is the restriction of movement between local populations. |
| <i>Potorous tridactylus</i>                | Long-nosed Potoroo         | Wet and dry sclerophyll forest may provide potential habitat for this species within the Study Area. The species has not been previously recorded within the Study Area. The closest records of the species are from Dharawal SCA however, the species is not thought to occur there any longer (DEC 2006a). The next closest records occur approximately 43 km south-west of the Subject Site (BioNet).  | Yes | Although rare and not previously recorded within the Study Area, the species has a small home range and if present, may be impacted by the Proposal.                                       |
| <i>Pteropus poliocephalus</i>              | Grey-headed Flying-fox*    | Rainforests, open forests and woodlands within the Study Area and Locality provide potential habitat for the Grey-headed Flying-fox. The species has been recorded within the Study Area, including the Subject Site (DECC Atlas of NSW Wildlife and Biosis Research).  | Yes | Potential foraging habitat would be directly impacted by the Proposal.   |
| <i>Miniopterus schreibersii oceanensis</i> | Eastern Bent-wing Bat*     | Rainforests, sclerophyll forests, open woodlands and grasslands within the Study Area and Locality provide potential foraging habitat for this species. The species breeds in caves which are not present within the Subject Site. The species has been recorded within the Study Area, including the Subject Site (Biosis Research).   | Yes | Potential foraging habitat would be directly impacted by the Proposal.   |
| <i>Chalinolobus dwyeri</i>                 | Large-eared Pied Bat       | Dry sclerophyll forests and woodlands within the Study Area may provide potential foraging habitat for this species. The species breeds in caves which are not present within the Subject Site. The species has not been previously recorded within the Study Area. The closest records of the species are from Dharawal SCA however, the species is not thought to occur there any longer (DEC 2006a). The species has also been recorded approximately 9 km north of the Subject Site (DECC Atlas of NSW Wildlife). | Yes | Potential foraging habitat would be directly impacted by the Proposal.   |
| <i>Falsistrellus tasmaniensis</i>          | Eastern False Pipistrelle* | Sclerophyll forests where trees are more than 20 m in height provide potential habitat for this species within the Study Area and Locality. As explained in Table 3, this species was 'possibly' recorded within the Study Area (Biosis Research). The species is also known to occur in Dharawal SCA (DEC 2006a).  | Yes | Potential breeding and foraging habitat would be directly impacted by the Proposal.  |

|  |                                       |   |     |   |
|--|---------------------------------------|---|-----|---|
| <i>Myotis adversus/Myotis macropus</i> | Large-footed Myotis /Southern Myotis* | Water bodies and the surrounding vegetation within the Study Area provide potential foraging habitat, and tree hollows and rocky overhangs and crevices within the Study Area provide potential breeding habitat for this species. This species has been recorded within the Study Area (DECC Atlas of NSW Wildlife and 'probably' by Biosis Research).   | Yes | Potential breeding and foraging habitat would be directly impacted by the Proposal. |
| <i>Saccolaimus flaviventris</i>        | Yellow-bellied Sheathtail Bat         | Wet and dry sclerophyll forest and open woodland within the Study Area may provide potential habitat for this species. The species has not been previously recorded within the Study Area. The closest records of the species are from Dharawal SCA however, the species is not thought to occur there any longer (DEC 2006a). The next closest record occurs approximately 13 km north of the Subject Site, recorded in 2005 (DECC Atlas of NSW Wildlife). | Yes | Potential breeding and foraging habitat would be directly impacted by the Proposal. |
| <i>Scoteanax rueppellii</i>            | Greater Broad-nosed Bat               | Moist gullies in mature coastal forests and rainforests provide potential habitat for this species within the Study Area and Locality. The species has been previously recorded within the Locality (DECC Atlas of NSW Wildlife), including within Dharawal SCA (DEC 2006a).  | Yes | Potential breeding and foraging habitat would be directly impacted by the Proposal. |
| <b>Reptiles</b>                        |                                       |   |     |   |
| <i>Hoplocephalus bungaroides</i>       | Broad-headed Snake*                   | Rocky outcrops, crevices and tree hollows within the Study Area provide potential habitat for this species. The species has been previously recorded within the Study Area (DECC Atlas of NSW Wildlife and Biosis Research), including within Dharawal SCA (DEC 2006a).   | Yes | The Proposal has the potential to impact directly on the Broad-headed Snake.        |
| <i>Varanus rosenbergi</i>              | Rosenberg's Goanna*                   | Heath, woodlands and sclerophyll forests with sandstone outcrops provide potential habitat for this species. The species has been recorded within the Study Area (Biosis Research), including within Dharawal SCA (DEC 2006a).  | Yes | The Proposal has the potential to impact directly on Rosenberg's Goanna.            |

\* = recorded within the Study Area by Biosis Research during current or previous surveys.

## 6.2 Assessment of Habitat

### 6.2.1 Description of Vegetation

Five plant communities were identified as occurring in the Study Area (Figure 5), these are; Exposed Sandstone Scribbly Gum Woodland, Sandstone Gully Apple Peppermint Forest, Sandstone Gully Peppermint Forest, Upland Swamps and Upper Georges River Sandstone Woodland. These plant communities were classified according to Specht (Specht 1970) and named according to the descriptions in *The Native Vegetation of the Woronora, O'Hares and Metropolitan Catchments* (NPWS 2003a).

The area of each plant community within the Subject Site, Study Area and Locality is included in Table 13 below.

**Table 13: Extant area of plant communities mapped within the Locality, Study Area, and Subject Site.**

| <sup>1</sup> Map Unit | Plant Community                                 | <sup>2</sup> Area Within Locality (ha) | Area within Study Area (ha) | <sup>3</sup> Area within Subject Site (ha) |
|-----------------------|---|--|-----------------------------|--|
| MU29                  | Exposed Sandstone Scribbly Gum Woodland (ESSW)  | 4109.2                                 | 197.2                       | 37.8                                       |
| MU26                  | Sandstone Gully Peppermint Forest (SGPF)        | 638.9                                  | 32.1                        | 22.7                                       |
| MU25                  | Sandstone Gully Apple Peppermint Forest (SGAPF) | 1088.9                                 | 2.8                         | -  |
| MU42<br>MU44          | Upland Swamps (US)                              | 407.5                                  | 2.4                         | -  |
| MU35                  | Upper Georges River Sandstone Woodland (UGRSW)  | 764.3                                  | 6.4                         | -  |
|                       | <b>Total Area (ha)</b>                          | <b>7,008</b>                           | <b>241</b>                  | <b>60.5</b>                                |

1. Classification according to NPWS (2003a) mapping.
2. N.B. Additional plant communities have been mapped within the Locality but will not be impacted by the Proposal.
3. Vegetation mapped within the Subject Site by Biosis Research Pty Ltd.

Brief descriptions of each plant community including location within the Study

Area, structural and floristic components, condition and disturbances is provided below.

### ***Exposed Sandstone Scribbly Gum Woodland***

**Location:** Exposed Sandstone Scribbly Gum Woodland was the dominant plant community recorded in the Study Area, occurring along the exposed ridge tops, upslope of Brennans Creek gully.

**Structure:** Using the definitions of Specht (1970), this plant community is classified as a woodland, with canopy trees ranging in height from 8 to 15 m, with 20% canopy cover. The small tree layer reached a height of 6 m and had a projective foliage cover of 10 to 40%. The shrub layer was dense, with 30 to 60% projective foliage cover and reaches a maximum height of between 3 and 5 m. The ground layer was relatively sparse, with 20% projective foliage cover and reaches a maximum height of 0.5 m.

**Canopy trees:** The dominant canopy species in this plant community included *Eucalyptus sieberi*, *Corymbia gummifera*, *E. racemosa* and *E. glodoidea*.

**Midstorey:** Dominated by *Banksia ericifolia*, *B. serrata* and *Leptospermum trinervium*.

**Shrubs:** The dominant species in the midstorey included *Acacia terminalis*, *Banksia spinulosa*, *Bossiaea obcordata*, *Dillwynia retorta*, *Eriostemon australasius*, *Hakea dactyloides*, *H. teretifolia*, *H. sericea*, *Lambertia formosa*, *Persoonia levis*, *P. pinifolia* and *Petrophile sessilis*.

**Ground layer:** Dominant species in the ground layer included *Epacris microphylla*, *Caustis flexuosa*, *Cyathochaeta diandra*, *Entolasia stricta*, *Lomandra cylindrica*, *Lomatia silaifolia*, *Patersoonia glabrata* and *Xanthorrhoea media*.

**Condition/Disturbances:** This plant community was considered to be in good condition, with high native species diversity and all structural layers intact. Existing disturbances include cleared tracks, transmission easements and the existing Stage 1 and 2 coal wash emplacement. This community was also affected by illegal rubbish dumping which is primarily located along unsealed access trails off Appin and Wedderburn Roads. Weed species were present in less than 5 % of the area covered by this community and were confined to areas of physical disturbance including the existing gas pipeline easement, electricity easement, road and trackside edges and near existing mine infrastructure. The dominant weeds recorded were exotic perennial grass species such as *Andropogon virginicus*, *Eragrostis curvula*, *Chloris gayana* and *Cynodon dactylon*.

**Habitat for rare or threatened flora:** *Persoonia hirsuta* was recorded in this plant community (Figure 3). Potential habitat for *Astrotricha crassifolia*, *Eucalyptus camfieldii*, *Darwinia peduncularis*, *Epacris purpurascens* var. *purpurascens*, *Acacia bynoeana*, *Leucopogon exolasius*, *Pomaderris adnata* and *Pultenaea aristata* also occurs in this plant community. This plant community also contained some very large hollow bearing trees. This plant community is not listed as an EEC on the TSC or EPBC Acts.

### ***Sandstone Gully Peppermint Forest***

**Location:** This was the dominant plant community within Brennans Creek valley. This vegetation community typically occurs below the break of slope, below the sandstone outcrops at the valley edge.

**Structure:** This plant community was classified as an open forest according to the definition of Specht (1970). The canopy reached a height of approximately 15 to 20 m, with a projective foliage cover of 30%. Steeper sections of the gully supported taller trees (to 30 m), at a higher density (up to 45% projective foliage cover). The midstorey generally reached a height of approximately 8 m and was relatively sparse in some areas (projective foliage cover of 15%) and more dense in other areas (30% projective foliage cover). Steeper areas supported taller trees in the midstorey (up to 10 m). Underneath is a dense shrub layer (40% projective foliage cover), to a maximum height of 3 m and up to 4 m in steeper areas. The ground layer was sparse, supporting a mix of herbaceous species.

**Canopy trees:** Dominated by *Eucalyptus globoidea*, *E. racemosa*, *E. agglomerata* and *E. piperita*, with *Corymbia gummifera* also occurring on higher slopes.

**Midstorey:** The small tree layer was dominated by *Allocasuarina littoralis*, *Ceratopetalum gummifera*, *Banksia serrata*, *B. ericifolia*, *Elaeocarpus reticulatus*, *Persoonia levis*, *Hakea sericea* and *Leptospermum trinervium*, with juvenile *Eucalyptus* spp. (canopy dominants) also occurring.

**Shrubs:** Dominant shrubs included *Acacia terminalis*, *Banksia serrata*, *B. ericifolia*, *B. spinulosa*, *Dillwynia retorta*, *Dodonaea triquetra*, *Persoonia pinifolia*, *P. levis*, *Petrophile pulchella*, *Platysace linearifolia*, *Leptospermum polygalifolium*, *Lepidosperma laterale*, *Lomandra longifolia*, *Hibbertia nitida* and *Pultenaea daphnoides*.

**Ground layer:** The ground layer was dominated by *Lomandra longifolia*, *L. multiflora*, *Baumea microphylla*, *Epacris pulchella*, *Pteridium esculentum*, *Cyathochaeta diandra*, *Lepidosperma laterale*, *Lomatia silaifolia*, *Patersonia glabrata* and *Woollisia pungens*. *Todea Barbara* was also recorded in this plant

community along the edge of the creek line.

**Condition/Disturbances:** This plant community was considered to be in good condition, with high native species diversity and all structural layers intact. Existing disturbances include cleared tracks, transmission easements and the existing Stage 1 and 2 coal wash emplacements. Weed species were present in less than 5 % of the area covered by this community. Weed species, such as *Ageratina adenophora* and *Juncus acutis* were recorded at isolated locations along Brennans Creek, particularly where fine sediment from mine effluent had accumulated. Some exotic perennial grass species were present in low densities along the existing gas line easement and disturbed areas along road and trackside edges.

**Habitat for rare or threatened flora:** *Persoonia hirsuta* and *Pultenaea aristata* were recorded in this plant community. Potential habitat for *Gyrostemon thesioides* and *Leucopogon exolasius* also occurs in this plant community. This plant community is not listed as an EEC on the TSC or EPBC Acts.

### ***Sandstone Gully Apple Peppermint Forest***

**Location:** Along the northern side of Brennans Creek Dam.

**Structure:** This plant community is classified as an open forest, according to the structural classifications of Specht (1970). The canopy reached a height of 15 m and had a projective foliage cover of 30%. Underneath the canopy was a midstorey supporting small trees to a height of approximately 5 m, with a projective foliage cover of 15%. The shrub layer reached a height of 3 m and had a projective foliage cover of 40 to 50%. The ground layer was relatively dense in some places (projective foliage cover of 60%) and more sparse in others (projective foliage cover of 10%).

**Canopy trees:** Dominant canopy trees included *Eucalyptus globoidea*, *Angophora costata*, *E. piperita*, *Corymbia gummifera*, *E. sieberi* and *E. racemosa*.

**Midstorey:** Dominated by *Banksia serrata*, *Ceratopetum gummiferum* and *Acacia longifolia*.

**Shrubs:** Dominated by *Acacia terminalis*, *Persoonia levis*, *Banksia spinulosa*, *Leucopogon ericoides*, *Hibbertia nitida* and *Leptospermum trinervium*.

**Ground layer:** Dominated by *Lepidosperma filiforme*, *Caustis flexuosa*, *Lomandra* spp., *Cyathochaeta diandra* and *Entolasia stricta*.

**Condition/Disturbances:** This plant community was considered to be in good condition, with a high diversity of native species and all structural layers intact.



The main disturbance to this plant community in the Study Area was the dam itself and cleared picnic areas and access tracks. Weed species were present in less than 5 % of the area covered by this community. Weeds such as *Andropogon virginicus*, were recorded along the access tracks.

**Habitat for rare or threatened flora:** Potential habitat for *Gyrostemon thesioides* and *Leucopogon exolasius* occurs in this plant community. This plant community is not listed as an EEC on the TSC or EPBC Acts.

### *Upland Swamps*

**Location:** Present as small areas of impeded drainage on ridge tops and upper slopes scattered throughout the Study Area. Upland Swamps within the Study Area were of two different types, these are Banksia Thicket (Map Unit 42) and Sedgeland-Heath Complex (Map Unit 44).

**Structure:** Banksia Thicket supported a large shrub layer ranging between 3 - 5 m in height with a projective foliage cover up to 50 %. The ground layer includes a sedge layer to approximately 1 m height and has a projective foliage cover of 40%.

Sedgeland Heath Complex supported a minimal shrub layer ranging between 1 and 3 m with a projective foliage cover of less than 5%. The ground layer was dominated by a dense layer of sedges, herbs and small shrubs to a height of 0.5 m and has a projective foliage cover of 60%.

**Shrubs:** The Banksia Thicket shrub layer was dominated by *Banksia ericifolia*, *Hakea teritifolia* and *Leptospermum polygalifolium*. The shrub layer within the Sedgeland Heath Complex included *Leptospermum trinervium*, *Isopogon anethifolius*, *Calytrix tetragona* and *Leptospermum continentale*.

**Ground layer:** The dominant ground layer species within the Banksia Thicket included sedges such as *Schoenus brevifolius*, *Lepidosperma* sp. and *Leptocarpus tenax*. The dominant ground layer within the Sedgeland Heath Complex included *Hemigenia purpurea*, *Cyathochaeta diandra*, *Ptilothrix deusta* and *Anisopogon avenaceus*.

**Condition/Disturbances:** This plant community was considered to be in good condition. Previous disturbances include clearing for tracks and a gas pipeline. No weed species were observed in any of the swamps within the Study Area.

**Habitat for rare or threatened flora:** Potential habitat for *Acacia baueri* ssp. *aspera*, *Boronia deanei*, *Cryptostylis hunteriana*, *Epacris purpurascens* var. *purpurascens* and *Pultenaea aristata* occurs in upland swamps communities within the Study Area. Upland Swamps present within the Study Area are not

listed as an EEC on the TSC or EPBC Act.

### ***Upper Georges River Sandstone Woodland***

**Location:** This plant community was located around Brennans Creek Dam and in the north-east of the Study Area.

**Structure:** This plant community is considered to be woodland, according to the vegetation structural classification of Specht (1970). The canopy reached a height of between 10 and 20 m and had a projective foliage cover of 20%. Underneath the canopy was a layer of small trees, which reached a height of 8 m and had a projective foliage cover of 10%. The shrub layer reached a height of 4 m, with a projective foliage cover of 20% and the understorey supported a relatively sparse layer of grasses and herbs.

**Canopy trees:** Dominant canopy species included *Eucalyptus racemosa*, *E. punctata*, *Corymbia gummifera* and *E. sieberi*.

**Midstorey:** Dominant small trees included *Banksia serrata*, *B. ericifolia* and *Leptospermum trinervium*.

**Shrubs:** The shrub layer was dominated by *Banksia spinulosa*, *Exocarpus stricta* and *Eriostemon australasius*.

**Ground layer:** Dominated by *Themeda australis* and *Lomandra cylindrica*.

**Condition/Disturbances:** This plant community was considered to be in good condition with a high diversity of native species and all structural layers intact. Disturbances included the dam and associated access tracks and transmission lines. The main disturbance to this plant community in the Study Area has arisen as a result of the Brennans Creek Dam and a cleared picnic areas and access tracks. Weed species were present in less than 5 % of the area covered by this community. Weeds such as *Andropogon virginicus*, were recorded along the access tracks.

**Habitat for rare or threatened flora:** Potential habitat for *Astrotricha crassifolia*, *Epacris purpurascens* var. *purpurascens*, *Grevillea parviflora* ssp. *parviflora* and *Melaleuca deanei* occurs in this plant community. This plant community is not listed as an EEC on the TSC or EPBC Acts.

## **6.2.2 Description of Fauna Habitat Values**

Please refer to Section 6.2.1 above for information relating to the vegetation habitat values as they relate to each plant community including location, structure, floristics (dominant species within each stratum), condition,

disturbance history and potential habitat for threatened species. A discussion of fauna habitat values and fire history is provided below.

### **Fauna Habitats**

Despite current on-site activities, sandstone habitats within the Study Area were in good condition, as were surrounding habitats to the east, south and north. Disturbances included vegetation loss from coal wash emplacement, power and gas easements, channelisation, tree die back in the upper sections of Brennans Creek within existing water treatment ponds and evidence of minor subsidence below Brennans Creek Dam.

The Study Area is expected to provide habitat resources for a range of species common to the area. It is also likely to provide habitat that would assist fauna movements to and from surrounding areas, including Dharawal State Conservation Area to the east and the Metropolitns Water Catchment areas to the south west.

### ***Open Forest and Woodland***

The dominant vegetation was woodland with an open shrub understorey that graded to open forest with a dense ground cover within the gullies. A variety of tree hollows were recorded throughout the area, which reflects the mature stage of most sections of woodland and forest and these are likely to provide suitable den and nesting habitat for a range of common birds and arboreal mammal species, including the Sulphur-crested Cockatoo (*Cacatua galerita*) and forest dwelling micro-bats. Locally recorded threatened species requiring large tree-hollows for mating and nesting include the Powerful Owl (*Ninox strenua*), Glossy Black-cockatoo (*Calyptorhynchus lathami*), Squirrel Glider (*Petaurus norfolcensis*) and Eastern Pygmy-possum (*Cercartetus nanus*).

### ***Fallen Timber and Bark***

Fallen branches and bark (scattered throughout wooded areas) provided refuge and nesting habitat for a range of terrestrial animals. Many invertebrates and amphibians rely on these 'moisture-retaining' microhabitats to over-winter or as refuge during periods of drought. Similarly, many reptiles rely on ground litter and debris for shelter and foraging. Larger hollow logs provided potential denning and nesting habitat for small to medium sized mammals including the threatened Spotted-tailed Quoll (*Dasyurus maculatus*).

### ***Rocky outcrops, Caves and Overhangs***

Characteristic of the local geology, sandstone outcrops were featured throughout the Study Area, including overhangs, exfoliating surfaces and deep cracking. These habitats provided refuge for a range of reptile species including

Blind Snake (*Ramphotyphlops nigrescens*), Southern Leaf-tailed Gecko (*Phyllurus platurus*), Lesueur's Velvet Gecko (*Oedura lesueurii*) and the threatened Broad-headed Snake and Rosenberg's Goanna (*Varanus rosenbergi*). The latter species require these habitats for over-wintering, thermoregulation and shelter and as a refuge for neonates, juveniles and prey species.

### ***Ponds, Dams, Creeks and Drainage Lines***

Wet depressions (heath/sedgeland), creeks and drainage lines provided optimal habitat for a range of vertebrate (amphibians, reptiles and small ground-dwelling mammals) and invertebrate species. About six small water treatment ponds occur within the West Cliff facility, but most were unsuitable habitat. However, Brennans Creek Dam and Brennans Creek, provided better opportunities for wetland flora and fauna.

The lower sections of Brennans Creek at West Cliff have been altered by existing land use but were in better condition than the highly disturbed upper reaches. Where emplacement has taken place (Stage 1 and Stage 2), channelisation (creek diversion) and sedimentation have caused a decline in aquatic habitat condition.

The water treatment ponds were considered to be in poor condition and unlikely to provide potential habitat for threatened species. The upper reaches of Brennans Creek were considered to be in poor to moderate condition and provided habitat for common species such as Blue Mountains Tree Frog (*Litoria citropa*) and Lesueur's Frog (*Litoria lesueuri*). The lower reaches of Brennans Creek, its tributaries, and Brennans Creek Dam were considered to be in moderate to good condition and potentially may provide habitat for threatened frog species such as Red-crowned Toadlet (*Pseudophryne australis*), Littlejohn's Tree Frog (*Litoria littlejohni*) and Giant Burrowing Frog (*Heleioporus australiacus*).

### ***Upland Swamps***

Like understorey vegetation, upland swamps provide important fauna refuge and foraging habitat for a range of small birds and mammals, as well as other ground-dwelling species. Species that may frequent this type of habitat include the regionally significant Southern Emu-wren (*Stipiturus malachurus*) and Buff Banded Rail (*Gallirallus philippensis*) and the threatened Rosenberg's Goanna (*Varanus rosenbergi*) and Giant Burrowing Frog.

Upland swamps within the Study Area were considered to be in good condition.

### **Fire History**

Fire history records covering the surrounding Dharawal State Conservation Area and Sydney Metropolitan Catchment Area Land are maintained by the

Sydney Catchment Authority and National Parks and Wildlife Service. Fire history records in these areas include five major wildfires in 1965/66, 1968/69, 1990/91, 2001/02 and 2005/06 each of which burnt the majority of the area within the reserves (NPWS 2006b). The last major fire at the West Cliff Study Area started near the township of Appin on December 25<sup>th</sup> of 2001 and burnt through to Helensburg in January 2002 (NPWS 2006b).

Based on surveys of the Study Area the 2001/02 fire burnt a significant portion of the West Cliff Colliery lease area and the surrounding Dharawal State Conservation Area and Sydney Metropolitan Catchment Area Land. A large proportion of the Subject Site was not burnt in the 2001/02 fire. The unburnt areas are discernable in aerial photographs of the Study Area (see Figure 2) as the more densely vegetated areas where bare ground is more or less not visible.

### 6.2.3 Discussion of Corridors

#### Wildlife Corridors and Connectivity

Wildlife corridors can be best defined as “retained and/or restored systems of (linear) habitat which, at a minimum enhances connectivity of wildlife populations and may help them overcome the main consequences of habitat fragmentation” (Wilson and Lindenmayer 1995). Alternatively they can be defined as “linear habitats that differ from a more extensive surrounding matrix. Frequently, they link one or more patches of habitat in the landscape, but they may also occur as isolated lines of habitat” (Bennett 1990).

A corridor serves a number of different functions in terms of wildlife conservation:

- Providing increased foraging area for wide-ranging species;
- Providing cover for movement between habitat patches, and enhancing the movement of animals through sub-optimal habitats;
- Reducing genetic isolation;
- Facilitating access to a mix of habitats and successional stages to those species which require them for different activities (e.g. foraging or breeding);
- Providing refuge from disturbances such as fire;
- Providing habitat in itself; and,
- Linking wildlife populations and helping to maintain immigration and re-colonisation between otherwise isolated patches. This in turn may

help reduce the risk of population extinction (Wilson and Lindenmayer 1995).

The functioning of a corridor can be best described in terms of its connectivity, of which there are two components.

#### *1. Structural connectivity*

This is the mappable spatial continuity of the corridor. This can include the distance over which the corridor extends, the width, the number of gaps and the presence of habitat nodes.

#### *2. Functional connectivity*

This is a measure of the ability of a species to move between two habitats. The functional connectivity of a corridor depends not only on its spatial continuity, but also on factors such as behaviour of the species, the scale of the species' movements, and its response to the width and quality of habitat in the corridor (Bennett 1990).

Some important considerations in corridors include:

#### *Gaps*

Gaps in a corridor can disrupt animal movements along a corridor. What constitutes a gap and its effectiveness as a barrier would depend on the species. For example, a 3 m dirt track across a corridor may inhibit the movement of Bush Rats and Brown Antechinus (Barnett *et al.* 1978), but is unlikely to inhibit the movement of large more mobile species. Similarly, gaps in the tree canopy may inhibit movements of arboreal animals but are unlikely to inhibit the movement of terrestrial species.

#### *The presence of habitat nodes*

Incorporation of nodes of habitat along the corridor can increase its effectiveness by providing additional habitat in which animals can pause during lengthy movements, or maintain a larger breeding population. Habitat nodes can include small forest patches adjacent to corridors.

#### *Quality of habitat in the corridor*

If animals are to live in and use a corridor for movements then it is best if there is an availability and reliability of essential resources.

#### *Edge effects*

As corridors are linear structures it means that the ratio of perimeter to area is

high and as a consequence corridors are particularly vulnerable to edge effects. Edge effects can include:

- Microclimate changes;
- Changes in the composition and structure of plant communities; and,
- Invasions of edge specialist species into the corridor (e.g. Noisy Miners in Australia inhabit the edges of patches and can be aggressive and territorial towards small insectivorous birds: Loyn *et al.* 1983)

Edge effects appear to be greatest when there is a sharp contrast between the two types of habitats.

#### *Width of corridor*

This is probably one of the most important considerations about a corridor. The wider the corridor the greater the number of habitat elements that can be included and hence the range of species that can use the corridor increases. A number of studies have shown that species diversity in a corridor increases with the width of the corridor (Stauffer and Best 1980, Arnold *et al.* 1987, Recher *et al.* 1987).

#### *Buffers*

The designation of buffer areas may assist to protect sensitive habitats within corridors. They can reduce the distance that edge effects penetrate into the corridor itself. Further, if of the same or similar habitat they can act as habitat nodes and increase the width of the corridor.

#### *Riparian habitat as a corridor within a woodland matrix*

Dendy (1987) defines a wildlife corridor as a narrow strip of hospitable territory traversing inhospitable territory providing access from one area to another. Riparian systems usually consist of wetter, denser forests, which traverse a drier landscape. They often originate in larger tracts of wet forest at their headwaters, and may encounter patches of similar habitats during their course. For animal species that require wet forests, riparian strips meet the requirements of a wildlife corridor. Corridors are also important because they maintain genetic variation and because natural corridors, such as riparian vegetation, may be important habitats in their own right (Simberloff and Cox, 1987).

Wider corridors (provided they are well vegetated) allow a greater number of species to move along them, and provide more breeding habitat (Saunders and de Rebeira, 1991). This is because narrow corridors contain less habitat and have greater edge effects (Soule and Gilpin, 1991). Most studies of corridors have demonstrated that a majority of the animal species found in the corridor are in

fact not wholly dependent on that vegetation, but instead use it for roosting and nesting. However, as corridor width increases so does the number of species dependent on the corridor vegetation (Lynch and Saunders, 1991). Therefore, wider riparian systems should contain a greater number of riparian-dependant species, and less upland or woodland-dependant species. Little quantitative work has been conducted on the affect of width of riparian habitats, but it is known that the number of species does increase as width increases in riparian habitats (England et al, 1981).

In well-watered regions streamlines form classic corridors, although the high level of moisture present in these environments may make them unsuitable as corridors for many species (Bridgewater, 1987). Obviously high moisture levels will have little or no effect to migrating birds. In arid regions, typically dry watercourses have many anastomosing branches which provide more avenues for dispersal (Bridgewater, 1987).

Corridors clearly serve a useful, perhaps vital, function in promoting local movements of animal species (Saunders and de Rebeira, 1991). It is believed that riparian habitats also serve the same functions (Dickson and Huntley, 1985), but a number of factors must first be considered. Firstly, the width of riparian habitats is very variable, and dispersing species may encounter problems in narrow sections due to edge effects (Watson, 1991). Secondly, rivers are rarely straight lines and therefore their associated habitats contain many doglegs and turns. Soule and Gilpin (1991) have demonstrated that a dogleg greatly reduces corridor capability. Riparian habitats probably do aid in dispersal of fauna, but their capability might not be as high as equivalent 'ideal' corridors.

Riparian corridors may also have detrimental effects, such as a barrier to dispersal of small mammals (Savidge, 1973) and aiding the dispersal of pest species such as rabbits, cats and foxes (Watson, 1991).

### **Corridors and Connectivity in the Area Surrounding the Proposal**

There are no non-riparian corridors (e.g. strips of vegetation through an otherwise cleared landscape) and no areas formally identified as wildlife corridors surrounding the Proposal. The Study Area lies within a massive expanse of continuous vegetation, which extends from the southern suburbs of Sydney 30-40 km to the north, the coast and Wollongong 20 km to the east, Appin 5 km to the west and Robertson 50 km to the south. The only major interruptions (barriers) within this area of continuous vegetation are Appin-Bulli Road, Mt Keira/Picton Road, and the Princes Highway/F6 Freeway. So with respect to corridors within the Study Area, the Proposal does not impact on these as they are not present in the form normally referred to as corridors (e.g. strips of vegetation through an otherwise cleared landscape). However, the surrounding landscape consists of more open Ridgetop Woodland that is interspersed



by denser and more mesic Gully Forest along rivers and creek lines, and this Gully Forest would act as a wildlife corridor for many species moving through the broader landscape. Although the Proposal would create a barrier to wildlife moving up Brennans Creek, the creek line is already blocked by the current coal wash emplacement and Brennans Creek Dam, and there are more suitable waterways with Gully Forest in the surrounding area that wildlife could utilise as a corridor (e.g. Georges River, Stokes Creek and O'Hares Creek). Additionally, these waterways would enable wildlife to disperse through the wider region, while Brennans Creek is a small waterway that would not facilitate movement beyond its headwaters. Although the Proposal will interrupt wildlife movements along Brennans Creek, it will not have a significant impact on the movement of any species within the wider region.

## **6.3 Affected Subject Species Information**

### **6.3.1 Discussion of Local And Regional Abundance**

Please refer to the species profiles in Section 6.3.5 and 6.3.6 for information specific to the known local population of each affected subject species.

### **6.3.2 Discussion of Other Known Local Populations**

Please refer to the species profiles in Section 6.3.5 and 6.3.6 for information specific to the known local population of each affected subject species.

### **6.3.3 Discussion of Habitat Utilisation**

Please refer to the species profiles in Section 6.3.5 and 6.3.6 for information specific to the habitat utilisation of each affected subject species.

### **6.3.4 Discussion of Conservation Status**

Please refer to the species profiles in Section 6.3.5 and 6.3.6 for information specific to the conservation status of each affected subject species.

### **6.3.5 Threatened Flora Species Profiles**

Unless otherwise stated the information contained in the following species profiles has been derived from the NSW Governments Bionet database and DECC's Threatened Species profiles and/or Environmental Impact Assessment Guidelines for each species.

## *Acacia baueri* subsp. *aspera*

### Discussion of Conservation Status

*Acacia baueri* subsp. *aspera* is listed as Vulnerable on both the TSC Act and EPBC Act. The species has a ROTAP listing of 2R (Briggs and Leigh 1995) suggesting a distribution ranging over less than 100 km. According to recovery actions listed for this species (DEC 2005a) it's conservation status may be upgraded to endangered if a significant number of new populations are not located during targeted survey.

*Acacia baueri* subsp. *aspera* is restricted to the Sydney region, occurring to the west of Sydney on the Kings Tableland in the Blue Mountains and sporadic locations on the Woronora Plateau to the south of Sydney (NPWS 2000a). Occurrences of the species within the Study Area are likely to be near the southern limit of its distribution.

This species is poorly represented within conservation reserves, with the majority of sites known from Crown and private lands. *Acacia baueri* subsp. *aspera* has been recorded from the Blue Mountains National Park, Royal National Park, Dharawal State Conservation Area (Fairley 2004) and within the Sydney Catchment Area at Mt Keira (NPWS 2000a).

The conservation status of this species may also be affected by Key Threatening Processes as listed under Schedule 3 of the TSC Act. Key Threatening Processes listed on the TSC Act relevant to the Proposal that may impact on potential habitat for *Acacia baueri* subsp. *aspera* include:

- 'Clearing of native vegetation' - approximately 60.5 ha of native vegetation including approximately 37.8 ha of ESSW will be cleared for the Proposal;
- 'Ecological consequences of high frequency fires' – the Proposal may alter the frequency of fires in the area. In the management of the land at West Cliff, BHPBIC will ensure that the lifecycle of threatened species that may be impacted by fire are considered in consultation with the DECC and other experts prior to any hazard reduction burning program;
- 'Invasion of native plant communities by exotic perennial grasses' – the Proposal may increase the threat of weed invasion by exotic perennial grasses, particularly given the presence of exotic perennial grasses in the vicinity of the existing emplacement areas and disturbed edges, however, management of weeds in the Study Area as described in the VFMP will mitigate this impact.
- 'Bushrock removal'- the Proposal would involve the removal of bushrock

including large rock platforms and outcrops which are potential habitat for this species,

- ‘Alteration of habitat following subsidence due to longwall mining’ – the Proposal will not increase subsidence related impacts in the Study Area.

To date, no recovery plan or threat abatement plan has been prepared for this species. DECC (2005a) has listed 15 priority actions to help recover this species. *Acacia baueri* subsp. *aspera* was not recorded in the Study Area despite targeted searches over several years and seasons, therefore not all priority actions are relevant to the Proposal. Those priority actions that are relevant to the Proposal include:

- Incorporate a suitable fire regime for the species into land management practices –BHPBIC will consider the impacts of any proposed hazard reduction burning on the lifecycle of *Acacia baueri* subsp. *aspera*.
- Identify, map and survey potential habitat –potential habitat for *Acacia baueri* subsp. *aspera* within the Study Area has been mapped and is included in Figure 5. Targeted surveys for this species were undertaken in these areas and the species was not recorded.

On the basis *Acacia baueri* subsp. *aspera* was not recorded in the Study Area, the Proposal is not considered likely to interfere with the recovery of the species.

### Discussion of Habitat Utilisation

*Acacia baueri* subsp. *aspera* was not recorded within the Study Area despite current and previous targeted surveys. The species is considered to have potential habitat within the Study Area and is known to occur in low, damp heathlands, often on exposed rocky outcrops and appears to prefer open conditions; rarely observed where there is any shrub or tree canopy development (NPWS 2000a).

On the Woronora Plateau *A. baueri* subsp. *aspera* occurs in sandstone woodland in association with *Eucalyptus sieberi*, *E. rossii*, *Allocasuarina distyla* and *Banksia ericifolia*. The geology is Hawkesbury Sandstone and soil landscapes include Maddens Plains, Bundeena and Lucas Heights (NPWS 2000a).

Specific areas of potential habitat within the Study Area include sites where shallow soils overlay sandstone benches, the base of sandstone benches and boulders and the upslope plateau areas (T. James pers. com). As with other *Acacia* species, *A. baueri* subsp. *aspera* has been observed in recently burnt areas, a habitat feature that is also well represented along ridge tops of the Study Area.

## Discussion of Local and Regional Abundance

### *Local*

*Acacia baueri* subsp. *aspera* was not recorded within the Study Area despite current and previous targeted surveys. The species has been recorded from at least 3 locations on the Woronora Plateau; these are Wedderburn, Dharawal State Conservation Area and Mt Keira (DECC 2007). Known populations are small (mostly <30 plants) and isolated (NPWS 2000a).

Within the Locality, the largest known population occurs at Wedderburn, immediately north of the Study Area. The Wedderburn population includes 60 plants within an area of 0.25 ha (NPWS 2000a). DECC records (Insert DECC 10k ref) indicate the species occurs approximately 6 km to the south-east of the Subject Site in the Dharawal State Conservation Area. A previous record of the species in the local area includes an unknown number of individuals near Appin Road approximately 5 km south-east of the Study Area (T. James, pers. comm.).

One plant has been recorded at Mt Keira (Fairley 2004) to the south-east of the Study Area.

### *Regional*

Very little information is available on the regional distribution of this species. Regional populations include those at Warumbul in the Royal National Park and Kings Tableland near Wentworth Falls in the Central Blue Mountains. Records in the Blue Mountains include four locations in the vicinity of Wentworth Falls and one location off Mt Irvine Road to the east of Mt Wilson (Bionet, 2004). Thirty plants have previously been recorded from one population within the Blue Mountains National Park (NPWS 2000a).

*Acacia bynoeana*

**Bynoe's Wattle**

## Discussion of Conservation Status

*Acacia bynoeana* is listed as Endangered on the TSC Act and Vulnerable on the EPBC Act. The species has a ROTAP listing of 3VC (Briggs and Leigh 1995) suggesting a distribution ranging over 100 km. More recent records indicate the species has a north-south range of 270 km and east-west range of 100 km (Driscoll 2006).

*Acacia bynoeana* is endemic to central eastern NSW, and is distributed from the Hunter district and Central Coast south to Berrima and Mittagong in the Southern Highlands and West to Lithgow. At the time of gazettal (1999) as an endangered

species (TSC Act), *A. bynoeana* was known from about 30 locations (NSW Scientific Committee 1999a) with the current records indicating approximately 356 known locations (Driscoll 2006).

*Acacia bynoeana* has been recorded within several conservation areas including the Blue Mountains, Royal, Tarlo River, Wollemi, Yengo and Marramorra National Parks Castlereagh, Agnes Banks Nature Reserves. The species was also known to occur within Ku-Ring-Gai Chase National Park, however subsequent targeted searches have failed to record this species here. Populations are also known to exist within Bargo, Colymea, Jiliby, Lake Macquarie, and Maroota Ridge State Conservation Areas and Berowra Valley Recreation Park.

The conservation status of *Acacia bynoeana* may also be affected by Key Threatening Processes as listed under Schedule 3 of the TSC Act. Key Threatening Processes listed on the TSC Act relevant to the Proposal that may impact on potential habitat for *Acacia bynoeana* include:

- ‘Clearing of native vegetation’ - approximately 37.8 ha of ESSW will be cleared for the Proposal;
- ‘Ecological consequences of high frequency fires’ – the Proposal may alter the frequency of fires in the area. In consultation with DECC and other experts, BHPBIC will consider the impact of any hazard reduction burn programs on the lifecycle of threatened species known to occur in the Study Area.
- ‘Invasion of native plant communities by exotic perennial grasses’ – the Proposal may increase the threat of weed invasion by exotic perennial grasses, particularly given the presence of exotic perennial grasses in the vicinity of the existing emplacement areas and disturbed edges; however, management of weeds on Study Area as described in the VFMP will mitigate this impact.
- ‘Bushrock removal’- the Proposal would involve the removal of bushrock including large rock platforms and outcrops which are potential habitat for this species. Although the listing of bushrock removal under the TSC Act makes specific reference to *Acacia bynoeana*, observations of this species in the Study Area were generally away from bushrock.

To date, no recovery plan or threat abatement plan has been prepared for this species. DEC (DEC 2005c) has listed 12 priority actions to help recover this species, of these, the following are considered relevant to the Proposal:

- Liaise with private and public land managers to facilitate the preparation and implementation of management plans that address threatening processes –

BHPBIC will consider the lifecycle of *Acacia bynoeana* in their management of the land at West Cliff, in consultation with DECC or other experts.

- Public authorities undertaking road, trail, or easement maintenance activities in potential habitat are to ensure that planning and maintenance staff are aware of the species and that processes are in place to avoid impacting upon it – *Acacia bynoeana* is known to occur along existing easements and roads within the Study Area. The locations of *Acacia bynoeana* populations in the Study Area have been mapped and will be considered prior to any maintenance works being undertaken at West Cliff that may impact the species. All records of this species from the current assessment will be provided to DECC. It is the responsibility of DECC to ensure local land managers are aware of this species' presence locally.
- Incorporate Study Area specific threat abatement measures for the species into Plan of Management for sites in council or crown reserves – The VFMP includes specific measures to ensure this species is managed appropriately at West Cliff.
- Ensure that sites on crown land are appropriately classified and managed – The VFMP includes specific measures to ensure this species is managed appropriately at West Cliff.
- Restrict access to sites, where necessary – the locations of *Acacia bynoeana* populations have been mapped and will be considered prior to any works being undertaken at West Cliff. – The VFMP includes specific measures to ensure this species is managed appropriately at West Cliff.
- Undertake targeted bush regeneration works, where required – The VFMP includes specific measures to ensure this species is managed appropriately at West Cliff and will include appropriate vegetation of the West Cliff Site.
- Retain vegetative linkages between sites where possible – the Proposal will result in the fragmentation of known habitat for the species in the Study Area.

The Proposal at West Cliff may impact on the recovery of the species considering that 11 plants will be cleared with a total of 282 plants recorded within the Study Area. The VFMP includes specific measures to ensure this species is managed appropriately at West Cliff.

### **Discussion of Habitat Utilisation**

*Acacia bynoeana* is known to occur in heath and dry sclerophyll forest. The soil substrate is typically sand or sandy/clay often with ironstone gravels and is usually very infertile and well drained. Within the Study Area, the distribution of

*Acacia bynoeana* corresponds to the Lucas Heights (lu) soil landscape as mapped by Hazelton (1990). This species appears to prefer open, sometimes disturbed sites such as trail margins, edges of roadside spoil mounds and in recently burnt open patches (DEC 2005a). A recent review of the species by Driscoll (2006) suggests that its occurrence along trail edges and disturbed areas is a consequence of the trails having been established through existing populations.

During the current surveys *Acacia bynoeana* was recorded within the Subject Site and from various locations within the Study Area. These recordings were in habitat types in concordance with those stated by DEC (2005a) and were concentrated in open, disturbed sites including trail margins, edges of roadside spoil mounds, areas disturbed by ants, and in relatively open areas that had been recently burnt (< 5 yr). The species was recorded in deep sandy soils on broad flat ridges and plateaus, generally in areas where sandstone outcropping was absent. Soils were notably bare with low leaf litter coverage.

Disturbance such as fire is known to promote the germination of the acacia species (McDougal 1996). Unburnt areas have also been considered as potential habitat for the species as it is likely to be present in the soil-stored seed bank.

*Acacia bynoeana* is a clonal species and is known to spread via underground stems, which makes abundance counts difficult (Driscoll 2006) and resulting in clustered groups within populations. The species has a patchy distribution across the Study Area where it was recorded from 4 discrete locations. The largest local population of this species, however, was recorded in the cleared and eroded roadside batter along Wedderburn Road.

Individuals within the Study Area varied in size from immature seedlings to mature specimens which reached a maximum height of 30 cm, never reaching 1 m. Many specimens were multi-stemmed and suckered or coppiced from a woody rootstock. Most individuals were in flower at the time of survey and few specimens were observed with dried seed pods, presumably set during previous flowering seasons. Based on these observations, populations in the Study Area exhibit active recruitment that appears to be related to disturbances.

Known habitat within the study is predominantly within or adjacent to disturbed remnants of Exposed Sandstone Scribbly Gum Woodland. Typical vegetation associations included a dominant canopy of *Eucalyptus racemosa*, *Corymbia gummifera* and *E. oblonga* with a sparse understorey of shrubs to 3 m high including *Leptospermum trinervium* and *Isopogon anemonifolius* and ground layer including *Cyathochaeta diandra*, *Anisopogon avenaceus* and *Poranthera ericifolia*.

Approximately 37.8 ha of ESSW will be directly impacted by the Proposal, this equates to 0.9 per cent of the extent of similar vegetation in the Locality, and 0.1

per cent of the extent of similar vegetation in the SCA catchment Areas mapped by NPWS (2003).. Potential habitat for this species within the Locality has been mapped in Figure 5.

### **Discussion of Local and Regional Abundance**

The number of individuals within populations is difficult to estimate as plants are known to spread via underground stems and groups of individuals may represent clonal suckers from one plant. On this basis, abundance counts used in this report may be inflated and are based on individual clumps which arise from a single stem or rootstock.

Abundance records for the species vary and according to the NSW Scientific Committee determination (1999a) ranges from 1-5 plants although some recordings include counts of 30-50 individuals. More recent records (Driscoll 2006) suggest population sizes range from 2-3110 plants.

#### ***Local***

Five separate sub-populations (groups within 1 km of each other) of this species were recorded within the Study Area. The total number of *A. bynoeana* recorded in the current study was estimated to be >1942 individuals, including 282 within the Study Area, >189 individuals within the boundaries of Dharawal State Conservation Area, and > 1320 individuals along edges both sides of Appin Road and Wedderburn Road, directly south of West Cliff Colliery. The largest sub-population within the Study Area is approximately 100 m to the west of the Emplacement, where 228 individuals were counted.

Given the estimated size of these populations and comparison with known population sizes elsewhere (Driscoll 2006), records gathered in the Study Area and Locality are among the largest population sizes known. The location of these records is shown in Figure 8.

One recording of this species is known within a 10 km radius of the Study Area and is located approximately 6 km to the South West of the Subject Site (DECC 2007). Other recordings in the Locality include a population off Wedderburn Road to the north of West Cliff (D. Keith. pers. comm.).

#### ***Regional***

Records to the south-west of the Study Area within the Wingecarribee LGA include a count of 12 individuals (Driscoll 2006). Significant populations of this species are known in the Blue Mountains area (DEC 2005c) although more recent records suggest large populations also exist in the Lake Macquarie State Conservation Area where it is estimated that greater than 1600 plants are present



within one hectare.

Recent regional records include the Colymea and Parma Creek areas west of Nowra (DEC 2005a). On the NSW central coast and tablelands, the species is known from a few isolated locations. Other specific regional locations where the species has been recorded include Morisset, Killara, Middle Harbour, Cooks River, Wilberforce, Maroota, Agnes Banks, Falconbridge, Wentworth Falls, Kulnura, Morisset, Loftus, Appin and Hill Top (McDougal 1996). Records also exist in the Hunter Valley near Kurri Kurri (RBG 2005). Biosis Research also recently recorded this species within the Cordeaux Catchment area.

### *Astrotricha crassifolia*

### Thick Leaf Star Hair

#### Discussion of Conservation Status

*Astrotricha crassifolia* is listed as Vulnerable on both the TSC and EPBC Acts. The species has a ROTAP listing of 3VC (Briggs and Leigh 1995) suggesting a distribution ranging less than 100 km.

*Astrotricha crassifolia* is known from Warrah, Mt Ettalong, Umina Beach, Mt Wondabyne, Patonga (Gosford LGA) and on the Woronora Plateau (Sutherland and Campbelltown LGAs). There is also a record from near Glen Davis (DEC 2005d). The species is also known to occur in Victoria.

Limited information is available on the distribution of *Astrotricha crassifolia* and it is assumed to be poorly represented within conservation reserves. This species has been recorded from within the Brisbane Water National Park, Royal National Park and Bournda National Park on the NSW South Coast (DEC 2005d).

The conservation status of this species may also be affected by Key Threatening Processes as listed under Schedule 3 of the TSC Act. Key Threatening Processes listed on the TSC Act relevant to the Proposal that may impact on potential habitat for *A. crassifolia* include:

- ‘Clearing of native vegetation’ - approximately 60.5 ha of native vegetation, including 37.8 ha of ESSW will be cleared for the Proposal;
- ‘Ecological consequences of high frequency fires’ – the Proposal may alter the frequency of fires in the area. In consultation with DECC and relevant experts, BHPBIC will consider the impact of any proposed hazard reduction program on threatened species
- ‘Invasion of native plant communities by exotic perennial grasses’ – the

Proposal may increase the threat of weed invasion by exotic perennial grasses, particularly given the presence of exotic perennial grasses in the vicinity of the existing emplacement areas and disturbed edges, however, management of weeds on Study Area as described in the VFMP will mitigate this impact.

To date, no recovery plan or threat abatement plan has been prepared for this species. DEC (2005d) has listed 12 priority actions to help recover this species. As *Astrotricha crassifolia* was not recorded in the Study Area, not all of the priority actions are relevant to the Proposal. Those that are considered relevant include:

- Identify, map and survey potential habitat (particularly potential habitat in Ku-ring-gai Chase NP) – potential habitat for *Astrotricha crassifolia* within the Study Area has been identified and mapped and is shown in Figure 5. *Astrotricha crassifolia* was not recorded in the potential habitat for the species in the Study Area despite targeted searches.

This species is not considered a cryptic species and if present should have been recorded in the Study Area. On the basis *Astrotricha crassifolia* was not recorded in the Study Area the Proposal is not considered likely to interfere with above listed recovery actions.

### **Discussion of Habitat Utilisation**

*Astrotricha crassifolia* was not recorded within the Study Area despite current and previous targeted surveys. The species is considered to have potential habitat within the Study Area and is known to occur in sandstone ridgetop woodland (DEC 2005d). Vegetation associations include typical sandstone genera such as *Hakea*, *Banksia* and *Xylomelum* (Benson and McDougall 2000c) all of which occur in the Study Area. The species is known to occur on infertile, shallow to deep loamy soils derived from sandstone (Benson and McDougall 2000c). *Astrotricha crassifolia* resprouts following fires (DEC 2005d) and potential habitat in the Study Area is also likely to include all portions of the Study Area that were impacted by fires within the last 5 years.

### **Discussion of Local and Regional Abundance**

#### ***Local***

The abundance of this species is unknown (Briggs and Leigh 1996a). Please refer to conservation status for the known distribution of this species. No records of this species are listed within 10 km of the Study Area (DECC 2007).

***Regional***

As per local abundance above.

***Boronia deanei*****Deane's Boronia****Discussion of Conservation Status**

*Boronia deanei* is listed as Vulnerable on both the TSC and EPBC Acts. The species has a ROTAP listing of 2VC (Briggs and Leigh 1995) suggesting a distribution ranging less than 100 km.

*Boronia deanei* is known from the far south-east of NSW and the Blue Mountains (including the upper Kangaroo River near Carrington Falls, the Endrick River near Nerriga and Nalbaugh Plateau), mainly in conservation reserves (DEC 2005e). This species has been recorded from within the Blue Mountains NP, Buderoo NP, Kanangra Boyd NP, Fitzroy Falls NP, Morton NP, and Nalbaugh NP (Briggs and Leigh 1996a). Populations of *Boronia deanei* within the Locality are not considered to be at or near the geographical limits of distribution for the species.

The conservation status of *Boronia deanei* may also be affected by Key Threatening Processes as listed under Schedule 3 of the TSC Act. Key Threatening Processes listed on the TSC Act relevant to the Proposal that may impact on potential habitat for *Boronia deanei* in the Study Area include:

- 'Clearing of native vegetation' – potential habitat within drainage lines and creeks are required to be cleared as part of this Proposal;
- 'Ecological consequences of high frequency fires' – the Proposal may alter the frequency of fires in the area. In consultation with DECC and relevant experts, BHPBIC will consider the impacts of any proposed hazard reduction program on threatened species occurring in the Study Area;
- 'Alteration to the natural flow regimes of rivers, streams, floodplains & wetlands' – the Proposal is likely to impact on two small ephemeral drainage lines and Brennans Creek.
- 'Invasion of native plant communities by exotic perennial grasses' – the Proposal may increase the threat of weed invasion by exotic perennial grasses, particularly given the presence of exotic perennial grasses in the vicinity of the existing emplacement areas and disturbed edges, however, management of weeds on Study Area as described in the VFMP will

mitigate this impact.

- ‘Alteration of habitat following subsidence due to longwall mining’ – the Proposal will not increase subsidence related impacts in the Study Area.

To date, no recovery plan or threat abatement plan has been prepared for this species. DEC (2005e) has listed five recommendations to help recover this species. As the species was not recorded in the Study Area despite targeted searches, the recommendations made by DECC are not relevant to the Proposal.

*Boronia deanei* is not a cryptic species and is unlikely to have been undetected in the Study Area during the targeted surveys. On this basis, the Proposal is not considered likely to interfere with the recommendations by DECC to recover the species.

### **Discussion of Habitat Utilisation**

*Boronia deanei* was not recorded within the Study Area despite current and previous targeted surveys. The species is considered to have potential habitat within the Study Area and is known to occur in wet heathlands, swamps and alongside streams (DEC 2005e). Predominant habitat within the Study Area is within and adjacent to upland swamps. Typical habitat includes species such as *Gymnoschoenus sphaerocephalus*, *Grevillea acanthifolia*, *Lepidosperma limicola*, *Baekkea utilis* and *Leptospermum lanigerum* (Benson 2001). Three of these species are considered relatively common within upland swamp habitats of the Study Area.

The species is known to occur on infertile, peaty soils and poor drained soils on sandstone (Benson 2001). The species is also known to resprout following fires (Benson 2001) and potential habitat in the Study Area is likely to include all portions of the Study Area that were impacted by fires within the last five years. The most recent fires in the Study Area occurred in December 2001/January 2002.

### **Discussion of Local and Regional Abundance**

#### *Local*

No records of this species are listed within 10 km of the Study Area (DECC 2007). The nearest known records are likely to be within the Morton National Park at Fitzroy falls. Previously this species was known to grow profusely in Morton NP near Bundanoon, but has rarely been seen in that area since the bushfires of the 1960s (DEH 2007).

### ***Regional***

References within the DEH species profile (DEH 2007) state that populations of this species occur in Budderoo NP, Kanangra-Boyd NP, Morton NP (<1000 plants) and Nalbaugh NP (>1000 plants) and in the Upper Kangaroo River area (15 plants).

### ***Darwinia peduncularis***

#### **Discussion of Conservation Status**

*Darwinia peduncularis* is listed as Vulnerable on Schedule 2 of the TSC Act. It is not listed as a nationally Vulnerable or Endangered under the EPBC Act. The species has a conservation rating of 3RC according to Briggs and Leigh (1995) suggesting a range greater than 100 km.

Populations of *Darwinia peduncularis* are known to be disjunct occurring mostly in Coastal NSW with a couple of isolated populations in the Blue Mountains. It has been recorded from Brooklyn, Berowra, Galston Gorge, Hornsby, Bargo River, Glen Davis, Mount Boonbourwa, Kings Tableland (NSW Scientific Committee) and is known to occur from Hornsby to the Hawkesbury River (Harden 1991).

*Darwinia peduncularis* is known to occur within the Blue Mountains and Wollemi National Parks (Briggs and Leigh 1995). This species is also known to occur in Marramorra National Park and Berowra Valley Regional Park (NSW Scientific Committee).

The conservation status of *Darwinia peduncularis* may also be affected by Key Threatening Processes as listed under Schedule 3 of the TSC Act. Key Threatening Processes listed on the TSC Act relevant to the Proposal that may impact on potential habitat for *Darwinia peduncularis* include:

- ‘Clearing of native vegetation’ - approximately 37.8 ha of potential habitat (ESSW) will be cleared for the Proposal;
- ‘Ecological consequences of high frequency fires’ – the Proposal may alter the frequency of fires in the area. In consultation with DECC and other experts, BHPBIC will consider the impact of any hazard reduction burn programs on the lifecycle of threatened species known to occur in the Study Area.
- ‘Invasion of native plant communities by exotic perennial grasses’ – the Proposal may increase the threat of weed invasion by exotic perennial

grasses, particularly given the presence of exotic perennial grasses in the vicinity of the existing emplacement areas and disturbed edges, however, management of weeds on Study Area as described in the VFMP will mitigate this impact.

To date, no recovery plan or threat abatement plan has been prepared for this species. DEC (2005i) has listed 5 priority actions to help recover this species, of these, the following one considered relevant to the Proposal:

- Identify and survey potential habitat, particularly in the Blue Mountains and Bargo areas. - potential habitat for *Darwinia peduncularis* within the Study Area (ESSW) has been mapped and is included in Figure 5. Targeted surveys for this species were undertaken in these areas and the species was not recorded.

*Darwinia peduncularis* is not a cryptic species and is unlikely to have been undetected in the Study Area during the targeted surveys. On this basis, the Proposal is not considered likely to interfere with the recommendations by DECC to recover the species.

### **Discussion of Habitat Utilisation**

*Darwinia peduncularis* was not recorded within the Study Area despite current and previous targeted surveys. The species is considered to have potential habitat within the Study Area and usually grows on or near rocky outcrops on sandy, well drained, low nutrient soil over sandstone (DEC 2005i).

Specific areas of potential habitat within the Study Area are considered to be on and near rocky areas within Exposed Sandstone Scribbly Gum Woodland. Potential habitat for this species is considered to be well represented in the Study Area and Locality.

### **Discussion of Local and Regional Abundance**

#### ***Local***

Little information is available on the local abundance of *Darwinia peduncularis*. The total number of individuals is likely to be less than 2500 and possibly less than 1500 (NSW Scientific Committee 1999a).

#### ***Regional***

Little information is available on the regional abundance of this species. Records of this species in Blue Mountains and Wollemi National Parks are known to contain less than 1000 plants (Briggs and Leigh 1995).

***Cryptostylis hunteriana*****Leafless Tongue Orchid****Discussion of Conservation Status**

*Cryptostylis hunteriana* is listed as a Vulnerable species on the TSC Act and EPBC Act.

*Cryptostylis hunteriana* has a wide but sporadic distribution from Rainbow Beach in Queensland, inland to the Gibraltar Ranges in NSW and south to Orbost in Victoria (DEC 2005g). Recordings include a number of localities on the NSW South Coast and in recent years at many sites between Batemans Bay and Nowra (DEC 2005g). Populations of this species that may occur within the Locality are not considered to be at the geographical limit of distribution for this species.

*Cryptostylis hunteriana* is known to occur within conservation reserves within NSW (Gibraltar Range, Ku-Ring-Gai Chase, Washpool and Ben Boyd National Parks) and two reserves within Victoria (Croajingalong National Park and William Hunter Flora Reserve). This species is not considered to be adequately represented in conservation reserves (Bell 2001).

*Cryptostylis hunteriana* is threatened by development, particularly within the coastal zone. Some populations are threatened by road works (DEC 2005g). To date (May, 2007), no NSW or national threat or recovery plans have been published for *Cryptostylis hunteriana*.

Key Threatening Processes listed on the TSC Act relevant to the Proposal that may impact on potential habitat for *Cryptostylis hunteriana* include:

- ‘Clearing of native vegetation’ – the Proposal will involve clearing native vegetation that is potential habitat for *Cryptostylis hunteriana*
- ‘Ecological consequences of high frequency fires’ – the Proposal may alter the frequency of fire within areas that are potential habitat for *Cryptostylis hunteriana*. BHPBIC will consider the impacts of any proposed hazard reduction program on threatened species, in consultation with DECC
- ‘Invasion of native plant communities by exotic perennial grasses’ – the Proposal may increase the threat of weed invasion by exotic perennial grasses, particularly given the presence of exotic perennial grasses in the vicinity of the existing emplacement areas and disturbed edges, however, management of weeds on Study Area as described in the VFMP will

mitigate this impact

As of May 2007, no NSW threat or recovery plans have been published for *Cryptostylis hunteriana*. DEC (2005g) has listed three recommendations to help recover this species, these are:

- Co-operatively develop (local governments and DECC) guidelines for survey and assessment, to be followed by developers, consultants and approval authorities
- Alert road maintenance staff to the presence of this species
- Monitor populations to determine the most appropriate timing and frequency of burning

These are not relevant to the Proposal as the species was not recorded in the Study Area. On the basis *Cryptostylis hunteriana* was not recorded in the Study Area the Proposal is not considered likely to interfere with above listed recommendations.

### **Discussion of Habitat Utilisation**

This species does not appear to have well defined habitat preferences and has been recorded from a range of plant communities, including swampy heaths and steep bare hillsides in tall eucalypt forest. Many locations appear to be on well drained sandy soils from both moist and dry habitats (Bell 2001).

DEC (2005g) suggests larger populations typically occur in woodland dominated by *Eucalyptus sclerophylla*, *E. sieberi*, *Corymbia gummifera* and *Allocasuarina littoralis*. The species appears to prefer open areas in the understorey of these woodlands, often in association with *Cryptostylis subulata* and *C. erecta* (DEC 2005g).

*Cryptostylis hunteriana* was not recorded within the Study Area despite current and previous targeted surveys. All plant communities within the Study Area are considered to be potential habitat for this species.

### **Discussion of Local and Regional Abundance**

#### ***Local***

*Cryptostylis hunteriana* has not been recorded within the Study Area or Locality. No records of this species are listed within 10 km of the Study Area (DECC 2007).



### ***Regional***

Populations have been recorded from the Central Coast region at Freemans Waterhole (15 plants) within the Awaba State Forest, Vales Point – Wyee (3 plants), Wyee Road (1 plant), Charmhaven (30 plants) and Chain Valley Bay (1 plant) (Bell 2001). The largest population within the central coast region is at Charmhaven where 30 plants were recorded in 1979, but have not since been detected at the Study Area. Populations on the north coast include Alum Mountain, Nelson Bay (30-40 plants) and Lemon Tree Passage (50 plants).

### ***Epacris purpurascens var. purpurascens***

#### **Discussion of Conservation Status**

*Epacris purpurascens var. purpurascens* is listed as a Vulnerable species on Schedule 2 of the TSC Act.

The species is known from Gosford in the north, to Narrabeen in the east, Silverdale in the west and Avon Dam vicinity in the south (DEC 2005m). The known southern-most geographical limit of distribution for this species is approximately 25 km to the south-west of the Study Area near Avon Dam (Bionet, 2007).

According to the DEC (2005m) *E. purpurascens var. purpurascens* has been recorded from Ku-Ring-Gai Chase National Park, Berowra Valley Regional Park, Muogamarra Nature Reserve, and Brisbane Waters National Park, with unconfirmed records from Gulger Nature Reserve and Bents Basin State Recreation Area. Large populations exist in protected water supply catchment lands in the vicinity of Picton Road, Wilton.

The conservation status of *Epacris purpurascens var. purpurascens* may also be affected by Key Threatening Processes as listed under Schedule 3 of the TSC Act. Key Threatening Processes listed on the TSC Act relevant to the Proposal that may impact on potential habitat for *E. purpurascens var. purpurascens* in the Study Area include:

- ‘Clearing of native vegetation’ – potential habitat within drainage lines and creeks are likely to be cleared as part of this Proposal
- ‘Ecological consequences of high frequency fires’ – the Proposal may alter the frequency of fires in the area. BHPBIC will consider the impacts of any proposed hazard reduction program on threatened species, in consultation with DECC

- ‘Alteration to the natural flow regimes of rivers, streams, floodplains & wetlands’ – the Proposal is likely to impact on two small ephemeral drainage lines and Brennans Creek
- ‘Invasion of native plant communities by exotic perennial grasses’ – the Proposal may increase the threat of weed invasion by exotic perennial grasses, particularly given the presence of exotic perennial grasses in the vicinity of the existing emplacement areas and disturbed edges, however, management of weeds on Study Area as described in the VFMP will mitigate this impact
- ‘Alteration of habitat following subsidence due to longwall mining’ – the Proposal will not increase subsidence related impacts in the Study Area

To date, no recovery plan or threat abatement plan has been prepared for this species. DECC has listed five priority actions to help recover this species (DEC 2005m). As the species was not recorded in the Study Area despite targeted surveys, not all of these priority actions are relevant to the Proposal. Those that are considered relevant include:

- Identify and survey potential habitat to detect new populations – potential habitat for the species in the Study Area has been identified and mapped (Figure 5). The species was not recorded in these areas despite targeted surveys.

*Epacris purpurascens* var. *purpurascens* is not a cryptic species and is unlikely to have been undetected in the Study Area during the targeted surveys. On this basis, the Proposal is not considered likely to interfere with the recommendations by DECC to recover the species.

### **Discussion of Habitat Utilisation**

*Epacris purpurascens* var. *purpurascens* not recorded within the Study Area despite current and previous targeted surveys. The species is known to occur in a range of habitat types, most of which have a strong clay influence, including ridgetop drainage depressions supporting wet heath within or adjoining shale cap communities, riparian zones draining into Sydney Sandstone Gully Forest, shale lenses within sandstone habitats and colluvial areas overlying or adjoining sandstone or tertiary alluvium (DEC 2005e).

The species is considered to have potential habitat in the Study Area within ridgetop drainage lines, Uplands Swamps, Sandstone Gully Peppermint Forest, Exposed Sandstone Scribbly Gum Woodland and Sandstone Gully Apple Peppermint Forest.

## Discussion of Local and Regional Abundance

Extant populations of *Epacris purpurascens* var. *purpurascens* contain between one and an estimated 15,000+ individuals (NPWS 2002c). Abundance of the species on any particular Study Area ranges from widespread and occasional to locally abundant, being influenced by past disturbance history (e.g. fire), as is population structure (NPWS 2002c).

### *Local*

*Epacris purpurascens* var. *purpurascens* was not recorded within the Study Area despite current and previous targeted surveys. The species has previously been recorded from thirteen locations within 10 km of the Study Area (DECC 2007). The nearest known records are within the Metropolitan Catchment Area approximately 5 km to the south-west of the Study Area. The numbers of individuals at these sites is unknown.

### *Regional*

The species is restricted to the Sydney Basin Bioregion. Records of the species are concentrated in two disjunct areas to the north and south of the Sydney Basin Bioregion. The greatest number of records appear between Sydney and Gosford on the Central Coast with a comparatively lesser number of records on the Woronora Plateau to the south of Sydney (Bionet, 2007).

## *Eucalyptus camfieldii*

### Discussion of Conservation Status

*Eucalyptus camfieldii* is listed as Vulnerable on Schedule 2 of the TSC Act. It is also listed as a nationally Vulnerable species under the EPBC Act. The species has a conservation rating of 2VCi according to Briggs and Leigh (1995) suggesting a geographic range of less than 100 km.

DEC (2005n) states that *E. camfieldii* has a narrow distribution and occurs in a band with the most northerly records in the Raymond Terrace Area south to Waterfall. Localised and scattered distribution includes sites at Norah Head (Tuggerah Lakes), Peats Ridge, Mt Colah, Elvina Bay Trail (West Head), Terrey Hills, Killara, North Head, Menai, Wattamolla and a few other sites in Royal National Park.

The conservation status of *Eucalyptus camfieldii* may also be affected by Key Threatening Processes as listed under Schedule 3 of the TSC Act. Key

Threatening Processes listed on the TSC Act relevant to the Proposal that may impact on potential habitat for *E. camfieldii* include:

- ‘Clearing of native vegetation’ - approximately 37.8 ha of ESSW will be cleared for the Proposal
- ‘Ecological consequences of high frequency fires’ – the Proposal may alter the frequency of fires in the area. In consultation with DECC and other experts, BHPBIC will consider the impact of any hazard reduction burn programs on the lifecycle of threatened species known to occur in the Study Area
- ‘Invasion of native plant communities by exotic perennial grasses’ – the Proposal may increase the threat of weed invasion by exotic perennial grasses, particularly given the presence of exotic perennial grasses in the vicinity of the existing emplacement areas and disturbed edges, however, management of weeds on Study Area as described in the VFMP will mitigate this impact

To date, no recovery plan or threat abatement plan has been prepared for *Eucalyptus camfieldii*.

*Eucalyptus camfieldii* is not a cryptic species and is unlikely to have been undetected in the Study Area during the targeted surveys. On this basis, the Proposal is not considered likely to interfere with the recommendations by DECC to recover the species.

### **Discussion of Habitat Utilisation**

Habitat for *Eucalyptus camfieldii* includes Shallow soiled sandstone or lateric tops amongst *Angophora hispida*, *Eucalyptus haemastoma*, and *E. oblonga* (Robinson 1994). This species is not a cryptic species and as such would have been recorded if present within the Study Area. Based on the current and previous surveys it is unlikely that this species occurs within the Study Area. Potential habitat within the Study Area is considered to be within Exposed Sandstone Scribbly Gum Woodland.

### **Discussion of Local and Regional Abundance**

#### *Local*

The abundance of this species is difficult to estimate because an extensive system of lignotubers can arise from one plant and may extend for up to 20 m (Fairley 2004). Population sizes of this species are unknown.

### ***Regional***

In the vicinity of the Study Area, habitat for *E. camfieldii* is likely to be widespread within ridgetop vegetation on the Woronora Plateau within the Dharawal State Conservation Area, Holsworthy Military Area, the Metropolitan Water Catchment Area and the Royal and Heathcote National Parks based on the known characteristics of these areas. Habitat for this species may also occur on privately owned land elsewhere on the Woronora Plateau. Habitat for this species within the areas managed by the various government departments is likely to be in good condition owing to the relatively high degree of protection afforded by the different areas. The habitat for this species in these areas is likely to remain protected indefinitely providing the continued ownership and control of these areas by the different government departments. The future of habitat for *Eucalyptus camfieldii* is uncertain on land that is privately owned and managed.

### ***Grevillea parviflora subsp. parviflora***

#### **Discussion of Conservation Status**

*Grevillea parviflora* subsp. *parviflora* is listed as Vulnerable on both the TSC and EPBC Acts.

*Grevillea parviflora* subsp. *parviflora* is historically known from the Prospect to Camden and Appin area, with disjunct populations near Putty, Cessnock and Cooranbong (NSW Scientific Committee 1998). The species has a broad distribution and habitat requirements and may be more common than currently believed (NPWS 2002a). The southern-most limit of distribution for this species is at Moss Vale to the south-west of the Study Area. On this basis, populations of this species that may occur in the Locality are considered to be near the southern limit of distribution for the species.

The main occurrence of the species is centred south of Sydney in the Appin Wedderburn-Picton-Bargo districts associated with the Nepean and Georges Rivers. Some former sites in the Sydney regions near Prospect and at Tahmoor and Thirlmere have now been developed and the nearby areas of potential habitat are degraded (NPWS 2002b).

Populations to the south of Sydney are informally protected within Wirrimbirra Sanctuary at Bargo and within a wildlife refuge near Maldon. A further two populations are protected within Sydney Water land, although these are on previously disturbed sites (NPWS 2002a). Biosis Research has also recorded this species within the metropolitan water catchment near Wilton where it is afforded

protection.

Within the Lower Hunter and Central Coast Region the species has been recorded at West Wallsend and Bottonderry (Murray et al. 2002). The species is poorly represented in conservation reserves and is only known from Werakata (Lower Hunter) National Park (Bell 2004).

The conservation status of this species may also be affected by Key Threatening Processes as listed under Schedule 3 of the TSC Act. Key Threatening Processes listed on the TSC Act relevant to the Proposal that may impact on potential habitat for *Grevillea parviflora* subsp. *parviflora* include:

- ‘Clearing of native vegetation’ – no vegetation that is considered potential habitat for this species will be cleared for the Proposal;
- ‘Ecological consequences of high frequency fires’ – the Proposal may alter the frequency of fires in the area. BHPBIC will consider the impacts of any proposed hazard reduction program on threatened species, in consultation with DECC; and,
- ‘Invasion of native plant communities by exotic perennial grasses’ – the Proposal may increase the threat of weed invasion by exotic perennial grasses, particularly given the presence of exotic perennial grasses in the vicinity of the existing emplacement areas and disturbed edges, however, management of weeds on Study Area as described in the VFMP will mitigate this impact.

No recovery plan or threat abatement plans have been prepared for *Grevillea parviflora* subsp. *parviflora* to date. DEC (2005r) has identified five priority actions to assist in the recovery of the species. Since *Grevillea parviflora* subsp. *parviflora* was not recorded in the Study Area, not all of the priority actions are relevant to the Proposal. Those that are relevant to the Proposal include:

- Identify and survey potential habitat to detect new populations – potential habitat (UGRSW and ESSW) for *Grevillea parviflora* subsp. *parviflora* in the Study Area has been identified and mapped (Figure 5). Despite targeted surveys in the potential habitat, the species was not recorded in the Study Area.

This species is not considered a cryptic species and if present should have been recorded in the Study Area. On the basis *Grevillea parviflora* subsp. *parviflora* was not recorded in the Study Area, the Proposal is not considered likely to interfere with priority actions for the species.

### Discussion of Habitat Utilisation

*Grevillea parviflora* subsp. *parviflora* occurs on sandy clay loam soils, often with lateritic ironstone gravels. Soils are mostly derived from Tertiary sands or alluvium and from the Mittagong Formation with alternating bands of shale and fine grained sandstones. Soil landscapes include Lucas Heights and Berkshire Park. The species is found on crests, upper slopes or flat plains in both low-lying areas between 30-65 m asl (particularly Lower Hunter Valley and Lake Macquarie) and on higher topography between 200-300 m asl. to the south of Sydney (NPWS 2002b).

*Grevillea parviflora* subsp. *parviflora* occurs in a range of vegetation types from heath and shrubby woodland to open forest. It is found over a range of altitudes from flat, low-lying areas to upper slopes and ridge crests. It often occurs in open, slightly disturbed sites such as along tracks. In the Sydney area the species has been recorded in Shale Sandstone Transition Forest (NPWS 2002b) and Coastal Foothills Spotted Gum Ironbark Forest.

Specific areas of potential habitat within the Study Area include are considered to be within Exposed Sandstone Scribbly Gum Woodland and Upper Georges River Sandstone Woodland. Populations are also found in open and disturbed sites along roads and tracks and within open areas of habitat (NPWS 2002a)

### **Discussion of Local and Regional Abundance**

There are at least 21 known populations of *G. parviflora* subsp. *parviflora* with several other older records requiring confirmation (NPWS 2002b). Populations vary mostly from small (<20 plants) to medium size (50-100 plants) and large (>200 plants).

#### ***Local***

The species has been recorded from 5 locations within 10 km of the Study Area. The nearest records approximately 8 km north of the Study Area are within woodlands near Wedderburn (DECC 2007).

#### ***Regional***

The largest known population occurs north of Bargo with an estimated 2,000+ plants (NPWS 2002b). More than 135 individuals have been recorded in the vicinity of Tahmoor within an area covering 7.1 ha. Within the Wirrimbirra Sanctuary at Bargo, 50 plants are known to exist (NPWS 2002a). Over 6,000 individuals have been recorded during recent surveys within Kurri Sand Swamp Woodland in the Lower Hunter Region (Biosis Research 2006a).

## *Gyrostemon thesioides*

### Discussion of Conservation Status

*Gyrostemon thesioides* is listed as an Endangered species on Schedule 1 of the TSC Act.

According to the DEC threatened species profile (DEC 2005t), this species has only ever been recorded at three sites in NSW, to the west of Sydney, near the Colo, Georges and Nepean Rivers. The most recent sighting was of a single male plant near the Colo River. The species has not been recorded from the Nepean and Georges Rivers for 90 and 30 years respectively. The species has previously been recorded from Ingleburn Reserve on the Georges River within the Campbelltown LGA but has not been recorded for over 30 years.

*Gyrostemon thesioides* appears to be poorly represented within conservation reserves in NSW and has recently been recorded from within the Wollemi National Park. The species has been recorded in conservation reserves within Tasmania including Douglas Apsley National Park, Freycinet National Park and Kent Group National Park (DPIWE 2003). The species also occurs in Western Australia, South Australia and Victoria.

The conservation status of *Gyrostemon thesioides* may also be affected by Key Threatening Processes as listed under Schedule 3 of the TSC Act. Key Threatening Processes listed on the TSC Act relevant to the Proposal that may impact on potential habitat for *Gyrostemon thesioides* in the Study Area include:

- ‘Clearing of native vegetation’ – potential habitat within drainage lines and creeks are likely to be cleared as part of this Proposal;
- ‘Ecological consequences of high frequency fires’ – the may alter the frequency of fires in the area. BHPBIC will consider the impacts of any proposed hazard reduction program on threatened species, in consultation with DECC;
- ‘Invasion of native plant communities by exotic perennial grasses’ – the Proposal may increase the threat of weed invasion by exotic perennial grasses, particularly given the presence of exotic perennial grasses in the vicinity of the existing emplacement areas and disturbed edges, however, management of weeds on Study Area as described in the VFMP will mitigate this impact; and,
- ‘Alteration of habitat following subsidence due to longwall mining’ – the Proposal will not increase subsidence related impacts in the Study Area.



To date, no recovery plan or threat abatement plan has been prepared for this species. DECC has listed five priority actions to help recover this species. Those that are relevant to the Proposal include:

- Conduct targeted surveys in likely habitat, especially along the Nepean, Georges and Colo Rivers, to locate new populations – Potential habitat for the species in the Study Area has been identified and mapped (Figure 5). The species has not been recorded in the Study Area despite targeted searches within the identified potential habitat.

The Proposal is not considered likely to interfere with above priority action.

### **Discussion of Habitat Utilisation**

*Gyrostemon thesioides* was not recorded within the Study Area despite targeted surveys. The species is known to occur on hillsides and riverbanks and may be restricted to fine sandy soils (DEC 2005t).

Habitat for this species includes alluvial soils derived from sandstone. It has also been suggested that the species requires wetter, eastern and southern facing slopes of sandstone valleys and/or proximity to shale colluvium (Steller 2004). Typical vegetation communities are thought to include a range of sandstone gully *Eucalyptus* spp. (Steller 2004). The species is considered to have potential habitat in the Study Area within Sandstone Gully Peppermint Forest and Sandstone Gully Apple Peppermint Forest.

### **Discussion of Local and Regional Abundance**

#### ***Local***

Limited information is available on the local abundance of this species at historic record sites. The species has no recent recordings within 10 km (DECC 2007) with only historic recordings on the Georges River in NSW. Searches for this plant at previously recorded locations have failed to confirm its persistence within the Georges River Catchment (Steller 2004).

#### ***Regional***

The regional distribution of this species is confined to a record within Wollemi National Park (DEC 2005t).

## *Leucopogon exolasius*

### Discussion of Conservation Status

*Leucopogon exolasius* is listed as a Vulnerable species on both the TSC and EPBC Acts.

The species is found along the upper Georges River area and in Heathcote National Park (DEC 2005§). The species has previously been recorded approximately 3 km from the Study Area within Dharawal State Conservation Area (DECC 2007). The known southern-most geographical limit of distribution for this species is approximately 25 km to the south of the Study Area near Cordeaux Dam (Bionet, 2007).

Recordings in conservation reserves include Dharawal State Conservation Area and Heathcote National Park. Populations also exist in protected water supply catchment lands in the vicinity of Woronora Plateau. An additional recorded location affording limited protection for the species includes sites within the Holsworthy Military Base (French 2000). The species is considered unlikely to be adequately represented in conservation reserves in the region.

The conservation status of this species may also be affected by Key Threatening Processes as listed under Schedule 3 of the TSC Act. Key Threatening Processes listed on the TSC Act relevant to the Proposal that may impact on potential habitat for *Leucopogon exolasius* in the Study Area include:

- ‘Clearing of native vegetation’ – potential habitat within drainage lines and creeks will be cleared as part of this Proposal;
- ‘Ecological consequences of high frequency fires’ – the Proposal may alter the frequency of fires in the area. BHPBIC will consider the impacts of any proposed hazard reduction program on threatened species, in consultation with DECC;
- ‘Alteration to the natural flow regimes of rivers, streams, floodplains & wetlands’ – the Proposal is likely to impact on at least two small ephemeral drainage lines and Brennans Creek;
- ‘Invasion of native plant communities by exotic perennial grasses’ – the Proposal may increase the threat of weed invasion by exotic perennial grasses, particularly given the presence of exotic perennial grasses in the vicinity of the existing emplacement areas and disturbed edges, however, management of weeds on Study Area as described in the VFMP will mitigate this impact.

- ‘Bushrock removal’- the Proposal would involve the removal of bushrock including large rock platforms and outcrops which are potential habitat for this species. Although the listing of bushrock removal under the TSC Act makes no specific reference to *Leucopogon exolasius*, potential habitat for this species is known to be associated with rocky areas;
- ‘Alteration of habitat following subsidence due to longwall mining’ – the Proposal will not increase subsidence related impacts in the Study Area.

To date, no recovery plan or threat abatement plan has been prepared for this species. DECC has listed six priority actions to help recover this species. Those that are considered relevant to the Proposal include:

- Undertake surveys of known sites and potential habitat, particularly on Dept of Defence land and along Georges River – potential habitat for the species within the Study Area has been identified and mapped (Figure 5). The species has not been recorded in the Study Area despite targeted surveys within potential habitat.

On the basis *Leucopogon exolasius* was not recorded in the Study Area during the current survey, the Proposal is not considered likely to interfere with the priority actions to assist in recovery of the species.

### **Discussion of Habitat Utilisation**

*Leucopogon exolasius* not recorded within the Study Area despite current and previous targeted surveys. Locally this species has been recorded from the Woronora River where it occurred within the rocky, bare riparian zone where alluvial soils were almost absent (M. Richardson, Biosis Research Pty. Ltd., pers. com.). The species is considered to have potential habitat in the Study Area in gullies within Sandstone Gully Peppermint Forest and Sandstone Gully Apple Peppermint Forest.

### **Discussion of Local and Regional Abundance**

Little information is available on the abundance of this species.

#### ***Local***

*Leucopogon exolasius* has been recorded from four locations with 10 km of the Study Area, all within Dharawal State Conservation Area (DECC 2007).

#### ***Regional***

The species is restricted to the Sydney Basin Bioregion. Records of the species

are concentrated to the south of the Sydney Basin Bioregion. A total of 20 recorded locations exist across the Sydney Basin Bioregion (Bionet, 2007).

*Melaleuca deanei*

Deanes Paperbark

**Discussion of Conservation Status**

*Melaleuca deanei* is endemic to NSW and is listed as Vulnerable on both the TSC and EPBC Acts.

According to the DECC threatened species profile, *M. deanei* occurs in two distinct areas, in the Ku-ring-gai/Berowra and Holsworthy/Wedderburn areas respectively. There are also more isolated occurrences at Springwood (in the Blue Mountains), Wollemi National Park, Yalwal (west of Nowra) and Central Coast (Hawkesbury River) areas. Potential occurrences of this species in the Study Area are not considered to be at the southern limit of distribution for this species.

Locations are known from the following National Parks and Wildlife Service reserves: Berowra Valley Regional Park, Brisbane Water National Park, Ku-ring-gai Chase National Park, Garigal National Park, Lane Cove National Park, Royal National Park and Heathcote National Park (NSW Scientific Committee 1999b). Despite occurring in several national parks, the majority of sites contain few individuals.

The conservation status of *Melaleuca deanei* may also be affected by Key Threatening Processes as listed under Schedule 3 of the TSC Act. Key Threatening Processes listed on the TSC Act relevant to the Proposal that may impact on potential habitat for *M. deanei* include:

- ‘Clearing of native vegetation’ - approximately 37.8 ha of potential habitat (ESSW) will be cleared for the Proposal;
- ‘Ecological consequences of high frequency fires’ – the Proposal may alter the frequency of fires in the area. BHPBIC will consider the impacts of any proposed hazard reduction program on threatened species, in consultation with DECC; and,
- ‘Invasion of native plant communities by exotic perennial grasses’ – the Proposal may increase the threat of weed invasion by exotic perennial grasses, particularly given the presence of exotic perennial grasses in the vicinity of the existing emplacement areas and disturbed edges, however, management of weeds on Study Area as described in the VFMP will

mitigate this impact.

To date, no recovery plan or threat abatement plan has been prepared for *Melaleuca deanei*. DEC (2005w) has listed 14 priority actions to help recover this species. Since the species was not recorded in the Study Area despite targeted searches, these priority actions are not considered relevant to the Proposal.

*Melaleuca deanei* is not a cryptic species and is unlikely to have been undetected in the Study Area during the targeted surveys. On this basis, the Proposal is not considered likely to interfere with the recommendations by DECC to recover the species.

### **Discussion of Habitat Utilisation**

*Melaleuca deanei* was not recorded within the Study Area despite current and previous targeted surveys. The species is considered to have potential habitat within ESSW in the Study Area and is known to occur in dry heathlands (DEC 2005w) and woodlands on sandy and lateritic soils (Fairley 2004). *Melaleuca deanei* resprouts following fires (DEC 2005w) and potential habitat in the Study Area is also likely to include all portions of the Study Area that were impacted by fires within the last 5 years.

### **Discussion of Local and Regional Abundance**

The NSW Scientific Committee final determination for this species has estimated the total population of the species is between 1000 and 3000 individuals. Due to the plant's clonal nature, ramet counts may overestimate population size by two to three times. There are approximately 75 known locations of the species with a majority of these (including many that are in conservation reserves) containing only a few individuals. Small populations are more susceptible to catastrophic events and localised extinction.

#### ***Local***

No records of this species are listed within 10 km of the Study Area (DECC 2007). The nearest occurrences to the Study Area include two records within the Sydney Metropolitan Catchment areas; one approximately 15 km south-west of the Subject Site near Wilton, and a second record approximately 7.5 km to the East of the Subject Site immediately west of Dharawal State Conservation area, near the Woronora River.

#### ***Regional***

The species has been recorded from approximately 17 locations south from

Botany Bay (DECC 2007). The majority of occurrences are on the Sandstone ridge tops between Sydney and the Central Coast.

*Persoonia hirsuta*

Hairy Geebung

**Discussion of Conservation Status**

*Persoonia hirsuta* is listed as Endangered on both the TSC and EPBC Acts. The species is restricted to the greater Sydney region in an area bounded by Putty, Glen Davis and Gosford in the north, and Royal National Park and Hill Top in the south.

*Persoonia hirsuta* has been recorded from within several National Parks including Blue Mountains, Wollemi, Dharug, Ku-ring-gai Chase, Marramarra, Royal and Sydney Harbour. During the current surveys the species was also recorded in Dharawal State Conservation Area. The species was also recorded within the Sydney Metropolitan Catchment area immediately south-west of the Subject Site.

The conservation status of this species may also be affected by Key Threatening Processes as listed under Schedule 3 of the TSC Act. Key Threatening Processes listed on the TSC Act relevant to the Proposal include:

- ‘Clearing of native vegetation’ - approximately 37.8 ha of known habitat will be cleared for the Proposal;
- Alteration to the natural flow regimes of river, streams, floodplains and wetlands - – the Proposal is likely to impact on at least two small ephemeral drainage lines and Brennans Creek. However, *Persoonia hirsuta* is not directly reliant on these drainage lines and rivers and is therefore unlikely to be impacted by this Key Threatening Process;
- Infection of native plants by *Phytophthora cinnamomi* – machinery could potentially introduce and spread *Phytophthora cinnamomi* through the Study Area. As a precaution, vehicles should be washed down using appropriate procedures to ensure the fungus is not spread. This is current practice on site at West Cliff.
- ‘Ecological consequences of high frequency fires’ – the Proposal may alter the frequency of fires in the area. BHPBIC will consider the impacts of any proposed hazard reduction program on threatened species, in consultation with DECC,
- ‘Invasion of native plant communities by exotic perennial grasses’ – the

Proposal may increase the threat of weed invasion by exotic perennial grasses, particularly given the presence of exotic perennial grasses in the vicinity of the existing emplacement areas and disturbed edges, however, management of weeds on Study Area as described in the VFMP will mitigate this impact.

The Proposal will subject the population of *Persoonia hirsuta* within the Study Area to at least four Key Threatening Processes. These are discussed in more detail below.

To date, no recovery plan or threat abatement plan has been prepared for this species. DEC (2005l) have listed 21 priority actions to help recover this species. Those considered relevant to the Proposal include:

- Assess the relative conservation significance of sites to determine recovery priorities – the Study Area is likely to be of high conservation significance for this species, given the relatively high density of the records of the species throughout the Study Area. 156 plants were recorded in the Study Area.
- Advise and liaise with private land managers to facilitate the preparation and implementation of Study Area management plans that address threatening processes – The VFMP includes specific measures to ensure this species is appropriately managed at West Cliff.
- Incorporate best knowledge regarding appropriate fire regime into land management practices – requirements of threatened species known to occur in the Study Area will be considered in any proposed fire regime. This is particularly important for *Persoonia hirsuta* as the species is thought to be killed by fire (DEC 2005l).
- Develop and implement Study Area-awareness and protection procedures for use by land owners/managers and public utilities and their contractors when undertaking road, trail, or easement maintenance – Many of the recorded *Persoonia hirsuta* within the Study Area occurred along and adjoining existing roads and powerline easements. The VFMP will incorporate land management awareness procedures for the whole of West Cliff.
- Restrict vehicular and pedestrian access to sites, where necessary – plants occurring near roads, underneath easements and in the vicinity of the Proposal may need to be fenced or flagged to ensure protection from maintenance activities and clearing.
- Undertake targeted bush regeneration works, where required – The VFMP

will include specific measures to manage this species appropriately at West Cliff. This will include revegetation where appropriate.

- Seek to increase the level of legislative protection for sites through land-use planning mechanisms and conservation agreements – plants outside the Subject Site should be managed in accordance with the VFMP.
- Retain or re-establish vegetation and fauna movement linkages between sites - the Proposal is likely to fragment the existing population in the Study Area and impact on existing fauna linkages.
- Consider inclusion in SeedQuest NSW program for research on seed viability and requirements for successful conservation storage – The VFMP includes specific measures to ensure this species is appropriately managed at West Cliff. It includes consideration for SeedQuest NSW inclusion.
- Carry out targeted surveys in potential habitat, particularly freehold lands, Crown land that may be alienated and council-managed lands – potential habitat for the species in the Study Area has been identified and mapped (Figure 5). The species was recorded in the Study Area, mainly within Exposed Sandstone Scribbly Gum Woodland.

### Discussion of Habitat Utilisation

*Persoonia hirsuta* is known to occur on sandy soils in dry sclerophyll open forest, woodland and heath on sandstone. Rare occurrences of the species are also known from shale derived soils (Harden 1991b).

During the current surveys *Persoonia hirsuta* was recorded within the Subject Site and from various locations within the Study Area. The species was largely recorded within Exposed Sandstone Scribbly Gum Woodland (ESSW), although 3 individuals were also located in Sandstone Gully Peppermint Forest close to the margin of ESSW.

Typical vegetation associations included a dominant canopy of *Eucalyptus sieberi*, *Corymbia gummifera* and *E. oblonga* with a dense understorey of shrubs to 3 m high including *Leptomeria acida*, *Lambertia formosa* and *Banksia serrata*. The species was recorded in both deep and shallow lateritic soils on the margins between the broad ridges and sandstone gullies, often in areas where sandstone outcropping was present.

The majority of individuals were recorded within the dense heathy understorey of woodlands that had not been burnt for a relatively long period (estimated > 10 yrs). The majority of individuals recorded were mature (average 0.5 to 1 m high) and in various stages of flower and fruit set. The only seedling specimens



recorded were two individuals (0.2 m high) from within a recently burnt area. No mature individuals were recorded from the recently burnt (<5 yrs) areas, supporting the notion that the species is killed by fire and reproduces by seed.

## Discussion of Local and Regional Abundance

### *Local*

The number of individuals within populations is typically 1-3 plants, although two recordings include counts of 10 - 20 individuals (NSW Scientific Committee 1998). The total number of *Persoonia hirsuta* recorded in the Study Area was approximately 156 individuals, including 47 within the boundaries of Subject Site (the Stage 3 Emplacement). The distribution of these records is illustrated in **Error! Reference source not found.**

According to the DECC Atlas of NSW Wildlife, only 3 recorded occurrences of this species are known within a 10 km radius of the Study Area. These are located on the perimeter of the Locality, between 5 and 6 km to the north and east of the Subject Site.

### *Regional*

Little information is available on the regional abundance of this species. Bionet records (Accessed January, 2007) include approximately 35 recorded locations between Bargo and Hilltop, approximately 30 km to the south-west of the Subject Site. Additional regional records include scattered occurrences across the north-west of the Sydney region.

*Pomaderris adnata*

Sublime Point Pomaderris

## Discussion of Conservation Status

*Pomaderris adnata* is listed as Endangered on Schedule 1 of the TSC Act.

According to the DEC threatened species profile (DEC 2005~) species is known only from one Study Area at Sublime Point, north of Wollongong and is not known from any conservation reserves. A second recorded location of this species is mapped on Bionet (2007) and is located near the escarpment edge, east of Helensburg. Recent unconfirmed records of this species suggest a further 6 recorded locations along the escarpment (NPA 2006).

The conservation status of *Pomaderris adnata* may also be affected by Key Threatening Processes as listed under Schedule 3 of the TSC Act. Key

Threatening Processes listed on the TSC Act relevant to the Proposal that may impact on potential habitat for *P. adnata* in the Study Area include:

- ‘Clearing of native vegetation’ – potential habitat within the Study Area is considered to be within ESSW, of which 37.8 ha will be cleared as part of the Proposal;
- ‘Ecological consequences of high frequency fires’ – the Proposal may alter the frequency of fires in the area. BHPBIC will consider the impacts of any proposed hazard reduction program on threatened species, in consultation with DECC;
- ‘Invasion of native plant communities by exotic perennial grasses’ – the Proposal may increase the threat of weed invasion by exotic perennial grasses, particularly given the presence of exotic perennial grasses in the vicinity of the existing emplacement areas and disturbed edges, however, management of weeds on Study Area as described in the VFMP will mitigate this impact.

To date, no recovery plan or threat abatement plan has been prepared for *Pomaderris adnata*. DECC has listed 10 priority actions to help recover this species. One is considered relevant to the current Proposal and involves the following.

- Conduct targeted surveys of potential habitat and identify and map potential habitat for the species – Potential habitat for this species is considered to be within ridgetop vegetation present within the Study Area and mapped as Exposed Sandstone Scribbly Gum Woodland.

*Pomaderris adnata* is not a cryptic species and is unlikely to have been undetected in the Study Area during the targeted surveys. On this basis, the Proposal is not considered likely to interfere with the recommendations by DECC to recover the species.

### **Discussion of Habitat Utilisation**

*Pomaderris adnata* occurs in heathy woodland and dry sclerophyll forest vegetation that is dominated by *Eucalyptus sieberi* and *Corymbia gummifera* with occasional *Hakea salicifolia* (DEC 2005~). Potential habitat within the Study Area is considered to be within Exposed Sandstone Scribbly Gum Woodland.

### **Discussion of Local and Regional Abundance**

#### *Local*

*Pomaderris adnata* occurs outside the Locality at Sublime Point, approximately 11 km from the Study Area. The total number of individuals recorded at the Sublime Point population is thought to include approximately 5 individuals (Fairley 2004). During the January 2002 bushfires, the population was burnt and no regeneration had occurred when observed in July 2003 (Fairley 2004).

Unconfirmed records of this species suggest that a further 200 individuals may be present from 6 locations on Illawarra Escarpment near Sublime Point (NPA 2006).

### ***Regional***

In the vicinity of the Study Area, habitat for *Pomaderris adnata* is likely to be widespread within ridgetop vegetation on the Woronora Plateau within the Dharawal State Conservation Area, Holsworthy Military Area, the Metropolitan Water Catchment Area and the Royal and Heathcote National Parks based on the known characteristics of these areas. Habitat for this species may also occur on privately owned land elsewhere on the Woronora Plateau.

Potential habitat for *Pomaderris adnata* within the areas managed by the various government departments is likely to be in good condition owing to the relatively high degree of protection afforded by the different areas. The habitat for this species in these areas is likely to remain protected indefinitely.

|                                  |                         |
|----------------------------------|-------------------------|
| <b><i>Pultenaea aristata</i></b> | <b>Prickly Bush Pea</b> |
|----------------------------------|-------------------------|

### **Discussion of Conservation Status**

*Pultenaea aristata* is listed as Vulnerable on both the TSC and EPBC Acts and is restricted to the Woronora Plateau ranging from Helensburgh to Mt Keira (DEC 2005€).

*Pultenaea aristata* has limited representation within formally reserved lands and has only been recorded within Dharawal State Conservation Area. Protection is afforded to the species within the Sydney Metropolitan Catchment Areas, where numerous populations are known (M. Richardson pers. comm.).

The conservation status of *Pultenaea aristata* may also be affected by Key Threatening Processes as listed under Schedule 3 of the TSC Act. Key Threatening Processes listed on the TSC Act relevant to the Proposal that may impact on potential habitat for *P. aristata* in the Study Area include:

- ‘Clearing of native vegetation’ – potential habitat within drainage lines and

creeks are likely to be cleared as part of this Proposal;

- ‘Ecological consequences of high frequency fires’ – the Proposal may alter the frequency of fires in the area. BHPBIC will consider the impacts of any proposed hazard reduction program on threatened species, in consultation with DECC;
- ‘Alteration to the natural flow regimes of rivers, streams, floodplains & wetlands’ – the Proposal is likely to impact on at least two small ephemeral drainage lines and Brennans Creek.
- ‘Invasion of native plant communities by exotic perennial grasses’ – the Proposal may increase the threat of weed invasion by exotic perennial grasses, particularly given the presence of exotic perennial grasses in the vicinity of the existing emplacement areas and disturbed edges, however, management of weeds on Study Area as described in the VFMP will mitigate this impact.
- ‘Alteration of habitat following subsidence due to longwall mining’ – the Proposal will not increase subsidence related impacts in the Study Area.

To date, no recovery plan or threat abatement plan has been prepared for this species. DEC (DEC 2005€) has listed two recommendations to help recover this species, these are:

- Review fire management requirements – The requirements of threatened species known to occur in the Study Area will be considered in any proposed fire regime.
- Confirm location details of existing records – Potential habitat for the species in the Study Area has been identified and mapped (Figure 5). The species is known to occur in the Study Area along drainage lines within Exposed Sandstone Scribbly Gum Woodland and Sandstone Gully Peppermint Forest and within Upland Swamps.

### **Discussion of Habitat Utilisation**

*Pultenaea aristata* is known to occur in both dry sclerophyll woodlands and wet heath on sandstone (DEC 2005€). During current and previous surveys of the Study Area, *P. aristata* was recorded within the Upland Swamps and along drainage lines within Exposed Sandstone Scribbly Gum Woodland and Sydney Sandstone Gully Peppermint Forest. The majority of records within the Study Area and Woronora Plateau are within the Upland Swamp sub-communities; including Cyperoid Heath, Restoid Heath and Banksia Thicket.

Within Exposed Sandstone Scribbly Gum Woodland, the species typically occurred near drainage lines or areas of impeded drainage. Within the Upland Swamps, common associate species included a sparse shrub layer dominated by *Banksia oblongifolia*, *Hakea dactyloides*, *Petrophile sessilis* and *Banksia ericifolia*, with a dense ground layer dominated by *Cyathochaeta diandra*, *Lepyrodia scariosa* and *Leptocarpus tenax*. The species was recorded at three locations within the Study Area all of which are in close proximity to each other in the south-east end of the Subject Site **Error! Reference source not found..** Counts of the species range from one to 20 plants at each location. *Pultenaea aristata* was recorded as a dominant shrub within Upland Swamps in Dharawal State Conservation Area, immediately adjoining the West Cliff Site, with at least 2000 plants recorded.

Within the Study Area, some *Pultenaea aristata* were located near areas of disturbance, such as those recorded near the access roads adjoining the existing emplacement areas. The plants were persisting in these areas despite disturbances such as weed invasion, runoff from adjoining cleared areas and the impacts from the dust of the existing emplacement areas and unsurfaced roads.

## Discussion of Local and Regional Abundance

### *Local*

The Atlas of NSW Wildlife (Accessed Dec, 2006) indicates two occurrences of this species within the Study Area. During surveys of the Study Area, the species was found to be locally abundant at some sites with along the upper reaches of Brennans Creek with a large abundance recorded adjacent to West Cliff within Upland Swamps in Dharawal State Conservation Area. The total number of *P. aristata* recorded in the Study Area is estimated to be 156 with 25 present within the bounds of the Subject Site. At least 2000 individuals were estimated to be present in an Upland Swamp within Dharawal State Conservation Area directly east of West Cliff Colliery.

### *Regional*

As previously discussed, this species is confined to the Woronora Plateau. Bionet (Accessed Jan, 2007) records list approximately 26 occurrences of the species across its distribution. Numerous records of the species are known from Upland Swamps within the Cordeaux Catchment where the species is well represented and occasionally the dominant shrub species (M. Richardson, Biosis Research, pers. comm.). Recent surveys of *P. aristata* populations undertaken by Biosis Research in the Cordeaux Catchment include area density estimates with an average abundance of 120,000 individuals per hectare.

### 6.3.6 Threatened Fauna Species Profiles

Unless otherwise stated the information contained in the following species profiles has been derived from the NSW Governments Bionet database and DECC's Threatened Species profiles and/or Environmental Impact Assessment Guidelines for each species.

|                   |                             |
|-------------------|-----------------------------|
| <b>Masked Owl</b> | <i>Tyto novaehollandiae</i> |
|-------------------|-----------------------------|

#### Discussion of Conservation Status

The Masked Owl *Tyto novaehollandiae* is listed as Vulnerable on Schedule 2 of the TSC Act.

This species has been recorded from most regions of NSW, particularly on the east of the Great Dividing Range (Higgins 1999).

It is not clear how well represented this species is within conservation reserves.

The conservation status of this species may also be affected by Key Threatening Processes as listed under Schedule 3 of the TSC Act. Key Threatening Processes associated with the Proposal include:

- 'Clearing of native vegetation';
- 'Removal of dead wood and dead trees'; and,
- 'Loss of hollow bearing trees'.

A draft recovery plan has been prepared for this species (DEC 2006b). The DECC has listed 23 priority actions to help recover this species, some of which are:

- Apply low-intensity, mosaic pattern fuel reduction regimes;
- Searches for the species should be conducted in suitable habitat in Proposal areas and proposed forest harvesting compartments;
- Retain at least a 200 metre buffer of native vegetation around known nesting sites;
- Retain large stands of native vegetation, especially those containing hollow-bearing trees;
- Protect riparian vegetation to preserve roosting areas;
- Protect hollow-bearing trees for nest sites. Younger recruitment trees

should also be retained to replace older trees in the long-term;

- Minimise visits to nests and other disturbances, including surveys using call playback, when owls are breeding; and,
- Assess the importance of the Study Area to the species' survival. Include the linkages the Study Area provides for the species between ecological resources across the broader landscape.

### **Discussion of Habitat Utilisation**

The Study Area contains potential foraging habitat and nesting resources for this species. The Masked Owl is often recorded in open forest and woodlands adjacent to cleared areas; preferring the tall, open woodlands. They feed on arboreal mammals that take shelter in tree hollows, but is more dependent on small, terrestrial mammals for food (Gibbons and Lindenmayer 1997, Higgins 1999).

The Masked Owl inhabits a diverse range of wooded habitat that provides tall or dense mature trees with hollows suitable for nesting and roosting (Higgins 1999). They nest in hollows, in trunks and in near vertical spouts or large trees, usually living but sometimes dead (Higgins 1999). Nest hollows are usually located within dense forests or woodlands.

### **Discussion of Local and Regional Abundance**

#### ***Local***

There is one record of the Masked Owl about 10 km to the south-east of the Study Area.

#### ***Regional***

Scattered records of the Masked Owl exist from the region, mostly associated with reserves. The species appears to be rare in the region when compared to the frequency and pattern of records in other parts of the state, though this could reflect low historical survey effort. It has been recorded on the northern end of the Illawarra Escarpment (NPWS 1998).

**Sooty Owl*****Tyto tenebricosa*****Discussion of Conservation Status**

The Sooty Owl *Tyto tenebricosa* is listed as Vulnerable on Schedule 2 of the TSC Act.

The Sooty Owl is generally confined to the east of the Great Dividing Range within a patchy distribution. It is uncertain how well represented this species is in conservation reserves in NSW.

The conservation status of this species may also be affected by Key Threatening Processes as listed under Schedule 3 of the TSC Act. Key Threatening Processes listed on the TSC Act relevant to the Proposal that may impact on potential habitat for the Sooty Owl include:

- 'Clearing of native vegetation';
- 'Removal of dead wood and dead trees'; and,
- 'Loss of hollow bearing trees'.

A draft recovery plan has been prepared for this species (DEC 2006b). DECC has listed 23 priority actions to help recover this species, some of which are:

- Apply low-intensity, mosaic pattern fuel reduction regimes;
- Searches for the species should be conducted in suitable habitat in Proposal areas and proposed forest harvesting compartments;
- Retain at least a 200 m buffer of native vegetation around known nesting sites;
- Retain large stands of native vegetation, especially those containing hollow-bearing trees;
- Protect riparian vegetation to preserve roosting areas;
- Protect hollow-bearing trees for nest sites. Younger recruitment trees should also be retained to replace older trees in the long-term;
- Minimise visits to nests and other disturbances, including surveys using call playback, when owls are breeding; and,
- Assess the importance of the Study Area to the species' survival. Include the linkages the Study Area provides for the species between ecological



resources across the broader landscape.

### **Discussion of Habitat Utilisation**

The Sooty Owl has been recorded in tall old-growth forests, including temperate and subtropical rainforests. In NSW this species is mostly found on escarpments with a mean altitude < 500 m. They nest and roost in hollows of tall emergent trees, mainly eucalypts (Higgins 1999) often located in gullies (Gibbons and Lindenmayer 1997). Nests have been located in trees 125 to 161 centimetres in diameter (Kavanagh 1992, cited in Gibbons and Lindenmayer 1997). Tree hollows also provide shelter for many prey species of the Sooty Owl.

Foraging and nesting habitat for this species exists in the Study Area.

### **Discussion of Local and Regional Abundance**

#### *Local*

There are two records of the Sooty Owl within 10 km of the Subject Site, both on the south-west margins of the 10 km radius from the Subject Site. The species is probably rare in the Locality.

#### *Regional*

Records exist for the Sooty Owl along the Illawarra Escarpment near Wollongong. It has been suggested this species is widespread along the Illawarra Escarpment, and this region may contain the best habitat in the Sydney Basin (NPWS 1998). The species is considered to be moderately common at a regional level.

|                    |                        |
|--------------------|------------------------|
| <b>Barking Owl</b> | <i>Ninox connivens</i> |
|--------------------|------------------------|

### **Discussion of Conservation Status**

The Barking Owl *Ninox connivens* is listed as Vulnerable on Schedule 2 of the TSC Act.

In NSW, the Barking Owl is widespread on the coastal plains and foothills and inland slopes and plains. Its distribution is sparse on the south-eastern slopes of the Great Dividing Range and in the arid zone.

The conservation status of the Barking Owl may also be affected by Key Threatening Processes as listed under Schedule 3 of the TSC Act. Key Threatening Processes listed on the TSC Act relevant to the Proposal that may impact on

potential habitat for the Barking Owl include:

- ‘Clearing of native vegetation’;
- ‘Removal of dead wood and dead trees’;
- ‘Ecological consequences of high frequency fires’; and,
- ‘Loss of hollow bearing trees’.

A draft recovery plan has been prepared for the Barking Owl (DEC 2006b). The DECC has listed 23 priority actions to help recover this species, some of which are:

- Apply low-intensity, mosaic pattern fuel reduction regimes;
- Searches for the species should be conducted in suitable habitat in Proposal areas and proposed forest harvesting compartments;
- Retain at least a 200 metre buffer of native vegetation around known nesting sites;
- Retain large stands of native vegetation, especially those containing hollow-bearing trees;
- Protect riparian vegetation to preserve roosting areas;
- Protect hollow-bearing trees for nest sites. Younger recruitment trees should also be retained to replace older trees in the long-term;
- Minimise visits to nests and other disturbances, including surveys using call playback, when owls are breeding; and,
- Assess the importance of the Study Area to the species' survival. Include the linkages the Study Area provides for the species between ecological resources across the broader landscape.
- 

### **Discussion of Habitat Utilisation**

The Barking Owl lives in forest and woodlands of tropical, temperate and semi-arid zones (Higgins 1999). Tree hollows are important for the Barking Owl as they provide habitat for hollow-dwelling arboreal marsupials, which comprise a large proportion of their diet, and nesting sites (Higgins 1999). Large mature trees with hollows at least 0.6 m deep are required for nesting (Gibbons and Lindenmayer 1997). The Barking Owl favours nesting and roosting in woodland alongside watercourses (Higgins 1999). The Barking Owl is thought to have a home range of

<200 ha, although no detailed studies have been conducted (Higgins 1999).

The Study Area contains potential foraging and nesting habitat for the species. Tree hollows of various sizes have been recorded in the Study Area.

### **Discussion of Local and Regional Abundance**

#### ***Local***

There is one record for the Barking Owl from the Illawarra Escarpment approximately 8 km east of the Study Area. The species appears to be rare in the Locality. Scarcity in the Locality may be a reflection of the large size of territories rather than an indication of abundance.

#### ***Regional***

Most records for the Barking Owl in the region fall on the coast or in the Blue Mountains. Several records exist from the outer Sydney suburbs. The species appears to be uncommon in the region.

|                              |                                       |
|------------------------------|---------------------------------------|
| <b>Glossy Black-cockatoo</b> | <b><i>Calyptorhynchus lathami</i></b> |
|------------------------------|---------------------------------------|

### **Discussion of Conservation Status**

The Glossy Black-cockatoo *Calyptorhynchus lathami* is listed as Vulnerable on Schedule 2 of the TSC Act.

The Glossy Black-cockatoo mainly occurs in coastal regions within NSW, it can also be found as far west as Cobar. The Study Area is not at or near the limits of the known distribution for this species. The species is represented in various conservation reserves in eastern NSW.

The conservation status of this species may also be affected by Key Threatening Processes as listed under Schedule 3 of the TSC Act. KTPs listed on the TSC Act relevant to the Proposal that may impact on potential habitat for the Glossy Black-cockatoo include:

- ‘Clearing of native vegetation’;
- ‘Removal of dead wood and dead trees’;
- ‘Ecological consequences of high frequency fires’; and,

- ‘Loss of hollow bearing trees’.

No Threat abatement plan exists for this species to date, however the DECC has prepared the following priority actions to aid the recovery of this species in NSW:

- Assist landholders who wish to enter into voluntary conservation agreements at key sites;
- Continue existing monitoring programs (e.g. Goonoo population) and encourage other community groups to develop a monitoring program of local populations;
- Develop/encourage strategic planning approach for Glossy Black Cockatoo at the local and regional level;
- Encourage the restoration of foraging habitat that has been cleared or degraded by previous impacts;
- Identify and map key breeding and foraging habitat, similar to the mapping done by Robinson (2004) at St Georges Basin;
- Increase landholder and public awareness and interest in Glossy Black Cockatoo conservation and habitat management;
- Periodically review Integrated Forest Operations Approval (IFOA) prescriptions to ensure adequate protection of nesting and foraging habitat;
- Prepare and distribute EIA guidelines to decision makers;
- Provide incentives for landholders to fence and manage key sites: and,
- Utilise the Glossy Black Cockatoo as a flagship threatened species for woodland and forest conservation education and awareness programs.

### **Discussion of Habitat Utilisation**

The Glossy Black-cockatoo inhabits forests with low nutrients, characteristically with key *Allocasuarina* spp. This species tends to prefer drier forest types (NPWS, 1999f) with a middle stratum of *Allocasuarina* below *Eucalyptus* or *Angophora*. Often confined to remnant patches in hills and gullies (Higgins, 1999). The Glossy Black-cockatoo breeds in hollows stumps or limbs, either living or dead (Higgins, 1999) and forages primarily on the cones of *Allocasuarina* species.

Foraging and nesting habitat for this species is present in the Study Area.

## Discussion of Local and Regional Abundance

### *Local*

Five records for this species occur within 10 km to the north and east of West Cliff. It has been recorded in the Metropolitan Water Catchments (Sydney Water, 1997). The species has been recorded several times within 10 km of the Study Area, often in the adjacent Dharawal State Conservation Area. Biosis Research has recorded this species on several occasions within the Cordeaux Catchment near Mount Kembla.

### *Regional*

Although a number of records exist in the region they tend to be sporadic, with a number of surveys failing to detect this species. The species is moderately common in the Blue Mountains to the west, but otherwise has a scattered distribution, being sparse to rare in abundance.

|                     |                          |
|---------------------|--------------------------|
| <b>Swift Parrot</b> | <i>Lathamus discolor</i> |
|---------------------|--------------------------|

## Discussion of Conservation Status

The Swift Parrot *Lathamus discolor* is listed as Endangered on Schedule 1 of the TSC Act and the EPBC Act.

Swift Parrot is highly nomadic. Records within NSW are generally either from the coast or from the western side of the Great Dividing Range. Records outside those bands tend to be scattered. The Swift Parrot breeds in Tasmania and migrates to the mainland for the winter. The Study Area is not at or near the limits of known distribution for this species.

The Swift Parrot is not considered to be adequately represented in conservation reserves (Debbie Saunders, Swift Parrot Project Officer NPWS, pers. comm. 2002).

The conservation status of the Swift Parrot may also be affected by Key Threatening Processes as listed under Schedule 3 of the TSC Act. KTPs listed on the TSC Act relevant to the Proposal that may impact on potential habitat for the Swift Parrot includes:

- 'Clearing of native vegetation'

There is no Threat abatement plan for the Swift Parrot to date. DECC has prepared a list of priority actions to aid in the recovery of this species in NSW. Some of these actions are listed below:

- Enhance habitat for Swift Parrots by planting suitable tree species to complement natural regeneration or to enhance remnants
- Protect, manage and restore Swift Parrot habitat on private land through conservation agreements, management agreements and incentive payments (refer to species profile for regionally specific habitat information)

### **Discussion of Habitat Utilisation**

The Swift Parrot is highly nomadic species that occurs in woodlands and forest in NSW from May to August and breeds in Tasmania during the warmer seasons (Higgins 1999). It migrates in response to food availability and seasonal changes (Higgins 1999).

This species feeds on the nectar from winter-flowering eucalypts, which are the most important habitat feature for this species on the mainland. Some such species are present in the Study Area, but due to the small size of the Study Area, it is expected that the species would only occur as an occasional visitor.

### **Discussion of Local and Regional Abundance**

#### ***Local***

One record of the Swift Parrot in the Locality exists, approximately 2 km north-west of the Study Area. The Swift Parrot has not been recorded within the Study Area.

#### ***Regional***

Records of the Swift Parrot in the region tend to be scattered, but slightly more common on the coast. Records within the region tend to fall around Sydney or on the coast near Wollongong. Records are scattered outside of these areas. As the species breeds in Tasmania, it is probable that records in the region are of wintering birds passing through.

|                          |                                  |
|--------------------------|----------------------------------|
| <b>Regent Honeyeater</b> | <b><i>Xanthomyza phrygia</i></b> |
|--------------------------|----------------------------------|

### **Discussion of Conservation Status**

The Regent Honeyeater *Xanthomyza phrygia* is listed as Endangered on Schedule 1 of the TSC Act and as Endangered on the EPBC Act.

This species has a patchy distribution in NSW. It is most common around Capertee Valley and the Bundarra-Barraba region where breeding populations are known to

exist. Records are also common along the coast south of Newcastle. The Study Area is not at or near the limits of known distribution for this species.

The Regent Honeyeater has been recorded in conservation reserves of Western Sydney including; Cattai and Scheyville National Parks; Castlereagh, Windsor Downs, Bent Basin and Gulguer Nature Reserves (Jones, et al. 1997). However, due to the nomadic nature of this species it cannot be conserved adequately within conservation reserves.

The conservation status of this species may also be affected by Key Threatening Processes listed on the TSC Act relevant to the Proposal that may impact on potential habitat for the Regent Honeyeater includes:

- ‘Clearing of native vegetation’

There is no Threat abatement plan prepared for this species to date. DECC has developed a list of priority actions to help recover this species in NSW. Some of these are listed below.

- Conduct regular surveys in the South Coast region;
- Conduct research into movement patterns of Regent Honeyeaters in the Hawkesbury-Nepean, Central West and Hunter – Central Rivers Catchments;
- Continue to assess the degree of movement between populations;
- Ensure appropriate environmental impact assessment of Proposals impacting on Regent Honeyeater habitat;
- Ensure Regent Honeyeater habitat on Public Land is managed appropriately;
- Implement threat abatement programs in the regularly used areas; and,
- Promote best practice natural resource management throughout the range of the species.

### **Discussion of Habitat Utilisation**

The Regent Honeyeater is considered to be a highly mobile species occurring in temperate eucalypt woodlands and open forests (NPWS 1999g). Most records are from box-ironbark eucalypt forests associations and wet lowland coastal forests (Pizzey 1983, NPWS 1999g).

Limited potential foraging opportunities for Regent Honeyeater are likely to occur in the Study Area; however records of the species in the Locality are so scarce it

seems unlikely to be dependant on any foraging habitat in the area. The species has not been recorded in the Study Area and is expected to occur only as an occasional visitor, if at all.

### **Discussion of Local and Regional Abundance**

#### ***Local***

One record for the Regent Honeyeater exists from Dharawal State Conservation Area, approximately 5 km north-east of the Study Area. The species is probably rare in the Locality.

#### ***Regional***

Within the region, records for the Regent Honeyeater are most common in Sydney suburbs and west in the Blue Mountains. The species is probably uncommon in the region. Records are also most prevalent on the coast and in known breeding centres.

|                     |  |
|---------------------|--|
| <b>Hooded Robin</b> | <b><i>Melanodryas cucullata cucullata</i> (south-eastern form)</b> |
|---------------------|--|

### **Discussion of Conservation Status**

The Hooded Robin *Melanodryas cucullata cucullata* is listed as Vulnerable on Schedule 2 of the TSC Act. This SIS is concerned only with the south-eastern form.

The Hooded Robin has a scattered and widespread distribution throughout NSW. The species is not frequently recorded east of the Great Dividing Range, except in the Hunter Region (Higgins and Peter 2002). The south-eastern form of Hooded Robin is found from Brisbane to Adelaide throughout much of inland NSW, with the exception of the north-west. It is rarely found on the coast (DEC 2005u), except from the Hunter Region (Higgins and Peter 2002).

Although the Hooded Robin has been recorded in a number of conservation reserves as described above, it is unknown if the species is adequately represented in conservation reserves.

The conservation status of the Hooded Robin may also be affected by Key Threatening Processes as listed under Schedule 3 of the TSC Act. Key Threatening Processes listed on the TSC Act relevant to the Proposal that may impact on potential habitat for the Hooded Robin include:

- ‘Clearing of native vegetation’
- ‘Removal of dead wood and dead trees’



- ‘Ecological consequences of high frequency fires’
- ‘Invasion of native plant communities by exotic perennial grasses’

No recovery or threat abatement plans have been prepared for the Hooded Robin. DECC lists the following actions to help recover the species:

- Retain dead timber on the ground in open woodland areas
- Enhance potential habitat through regeneration by reducing the intensity and duration of grazing
- Fence habitat to protect from long-term, intense grazing
- Increase the size of existing remnants, by planting trees and establishing buffer zones of un-modified, uncultivated pasture around woodland remnants

### **Discussion of Habitat Utilisation**

The Hooded Robin lives in a wide range of temperate woodland habitats and a range of woodlands and shrublands in semi-arid areas (Traill and Duncan 2000). It is not a common species and generally occurs in sedentary groups of two or three individuals (Boles 1988). The species is often quiet and can be difficult to detect (Boles 1988).

The Hooded Robin requires structurally diverse habitats featuring mature eucalypts, saplings, some small shrubs and a ground layer of moderately tall native grasses. It often perches on low dead stumps and fallen timber or on low-hanging branches, using a perch-and-pounce method of hunting insect prey. Territories range from around 10 ha during the breeding season, to 30 ha in the non-breeding season. The species may breed any time between July and November, often rearing several broods. The nest is a small, neat cup of bark and grasses bound with webs, in a tree fork or crevice, from less than 1 m to 5 m above the ground (DEC 2005u).

The Hooded Robin prefers lightly wooded country, usually open eucalypt woodland, acacia scrub and mallee, often in or near clearings or open areas. Potential habitat occurs within the open woodlands and forests.

### **Discussion of Local and Regional Abundance**

#### ***Local***

The Hooded Robin has not been recorded in the Locality. There is one record of the species approximately 10 km to the west at Douglas Park. There are three records approximately 25 km from the Subject Site; one west at Picton and two north-west

near Camden. The species is probably rare within the Locality due to sub-optimal habitat.

### ***Regional***

The Hooded Robin has a scattered and widespread distribution within the region and is uncommonly recorded east of the Great Dividing Range. Most records come from the Blue Mountains National Park, Nattai National Park, and the Liverpool area.

|                         |                                     |
|-------------------------|-------------------------------------|
| <b>Diamond Firetail</b> | <b><i>Stagonopleura guttata</i></b> |
|-------------------------|-------------------------------------|

### **Discussion of Conservation Status**

The Diamond Firetail *Stagonopleura guttata* is listed as Vulnerable on Schedule 2 of the TSC Act.

This Diamond Firetail is most commonly found on the western slopes and plains of the Great Dividing Range. The Study Area is not at or near the limits of the known distribution of this species.

It is unknown whether the Diamond Firetail is adequately represented in conservation reserves.

The conservation status of this species may also be affected by Key Threatening Processes as listed under Schedule 3 of the TSC Act. Key Threatening Processes listed on the TSC Act relevant to the Proposal that may impact on potential habitat for the Diamond Firetail include:

- ‘Clearing of native vegetation’
- ‘Removal of dead wood and dead trees’
- ‘Ecological consequences of high frequency fires’
- ‘Invasion of native plant communities by exotic perennial grasses’

No Threat abatement plan for this species exists. DECC have provided the following priority actions to aid the recovery of this species.

- Increase understanding of woodland birds through promotion of the DECC website and other educational material
- Develop habitat identification, management and enhancement guidelines

for woodland birds

- Implement sympathetic habitat management in conservation reserves, council reserves and crown reserves where the species occurs
- Identify key habitats or areas on a regional basis for protection and enhanced management through incentives
- Conduct ecological research to determine habitat and resource requirements, threats and conservation issues
- Undertake surveys for threatened woodland birds in new and existing conservation reserves containing suitable habitat to assess the species' conservation status and identify key breeding and foraging habitat

### **Discussion of Habitat Utilisation**

The Diamond Firetail occurs in eucalypt woodlands with a grassy understorey, mostly west of the Great Dividing Range with some populations occurring in the drier woodlands in coastal areas such as the Hunter Valley (DEC 2005j). The species is considered sedentary and is often recorded in small family groups in riparian zones.

Potential habitat exists in the Study Area for the Diamond Firetail where open woodland with a grassy understorey occurs. Given its preference for areas west of the Great Dividing Range, it is expected that the species is rarely found in the area and not solely reliant on the potential habitat in the Study Area.

### **Discussion of Local and Regional Abundance**

#### ***Local***

Three records exist approximately within 10 km of the Study Area, all of them to the west. It appears to be locally rare, with a few records from approximately 10 km west of the Study Area.

#### ***Regional***

This species usually occurs west of the Great Dividing Range. It is uncommon in the region. Several records exist from the Blue Mountains and in the Wollondilly LGA west of the Study Area.

|                          |   |
|--------------------------|---|
| <b>Brown Treecreeper</b> | <b><i>Climacteris picumnus victoriae</i> (eastern subspecies)</b> |
|--------------------------|---|

### Discussion of Conservation Status

The Brown Treecreeper *Climacteris picumnus victoriae* (eastern subspecies) is listed as Vulnerable on Schedule 2 of the TSC Act.

The conservation status of the Brown Treecreeper may also be affected by Key Threatening Processes as listed under Schedule 3 of the TSC Act. Key Threatening Processes listed on the TSC Act relevant to the Proposal that may impact on potential habitat for the Brown Treecreeper include:

- 'Clearing of native vegetation'
- 'Removal of dead wood and dead trees'
- 'Ecological consequences of high frequency fires'

No recovery or threat abatement plans have been prepared for the Brown Treecreeper. However, the DECC lists the following actions to help to recover the species:

- Modify grazing management practices that will maintain or improve habitat values and still allow some grazing to occur at strategic times of the year
- Do not allow further loss of dead standing or fallen timber from firewood collection or on-farm practices such as 'tidying up'; do not allow removal of hollow-bearing dead or living trees and stumps on private and public lands
- Fencing of known habitat to protect natural features and to allow natural regeneration
- Increase remnant size and connectivity through incentives and DECC threatened species extension services

### Discussion of Habitat Utilisation

The Brown Treecreeper lives in eucalypt woodlands. The species mainly inhabits woodlands dominated by stringybarks or other rough-barked eucalypts, especially in areas of relatively flat open country, which lacks a dense shrub layer, with finer scale habitat features such as short grass or bare ground that has fallen logs or dead trees present (Traill and Duncan 2000). The Brown Treecreeper nests in hollows, usually in dead branches or spouts, but also in trunks of living or dead trees.

The Brown Treecreeper is almost entirely insectivorous, but will occasionally take

nectar. It forages for ants, beetles and larvae in trees and on the ground. In trees, the species mostly forages among crevices and holes on trunks and larger limbs, preferring rough-barked eucalypts. On the ground the species forages on fallen logs and under bark, at the base of grass tussocks and amongst leaf litter and other debris.

Potential habitat exists within the eucalypt woodlands of the Study Area and especially those areas with finer scale habitat features such as short grass or bare ground; scattered timber and tree hollows.

## **Discussion of Local and Regional Abundance**

### ***Local***

The species has not been recorded in the Study Area. There have been 3 recorded sightings within 10 km of the Study Area; one to the north-east and two north-west.

### ***Regional***

The Brown Treecreeper is widely distributed in eastern Australia. The eastern subspecies *Climacteris picumnus victoriae* occurs from the western slopes to the coastal watersheds of the Great Dividing Range, south of the Bunya Mountains in south-eastern Queensland through NSW and Victoria and west to the Grampians (Higgins *et al* 2001).

The Brown Treecreeper is widespread on and to the west of the divide but sparsely scattered east of the Great Dividing Range. The species' range has not been reduced, but decline in population density have been reported in most parts of its range (Garnett & Crowley 2000) and is now extinct in some areas of NSW (NPWS 2001). Declines in populations have been recorded from the Cumberland Plain (Hoskin 1991; Keast 1995; Egan *et al.* 1997), the New England Tablelands (Barrett *et al.* 1994), the Inverell district (Baldwin 1975), from Munghorn Gap Nature Reserve near Mudgee, and from travelling stock routes in the Parkes district (N. Schrader, unpublished).

The Brown Treecreeper has been recorded in the Blue Mountains National Park and Wollemi National Park, where it is considered to be moderately abundant; although it is unknown if this species is adequately represented in conservation reserves.

**Eastern False Pipistrelle***Falsistrellus tasmaniensis***Discussion of Conservation Status**

The Eastern False Pipistrelle *Falsistrellus tasmaniensis* is listed as Vulnerable on Schedule 2 of the TSC Act.

The Eastern False Pipistrelle has a distribution that extends east of the Great Dividing Range throughout the coastal regions of NSW. The Study Area does not occur at or near the limit of distribution of the Eastern False Pipistrelle.

The extent to which the Eastern False Pipistrelle is represented in conservation reserves is unclear.

The conservation status of the Eastern False Pipistrelle may also be affected by Key Threatening Processes as listed under Schedule 3 of the TSC Act. Threatening processes for microchiropteran bats are generally not well known due to a lack of research. However, KTPs that may affect the Eastern False Pipistrelle that may be associated with the Proposal include:

- ‘Clearing of native vegetation’
- ‘Removal of dead wood and dead trees’

No recovery or threat abatement plans have been prepared for the Eastern False Pipistrelle. However, the DECC lists the following actions to help to recover the species:

- Retain native vegetation that is floristically and structurally diverse
- Minimise the use of pesticides within or adjacent to areas where insectivorous bats occur
- Protect roost sites from disturbance

**Discussion of Habitat Utilisation**

This species inhabits sclerophyll forests, preferring wet habitats where trees are more than 20 m high (Churchill 1998). The species generally roosts in eucalypt hollows, but has also been found under loose bark on trees and in buildings. The Eastern False Pipistrelle hunts beetles, moths, weevils and other flying insects above or just below the tree canopy. There is debate about whether or not this species moves to lower altitudes during winter, or whether they remain sedentary and enter torpor (Menkhorst and Lumsden 1995). This species also appears to be highly mobile and records indicate movements of up to 12 km between roosting and foraging sites (Menkhorst and Lumsden 1995).

Limited potential habitat exists within eucalypt forests and woodlands of the Study Area.

### **Discussion of Local and Regional Abundance**

#### ***Local***

The Eastern False Pipistrelle has been previously recorded once within 10 km of the Study Area, in the adjacent Dharawal State Conservation Area. Records of this species are not typically clustered geographically, and isolated records occur 5-10 km apart throughout the Sydney and Illawarra regions. The species is probably uncommon within the Locality.

#### ***Regional***

The Eastern False Pipistrelle has a scattered and widespread distribution within the Sydney Basin Bioregion with more records occurring south of Sydney and on the Central Coast than other areas of the region.

|                             |  |
|-----------------------------|--|
| <b>Eastern Freetail-bat</b> | <b><i>Mormopterus norfolkensis</i></b> |
|-----------------------------|--|

### **Discussion of Conservation Status**

The Eastern Freetail-bat *Mormopterus norfolkensis* is listed as Vulnerable on Schedule 2 of the TSC Act.

The distribution of the Eastern Freetail-bat in NSW extends east of the Great Dividing Range from the northern border of NSW to the South Coast. The Study Area does not occur at or near the limit of distribution of the Eastern Freetail-bat.

The extent to which the Eastern Freetail-bat is represented in conservation reserves is unclear.

The conservation status of the Eastern Freetail-bat may also be affected by Key Threatening Processes as listed under Schedule 3 of the TSC Act. Threatening processes for microchiropteran bats are generally not well known due to a lack of research. However, KTPs associated with this Proposal that may have an impact on the Eastern Freetail-bat include:

- 'Clearing of native vegetation'
- 'Removal of dead wood and dead trees'

No recovery or threat abatement plans have been prepared for the Eastern Freetail-

bat. However, the DECC lists the following actions to help to recover the species:

- Retain hollow-bearing trees and provide for hollow tree recruitment
- Retain foraging habitat
- Minimise the use of pesticides in or adjacent to foraging areas

### **Discussion of Habitat Utilisation**

The Eastern Freetail-bat occurs in dry sclerophyll forest and woodland east of the Great Dividing Range. It roosts mainly in tree hollows, but will also roost under bark or in man-made structures (Allison and Hoye 1995, Churchill 1998). This species is solitary and considered to be insectivorous however little is known of its habits.

Limited potential habitat exists within eucalypt forests and woodlands of the Study Area.

### **Discussion of Local and Regional Abundance**

#### ***Local***

The Eastern Freetail-bat has not been recorded in the Study Area. There is one record of the species in the Locality, in the adjacent Dharawal State Conservation, and another three records within 10km of the Study Area. The local distribution of the species is scattered, but more common to the north around southern Sydney and in the Blue Mountains to the north-west.

#### ***Regional***

Records for the Eastern Freetail-bat are scattered throughout the Sydney Basin Bioregion, but concentrate nearer the coast (DECC Atlas of NSW Wildlife).

|                             |                          |
|-----------------------------|--------------------------|
| <b>Eastern Pygmy-possum</b> | <i>Cercartetus nanus</i> |
|-----------------------------|--------------------------|

### **Discussion of Conservation Status**

The Eastern Pygmy-possum *Cercartetus nanus* is listed as Vulnerable on Schedule 2 of the TSC Act.

The conservation status of the Eastern Pygmy-possum may also be affected by Key Threatening Processes (KTPs) as listed under Schedule 3 of the TSC Act. KTPs relevant to the Proposal that may impact on potential habitat for this species



include:

- ‘Clearing of native vegetation’;
- ‘Removal of dead wood and dead trees’;
- ‘Ecological consequences of high frequency fires’;
- ‘Predation by feral cats’; and,
- ‘Predation by the European Red Fox’.

No recovery plan has been prepared for the Eastern Pygmy-possum, although some recommendations provided by the DECC to help recover the species are listed below. A Threat abatement plan relevant to this species is Predation by the Red Fox. The Threat abatement plan aims to reduce the impacts of Red Foxes on threatened species to conserve biodiversity (NPWS 2001d).

The DECC lists the following priority actions to help to recover the Eastern Pygmy-possum:

- Control feral predators and rabbits;
- Avoid frequent burning of habitat;
- Protect habitat in Proposal areas and retain linkages across the broader landscape; and,
- Regenerate and replant local feed sources.

### **Discussion of Habitat Utilisation**

The Eastern Pygmy-possum inhabits a variety of habitats from rainforest through to sclerophyll forest and tree heath. Banksias and myrtaceous shrubs and trees are a favoured food source. The species also feeds on insects throughout the year; this feed source may be more important in habitats where flowers are less abundant such as wet forests (DEC 2005).

The species breeds and shelters in tree hollows, rotten stumps, holes in the ground, abandoned bird-nests, Ringtail Possum (*Pseudocheirus peregrinus*) dreys or thickets of vegetation, (e.g. grass-tree skirts). It will often nest in tree hollows, but can also construct its own nests (Turner and Ward 1995); nest-building appears to be restricted to breeding females. 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 nine nest sites within a 0.5 ha area over a five-month

period (Ward 1990).

The Eastern Pygmy-possum appears to be mainly solitary, with each individual using several nests. Males have non-exclusive home-ranges of about 0.68 ha and females about 0.35 ha (DEC 20051).

Potential habitat occurs within the Study Area in optimal woodland and forest habitat with an understorey containing heath, banksias or myrtaceous shrubs for foraging and suitable sheltering and breeding habitat.

### **Discussion of Local and Regional Abundance**

#### ***Local***

The Eastern Pygmy-possum has not been recorded within the Study Area or the Locality. However, there are several records within 5 km of the Locality and also from the nearby Dharawal State Conservation Area, mostly in the north-west and south-east portions of the reserve.

#### ***Regional***

Beyond the immediate Locality, records indicate the species is present in low numbers throughout large reserves. Within the Sydney Basin Bioregion the Eastern Pygmy-possum is mostly distributed along the coast with most records occurring between Shoalhaven and the Central Coast.

The Eastern Pygmy-possum has a wide distribution from the coast to the Great Dividing Range throughout the length of NSW, and as far as Pillaga, Dubbo, Parkes and Wagga Wagga on the western slopes (DEC 20051). Within this range it appears to be patchily distributed and numbers are generally low. The Eastern Pygmy-possum is found in south-eastern Australia, from southern Queensland to eastern South Australia and in Tasmania (DEC 20051). The Study Area is not at the species' limit of distribution.

The Eastern Pygmy-possum has been recorded in a number of conservation reserves, such as Barren Grounds Nature Reserve-Budderoo National Park, Royal National Park, Heathcote National Park and Kioloa State Forest. Whilst the species has been recorded in various reserves, it is in low numbers. It remains unclear how well represented this species is in conservation reserves.

**Gang-gang Cockatoo*****Callocephalon fimbriatum*****Discussion of Conservation Status**

The Gang-gang Cockatoo *Callocephalon fimbriatum* is listed as Vulnerable on Schedule 2 of the TSC Act.

In New South Wales, the Gang-gang Cockatoo is distributed from the south-east coast to the Hunter region, and inland to the Central Tablelands and south-west slopes. The species has been recorded as far north as Coffs Harbour and south well into Victoria. The Study Area is not close to the boundaries of the species' current distribution.

Gang-gang Cockatoos have been recorded in various reserves throughout eastern and central NSW. It is considered to be adequately represented in reserves within the Sydney Basin Bioregion.

The conservation status of this species may also be affected by Key Threatening Processes as listed under Schedule 3 of the TSC Act. Key Threatening Processes relevant to the Proposal that may impact on potential habitat for the Gang-gang Cockatoo include:

- 'Clearing of native vegetation'
- 'Removal of dead wood and dead trees'
- 'Ecological consequences of high frequency fires'
- 'Human-caused Climate Change'. This species prefers cold-climate vegetation communities

No recovery or threat abatement plans have been prepared for the Gang-gang Cockatoo. However, the DECC lists the following actions to help to recover the species:

- Habitat management in relation to fire
- Habitat rehabilitation/restoration and/or regeneration
- Monitoring

**Discussion of Habitat Requirements**

In summer, the Gang-gang Cockatoo occupies tall montane forests and woodlands, particularly in heavily timbered and mature wet sclerophyll forests (Higgins 1999). It also occurs in subalpine Snow Gum woodland and occasionally in temperate or regenerating forest (Forshaw and Cooper 1981). In winter, it 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). Gang-gang Cockatoos nest in tree hollows, preferring live trees often near water with hollows between 70-200 cm deep and approximately 25 cm in diameter. These trees often occur in mature sclerophyll forest with a dense shrubby understorey.

The Gang-gang Cockatoo forages for seeds in the canopies of native and introduced trees, especially eucalypts. Little is known about the movements of this species, although they are considered to be mobile and known to migrate in response to food availability.

The Gang-gang Cockatoo has been recorded within the Locality. Habitat exists within the open eucalypt forests and woodlands of the Study Area including nesting and roosting habitat is present.

### **Discussion of Local and Regional Abundance**

#### ***Local***

The species has been recorded several times in the Locality. The species has also been previously recorded within 10 km of the Study Area at the northern boundaries and south-eastern portion of Dharawal State Conservation Area, and 5km south at Lake Cataract.

#### ***Regional***

Hundreds of records exist within the Sydney Basin Bioregion, occurring along the coast and along the Great Dividing Range. The species is moderately common within the region.

|                                |                                    |
|--------------------------------|------------------------------------|
| <b>Greater Broad-nosed Bat</b> | <b><i>Scoteanax rueppellii</i></b> |
|--------------------------------|------------------------------------|

### **Discussion of Conservation Status**

The Greater Broad-nosed Bat *Scoteanax rueppellii* is listed as Vulnerable on Schedule 2 of the TSC Act.

The distribution of this species extends east of the Great Dividing Range from the northern border of NSW to the South Coast. The Study Area does not occur at or near the limit of distribution of the Greater Broad-nosed Bat.

The extent to which this species is represented in conservation reserves is unclear. Records are scattered and sparse. It is unlikely this species is represented adequately in conservation reserves.

The conservation status of this species may also be affected by Key Threatening Processes as listed under Schedule 3 of the TSC Act. Threatening processes for microchiropteran bats are generally not well known due to a lack of research. However, KTPs associated with this Proposal that may have an impact on the Greater Broad-nosed Bat include:

- ‘Clearing of native vegetation’
- ‘Removal of dead wood and dead trees’
- ‘Alteration to the natural flow regimes of rivers, streams, floodplains & wetlands’
- Loss of hollow-bearing trees (proposed KTP)

No recovery or threat abatement plans have been prepared for the Greater Broad-nosed Bat. However, the DECC has developed a list of priority actions to help to recover the species. Some of these actions are:

- Actively encourage the conservation of the riparian vegetation and water quality of streams and rivers
- DECC should be consulted when planning development/s to minimise impact/s on populations
- Conduct searches for the species in suitable habitat in Proposal areas
- Retain stands of native vegetation, especially those with hollow-bearing trees (including dead trees), and retain other structures containing bats
- Retain a buffer of vegetation around roost sites in vegetated areas
- Protect hollow-bearing trees as breeding sites, including those on farmland; younger mature trees should also be retained to provide replacements for the older trees as they die and fall over
- Encourage regeneration and replanting of local flora species to maintain bat foraging habitat
- Assess the Study Area's importance to the species' survival, including linkages provided between ecological resources across the broader landscape

### **Discussion of Habitat Utilisation**

The Greater Broad-nosed Bat prefers moist gullies in mature coastal forests and rainforests, between the Great Dividing Range and the coast. It is only found at low

altitudes below 500 m (Churchill 1998). In dense forests they utilise natural and human-made openings in the forest for flight paths. The species roosts in hollow tree trunks and branches (Churchill 1998) and has also been found in buildings. It forages after sunset, flying slowly and directly along creek and river corridors at an altitude of 3 - 6 m. Open woodland habitat and dry open forest suits the direct flight of this species as it searches for beetles and other large, slow-flying insects; this species has been known to eat other bat species. Little is known of its reproductive cycle, however a single young is born in January; prior to birth, females congregate at maternity sites located in suitable trees, where they appear to exclude males during the birth and raising of the young.

Potential habitat exists within the eucalypt woodlands and forests of the Study Area. The Study Area does not provide the preferred habitat of tall, wet forest. The species forages along creeks and small rivers and roosts in tree hollows or under bark.

### **Discussion of Local and Regional Abundance**

#### ***Local***

The species has been previously recorded on several occasions within 10 km of the Study Area and within the Locality. Scattered records of the species exist to the north, south, and east of the Study Area. The species has not been recorded within the Study Area.

#### ***Regional***

Records of this species are scattered throughout the Sydney Basin Bioregion, but are concentrated nearer the coast, east of the Great Dividing Range (DECC Atlas of NSW Wildlife). It is probably uncommon in most areas of the region, except for some isolated areas on the coast.

## **Powerful Owl**

*Ninox strenua*

### **Discussion of Conservation Status**

The Powerful Owl *Ninox strenua* is listed as Vulnerable on the TSC Act.

This species has a wide distribution along the coastal region, mainly east of the Great Dividing Range, although scattered records exist to the west (Higgins, 1999).

Records exist for this species from Royal National Park, Heathcote National Park and Dharawal State Conservation Area. It is estimated that while the species is

recorded in conservation reserves, just as many records of the species are from private land. The Study Area does not occur at or near the limit of distribution of the Powerful Owl.

The conservation status of this species may also be affected by Key Threatening Processes as listed under Schedule 3 of the TSC Act (1995). Key Threatening Processes listed on the TSC Act relevant to the Proposal that may impact on actual and potential habitat for the Powerful Owl include:

- ‘Clearing of native vegetation’
- ‘Ecological consequences of high frequency fires’ - the Proposal is not likely to increase the frequency of fires in the area
- ‘Removal of dead wood and dead trees’ - the removal of standing dead trees may lead to the loss of breeding and roosting habitat, whilst the loss of fallen dead wood may lead to the loss of habitat for prey species
- ‘Bushrock removal’ - the Proposal would involve the removal of bushrock including large rock platforms and outcrops, which may provide potential habitat for prey species
- ‘Loss of hollow-bearing trees’ has been proposed as a Key Threatening Process

A recovery plan has been prepared for this species (DEC 2006b). DECC has listed 23 priority actions to help recover this species, some of which are:

- Apply low-intensity, mosaic pattern fuel reduction regimes
- Searches for the species should be conducted in suitable habitat in proposed development areas and proposed forest harvesting compartments
- Retain at least a 200 m buffer of native vegetation around known nesting sites
- Retain large stands of native vegetation, especially those containing hollow-bearing trees
- Protect riparian vegetation to preserve roosting areas
- Protect hollow-bearing trees for nest sites. Younger recruitment trees should also be retained to replace older trees in the long-term
- Minimise visits to nests and other disturbances, including surveys using

call playback, when owls are breeding

- Assess the importance of the Study Area to the species' survival. Include the linkages the site provides for the species between ecological resources across the broader landscape

To date, no threat abatement plan has been prepared for the Powerful Owl.

### **Discussion of Habitat Utilisation**

The Powerful Owl occupies wet and dry eucalypt forests and rainforests. It 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).

Potential foraging and nesting habitat exists within the Study Area. The Powerful Owl utilises a variety of habitats from woodland through to moist and dry eucalypt forest and rainforest. The species usually roosts in gully areas and nests in large tree hollows. It forages after sunset, often covering great distances in its search for food. The Study Area contains many tree hollows of varying sizes, offering both suitable foraging habitat and suitable nesting habitat for the Powerful Owl.

### **Discussion of Local and Regional Abundance**

#### ***Local***

The species has been recorded both on the Study Area and in the Locality. The local distribution is scattered, probably reflecting the large territory size of the species.

#### ***Regional***

The Powerful Owl has a scattered distribution within the region with the highest abundance of records occurring along the coast in the Royal National Park and the Illawarra Escarpment. It is probably uncommon in most areas of the region, except for some areas on the coast immediately north and immediately south of Sydney.



**Speckled Warbler*****Pyrrholaemus sagittatus*****Discussion of Conservation Status**

The Speckled Warbler *Pyrrholaemus sagittatus* is listed as Vulnerable on Schedule 2 of the TSC Act.

In NSW, Speckled Warblers occupy Eucalypt and Cypress woodlands on the slopes west of the Great Dividing Range, with an extension of range into the Cypress woodlands of the northern Riverina. Populations also occur in drier coastal areas such as the Cumberland Plain, Western Sydney and the Hunter and Snowy River valleys (Blakers et al. 1984, Schodde & Mason 1999, (DEC 2001). The Speckled Warbler is distributed from south-eastern Queensland, through central and eastern NSW to Victoria (DEC 2001). The Study Area is not located at the species' limit of distribution.

The species has been recorded within a number of conservation reserves within the region, as well as Kosciuszko National Park, Cocoparra Nature Reserve, Goobang National Park, Pilliga East State Forest, Mount Kaputar National Park and Guy Fawkes River National Park. The Speckled Warbler may be reasonably represented in conservation reserves.

The conservation status of this species may also be affected by Key Threatening Processes as listed under Schedule 3 of the TSC Act. Key Threatening Processes relevant to the Proposal that may impact on potential habitat for the Speckled Warbler include:

- 'Clearing of native vegetation'
- 'Removal of dead wood and dead trees'
- 'Ecological consequences of high frequency fires'
- 'Predation by feral cats'
- 'Predation by the European Red Fox'
- 'Invasion of native vegetation communities by exotic perennial grasses'

No recovery plan has been prepared for the Speckled Warbler, although some actions have been recommended by the DECC to help recover the species are listed below. A threat abatement plan relevant to this species is Predation by the Red Fox. The threat abatement plan aims to reduce the impacts of Red Foxes on threatened species such as the Speckled Warbler and generally to conserve biodiversity (NPWS 2001d).

The DECC lists the following actions to help to recover the species:

- Undertake fox and feral cat control programs
- NPWS should be consulted when planning development to minimise impact on populations
- Retain dead timber on the ground in open woodland areas
- Retain existing vegetation along roadsides, in paddocks and remnant stands of native trees
- Encourage regeneration of habitat by fencing remnant stands
- Fence suitable woodland habitats, particularly those with unimproved pasture and an intact native ground plant layer
- Increase the size of existing remnants by planting trees and establishing buffer zones of unimproved uncultivated pasture around woodland remnants
- Assess the importance of the site to the species' survival. Include the linkages the site provides for the species between ecological resources across the broader landscape
- Report any new sightings of the Speckled Warbler to the Department of Environment and Climate Change

### **Discussion of Habitat Utilisation**

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 (NSW Scientific Committee 2001a). The species is sedentary, living in pairs or trios and occupy a breeding territory of about 10 ha, with a slightly larger home-range when not breeding (DEC 2005,,). They nests on the ground in grass tussocks, dense litter and fallen branches. The diet consists of seeds and insects, foraging on the the ground and in the understorey for arthropods and seeds (Blakers *et al.* 1984). Home ranges vary from 6-12 hectares (NSW Scientific Committee 2001a).

Potential habitat exists in the Study Area within the eucalypt woodlands where a grassy understorey is present, however, the habitat in the Study Area is sub-optimal for this species. The Speckled Warbler prefers more open and grassy woodlands than those present in the Study Area.

## Discussion of Local and Regional Abundance

### *Local*

The species has not been previously recorded within the Study Area, or the Locality, or within 10 km of the Study Area. The nearest records are from approximately 10km west in Picton.

### *Regional*

Within the Sydney Basin Bioregion, the Speckled Warbler has a scattered distribution, having been recorded in Nattai National Park, Yerranderie State Recreation Area, around Windsor, in Wollemi National Park, in and around Manobalai Nature Reserve, in Yengo National Park and in Kurri Kurri. The species is probably uncommon within the region.

|                        |                              |
|------------------------|------------------------------|
| <b>Squirrel Glider</b> | <i>Petaurus norfolcensis</i> |
|------------------------|------------------------------|

## Discussion of Conservation Status

The Squirrel Glider *Petaurus norfolcensis* is listed as Vulnerable on Schedule 2 of the TSC Act.

This species is sparsely distributed along the east coast and immediate inland areas as far west as the Coonabarabran (DEC 1999). The species is sparsely distributed in eastern Australia, from northern Queensland to western Victoria (NPWS 1999i). The Study Area is not at the species' limit of distribution.

The Squirrel Glider has been recorded in Blue Mountains National Park, Brisbane Waters NP, Tooloom NP, Border Rangers NP, Mount Warning NP, Warrumbungle NP and Binnaway Nature Reserve (DEC 1999). However, it is not known how well this species is represented in these conservation reserves.

The conservation status of this species may also be affected by Key Threatening Processes as listed under Schedule 3 of the TSC Act. Key Threatening Processes relevant to the Proposal that may impact on potential habitat for the Squirrel Glider include:

- 'Clearing of native vegetation'
- 'Removal of dead wood and dead trees'
- 'Ecological consequences of high frequency fires'

- ‘Predation by feral cats’
- ‘Predation by the European Red Fox’
- ‘Loss of Hollow-bearing Trees’ has been proposed as a Key Threatening Process by the NSW Scientific Committee

No recovery or threat abatement plans have been prepared for the Squirrel Glider. However, the DECC lists the following actions to help to recover the species:

- Retain food resources, particularly sap-feeding trees and understorey feed species such as Acacias and banksias
- Retain den trees and recruitment trees (future hollow-bearing trees)
- Replace the top one or two strands of barbed wire on fences with regular wire in and adjacent to known habitat
- Retain and protect areas of habitat, particularly mature or old growth forest containing hollow-bearing trees and sap-feeding trees
- In urban and rural areas retain and rehabilitate habitat to maintain or increase the total area of habitat available, reduce edge effects, minimise foraging distances and increase the types of resources available

### **Discussion of Habitat Utilisation**

The Squirrel Glider generally occurs in dry sclerophyll forests and woodlands, but is absent from dense coastal ranges in the southern part of its range (Suckling 1995). It 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 suitable vegetation, at least one tree species should flower heavily in winter and one species of eucalypt should be smooth barked (Menkhorst *et al.* 1988).

The Squirrel Glider prefers mixed species stands with a shrub or Acacia midstorey which provide ideal foraging habitat; which generally consists of Acacia gum, Eucalypt sap, nectar, honeydew and manna, with invertebrates and pollen providing protein (NPWS 1999i). The species live in family groups of a single adult male and one or more adult females and offspring. They require abundant tree hollows for refuge and nest sites.

Potential habitat occurs within the forests and woodlands of the Study Area.

### **Discussion of Local and Regional Abundance**

***Local***

The species has not been recorded in the Locality, but is known from two records from within 10 km of the Study Area in the Metropolitan Water Catchments between Dharawal State Conservation Area and Campbelltown. The species has not been recorded in the Study Area.

***Regional***

Within the Sydney Basin Bioregion the Squirrel Glider has a widespread and scattered distribution. The species is probably less common in the southern part of the region than in the northern part. Most records of the species within the region occur on the Central Coast and in the Hunter Valley.

**Turquoise Parrot*****Neophema pulchella*****Discussion of Conservation Status**

The Turquoise Parrot *Neophema pulchella* is listed as Vulnerable on Schedule 2 of the TSC Act.

This species is typically recorded west of the escarpment in the tablelands and on the western slopes, extending to the coastal districts through the dry forests of the Hunter Valley. The Study Area does not occur at or near the limit of distribution of the Turquoise Parrot.

The Turquoise Parrot has been recorded within various conservation reserves in eastern and central NSW (NPWS 1999j). However, it is not known if the species is adequately represented in these reserves.

The conservation status of this species may also be affected by Key Threatening Processes as listed under Schedule 3 of the TSC Act. Key Threatening Processes relevant to the Proposal that may impact on potential habitat for the Turquoise Parrot include:

- ‘Clearing of native vegetation’
- ‘Removal of dead wood and dead trees’
- ‘Ecological consequences of high frequency fires’
- ‘Predation by feral cats’
- ‘Predation by the European Red Fox’

- ‘Invasion of native vegetation communities by exotic perennial grasses’
- ‘Loss of Hollow-bearing Trees’ has been proposed as a Key Threatening Process by the NSW Scientific Committee

No recovery or threat abatement plan has been prepared for the Turquoise Parrot. However, the DECC lists the following actions to help to recover the species:

- Community and land-holder liaison/awareness and/or education (select targeted areas which contain large populations and liaise with landholders to protect hollow-bearing trees)
- Habitat management in relation the control of feral cats and foxes near high density populations

### **Discussion of Habitat Utilisation**

Turquoise Parrots occur in open woodlands and eucalypt forests with a ground cover of grasses and understorey of low shrubs (Morris 1980). It is found in the foothills of the Great Divide, including steep rocky ridges and gullies (Higgins 1999). They nest in hollow-bearing trees or hollows in tree stumps and they prefer to breed in open grassy forests and woodlands, and gullies which are moist (Higgins 1999).

Turquoise Parrots are usually recorded in pairs or small, possibly family groups and have also been reported in flocks of up to thirty individuals. The species prefers to feed in the shade of trees and spends most of the day on the ground searching for the seeds of grasses and herbaceous plants, or browsing on vegetable matter. The species nests in tree hollows, logs or posts, from August to December. It lays four or five white, rounded eggs on a nest of decayed wood dust (DEC 2005E).

Potential habitat exists within the open woodland and eucalypt forests of the Study Area, where there is a ground cover of grasses and understorey of low shrubs.

### **Discussion of Local and Regional Abundance**

#### ***Local***

The species has been previously recorded once within the Locality, approximately 5 km north-east of the Study Area in Dharawal State Conservation Area, and once 10 km south-west in Metropolitan Water Catchments, Wilton.

#### ***Regional***

Records of this species are scattered throughout the Sydney Basin Bioregion (DECC Atlas of NSW Wildlife). The species is likely to be uncommon within the

region.

|                                      |                                 |
|--------------------------------------|---------------------------------|
| <b>Yellow-bellied Sheathtail-bat</b> | <i>Saccolaimus flaviventris</i> |
|--------------------------------------|---------------------------------|

### Discussion of Conservation Status

The Yellow-bellied Sheathtail-bat *Saccolaimus flaviventris* is listed as Vulnerable on Schedule 2 of the TSC Act.

The Yellow-bellied Sheathtail-bat is a wide-ranging species primarily occurring through tropical Australia, but with many records extending into New South Wales. They have been reported from southern Australia only between January and June. The Study Area does not occur at or near the limit of distribution of the Yellow-bellied Sheathtail-bat.

Due to the scattered and scarce records for this species, it is unknown whether it is adequately represented in conservation reserves.

The conservation status of this species may also be affected by Key Threatening Processes as listed under Schedule 3 of the TSC Act. Key Threatening Processes relevant to the Proposal that may impact on potential habitat for the Yellow-bellied Sheathtail-bat include:

- 'Clearing of native vegetation'
- 'Removal of dead wood and dead trees'
- 'Loss of Hollow-bearing Trees' has been proposed as a Key Threatening Process by the NSW Scientific Committee

No recovery or threat abatement plans have been prepared for the Yellow-bellied Sheathtail-bat. However, the DECC lists a number of actions to help recover the species. Those relevant to the Proposal include:

- Conduct searches for the species in suitable habitat in Proposal areas
- Retain stands of native vegetation, especially those with hollow-bearing trees (including dead trees), and retain other structures containing bats. Species requirements will be considered in the VFMP prepared for West Cliff
- Retain a buffer of vegetation around roost sites in vegetated areas. Species requirements will be considered in the VFMP prepared for West Cliff
- Protect hollow-bearing trees for breeding sites including those on farmland; younger mature trees should also be retained to provide

replacements for the older trees as they die and fall over. Species requirements will be considered in the VFMP prepared for West Cliff

- Encourage regeneration and replanting of local flora species to maintain bat foraging habitat. Species requirements will be considered in the VFMP prepared for West Cliff

Assess the Study Area's importance to the species' survival, including linkages provided between ecological resources across the broader landscape. The site is part of a larger expanse of native vegetation.

### **Discussion of Habitat Utilisation**

The Yellow-bellied Sheath-tail-bat is restricted to tall mature forests in regions of high rainfall. Its preferred habitats are productive, tall open sclerophyll forests where mature trees provide shelter and nesting hollows. Critical elements of habitat include sap-trees, winter flowering eucalypts, mature trees suitable for den sites and a mosaic of different forest types (NPWS 1999k).

Potential habitat occurs within the open forests and woodlands of the Study Area. The species will forage in forested (above the canopy) as well as treeless areas, and requires tall, mature trees with hollows for breeding.

### **Discussion of Local and Regional Abundance**

#### ***Local***

The species has not been recorded in the Study Area, nor has it previously been recorded within 10km of the Study Area. The closest record of the species is approximately 15 km north-west of the Study Area in Campbelltown. However, this species has been recorded in the nearby Dharawal State Conservation Area, although it has not been sighted for many years.

#### ***Regional***

The Yellow-bellied Sheath-tail-bat has a scattered distribution within the region, with the highest abundance of records occurring along the coast. It is probably uncommon in the region, except for a number of isolated coastal locations.



**Eastern Bent-wing Bat*****Miniopterus schreibersii oceanensis*****Discussion of Conservation Status**

The Eastern Bent-wing Bat *Miniopterus schreibersii oceanensis* is listed as Vulnerable on the TSC Act.

This species has a wide distribution throughout non-arid regions of NSW. The Study Area is not at the limit of distribution of the Eastern Bent-wing Bat.

Many records of this species fall outside of conservation reserves. It is therefore unlikely that the species is adequately represented in conservation reserves.

The conservation status of this species may also be affected by Key Threatening Processes as listed under Schedule 3 of the TSC Act. Key Threatening Processes listed on the TSC Act relevant to the Proposal that may impact on actual and potential habitat for the Eastern Bent-wing Bat include:

- 'Clearing of native vegetation'
- 'Removal of dead wood and dead trees'
- 'Predation by the European Red Fox'
- 'Loss of Hollow-bearing Trees' has been proposed as a Key Threatening Process by the NSW Scientific Committee

To date, no recovery plan has been prepared for the Eastern Bent-wing Bat. However, the DECC lists a number of actions to help recover the species. Those relevant to the Proposal are listed below:

- Retain native vegetation around roost sites, particularly within 300 m of maternity caves – No caves are present in the Study Area. Species requirements will be considered in the VFMP prepared for West Cliff
- Protect roosting sites from damage or disturbance - Species requirements will be considered in the VFMP prepared for West Cliff

A threat abatement plan relevant to the Eastern Bent-wing Bat is 'Predation by the Red Fox'. Although the Eastern Bent-wing Bat is not listed as a priority species of concern in the plan, the plan aims to reduce the impacts of red foxes on threatened species (NPWS 2001d).

**Discussion of Habitat Utilisation**

The Eastern Bent-wing Bat uses a broad range of habitats including rainforests, wet and dry sclerophyll forests, open woodlands and open grasslands (Churchill, 1988). The species roosts in caves, but can also use manmade structures such as mines and road culverts (Churchill, 1988, Dwyer, 1995). Specific caves are used as nursery caves, containing a large number of individuals, which can be used year after year (Churchill, 1988, Dwyer, 1995).

Potential foraging habitat occurs within the open forests and woodlands of the Study Area. The species requires caves for breeding, which are not present in the Study Area. The species also uses caves for roosting but may also use abandoned mines, buildings and storm water drains. The Eastern Bent-wing Bat forages for flying insects above the tree canopy (DEC 2005k). The species can travel many kilometres between roost sites.

### **Discussion of Local and Regional Abundance**

#### ***Local***

The species has been recorded within the Study Area. Other records in the Locality come from Dharawal State Conservation Area to the north and east and a timber reserve on the outskirts of Wollongong to the south.

#### ***Regional***

The species has a wide distribution within the Sydney Basin Bioregion, but is most commonly found along the coast. It appears to be moderately common within the region.

|              |                                      |
|--------------|--------------------------------------|
| <b>Koala</b> | <b><i>Phascolarctos cinereus</i></b> |
|--------------|--------------------------------------|

### **Discussion of Conservation Status**

The Koala *Phascolarctos cinereus* is listed as Vulnerable on the TSC Act.

The Koala mainly occurs on the central and north coasts in fragmented populations. The species also occurs in sparse and disjunct populations on the south coast, particularly around Eden (Reed and Lunney, 1990).

This species is probably well represented within conservation reserves. In NSW, Koalas have been recorded in numerous conservation reserves along the east coast and the slopes and tablelands of the Great Dividing Range (NPWS 1999f). The Study Area is not at the limit of distribution of the Koala in NSW.

The conservation status of this species may also be affected by Key Threatening

Processes as listed under Schedule 3 of the TSC Act. Key Threatening Processes listed on the TSC Act relevant to the Proposal that may impact on potential habitat for the Koala include:

- ‘Clearing of native vegetation’
- ‘Ecological consequences of high frequency fires’

A draft recovery plan has been prepared for the Koala (NPWS 2003b). The aim of the plan is to facilitate the implementation of current legislation in protecting the Koala, especially on a local scale. DECC has listed 29 priority actions to help recover this species. Those relevant to the Proposal include:

- Apply low intensity, mosaic pattern fuel reduction burns in or adjacent to Koala habitat. Species requirements will be considered in the VFMP prepared for West Cliff
- Retain suitable habitat, especially areas dominated by preferred feed-tree species. Species requirements will be considered in the VFMP prepared for West Cliff
- Revegetate with suitable feed tree species and develop habitat corridors between populations. Species requirements will be considered in the VFMP prepared for West Cliff

### **Discussion of Habitat Utilisation**

The species 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).

Potential and known foraging habitat occurs within the open forests and woodlands of the Study Area. Despite an extant population 7-8 km to the north of the Study Area (Wedderburn), the Koala is not expected to rely on the habitats at West Cliff. This assertion is based on a local deficiency of ‘preferred’ feed trees, low nutrient soils, and an absence of any evidence of recent Koala activity, such as scats and tree markings.

### **Discussion of Local and Regional Abundance**

#### ***Local***

There are a large number of records of Koalas within 10 km of the Study Area, including a large population within 10 km of the Study Area at Wedderburn. Populations also exist east of Campbelltown and in the far northern suburbs of Sydney. There are also records from the Water Supply Reserve south of

Wollondilly. The species has been previously recorded throughout the Locality and on the Subject Site.

### ***Regional***

Populations of the species are known to occur throughout the Woronora Plateau (Robinson, 1985).

## **Grey-headed Flying-fox**

## ***Pteropus poliocephalus***

### **Discussion of Conservation Status**

The Grey-headed Flying-fox *Pteropus poliocephalus* is listed as Vulnerable on both the TSC and EPBC Act.

This species occurs in a coastal belt throughout the length of NSW, but only occasionally west of the Great Dividing Range (Tidemann, 1995). The Study Area is not at the limit of distribution of the Grey-headed Flying-fox in NSW.

In NSW, Grey-headed Flying-foxes have been recorded in numerous conservation reserves along the east coast, and the tablelands and eastern slopes of the Great Dividing Range (NPWS 2001a). This species is probably well represented within conservation reserves.

The conservation status of this species may also be affected by Key Threatening Processes as listed under Schedule 3 of the TSC Act. Key Threatening Processes relevant to the Proposal that may impact on actual and potential habitat for the Grey-headed Flying-fox include:

- ‘Clearing of native vegetation’

To date, no recovery plan or threat abatement plan has been prepared for the Grey-headed Flying-fox. However, the DECC lists a number of actions to help recover the species. Those relevant to the Proposal include:

- Protect roost sites, particularly avoid disturbance from September through to November. – No known roost sites exist in the Locality, however, species requirements will be considered in the VFMP prepared for West Cliff
- Identify and protect key foraging areas - Species requirements will be considered in the VFMP prepared for West Cliff

## Discussion of Habitat Utilisation

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).

Potential foraging habitat occurs within the forests and woodlands of the Study Area. The Study Area is unlikely to support a camp Study Area (where roosting and breeding occurs) as it does not support rainforest, coastal scrub, or dense canopies. This is a highly mobile species that may travel great distances in search of food. The species is known to travel up to 50 km from a camp Study Area to forage (DEC 2005s). It is not expected that the species would be reliant on the foraging resources available in the Study Area. No camps exist within the Study Area or the Locality.

## Discussion of Local and Regional Abundance

### *Local*

The species has been observed foraging in the Study Area and also has been recorded numerous times within the Locality.

### *Regional*

There are many records of the Grey-headed Flying-fox in the broader region. Records tend to be clustered around the coast.

|                                  |                              |
|----------------------------------|------------------------------|
| <b>Brush-tailed Rock Wallaby</b> | <i>Petrogale penicillata</i> |
|----------------------------------|------------------------------|

## Discussion of Conservation Status

The Brush-tailed Rock Wallaby is listed as Vulnerable on both the TSC and EPBC Act.

The species' former range in NSW was large, extending from the coast to the semi-arid regions of the state. It now exists in a narrow band, extending north from Sydney to the Queensland border inland from the coast. The Study Area is not at or near the limits of known distribution for this species.

It is unknown whether this species is adequately represented in conservation reserves.

The conservation status of this species may also be affected by Key Threatening Processes as listed under Schedule 3 of the TSC Act. Key Threatening Processes

relevant to the Proposal that may impact on potential habitat for the Brush-tailed Rock Wallaby include:

- ‘Clearing of native vegetation’
- ‘Predation by the European Red Fox’
- ‘Competition and habitat degradation by feral goats’

The threat abatement plan relevant to this species is ‘Predation by the Red Fox’. The plan aims to reduce predation on native animals by the European Red Fox. No recovery plan has been prepared, but the DECC has prepared a list of priority actions to assist in the species’ recovery in NSW. Those relevant to the Proposal are outlined below:

- Identify sites and appropriate land management mechanisms to ameliorate significant impacts caused by habitat loss where such specific management actions are required – Species requirements will be considered in the VFMP prepared for West Cliff.

### **Discussion of Habitat Utilisation**

The Brush-tailed Rock Wallaby is found in rocky areas in a wide variety of habitats including rainforest gullies, wet and dry sclerophyll forest, and 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).

Habitat for the species may occur in parts of the Study Area containing rocky outcrops and rock crevices suitable for shelter. The few records of the species within 30 km of the Study Area are over 30 years old, and it is unlikely that the species still occurs in the area.

### **Discussion of Local and Regional Distribution**

#### ***Local***

There are no records for this species within 10 km of the Study Area.

#### ***Regional***

The species appears rare in the region, with only 2 records within 15 km from the Study Area. Within the region, the species has a scattered and patchy distribution, with most records occurring in the Blue Mountains or further south in reserves west of Nowra.

**Rosenberg's Goanna***Varanus rosenbergi***Discussion of Conservation Status**

Rosenberg's Goanna *Varanus rosenbergi* is listed as Vulnerable on the TSC Act.

The species distribution is generally restricted to the Sydney region, with some records from the Canberra area. The Study Area is not at or near the limits of the species' known distribution.

Most records of this species are from conservation reserves. However, considering the restricted range of this species and the fact that many records fall close to the boundaries of conservation reserves, it is unknown if this species has an adequate representation in conservation reserves.

The conservation status of this species may also be affected by Key Threatening Processes as listed under Schedule 3 of the TSC Act. Key Threatening Processes relevant to the Proposal that may impact on potential habitat for Rosenberg's Goanna include:

- 'Clearing of native vegetation'
- 'Removal of dead wood and dead trees'
- 'Bushrock removal'
- 'Predation by feral cats'
- 'Predation by the European Red Fox'

The threat abatement plan relevant to this species is 'Predation by the Red Fox'. The plan aims to reduce predation on native animals by the European Red Fox. No recovery plan has been prepared, but the DECC has prepared a list of priority actions to assist in the species' recovery in NSW. Those relevant to the Proposal are outlined below:

- Identify suitable habitat across the range of the species with reference to satellite imagery and vegetation surveys – Species requirements will be considered in the VFMP prepared for West Cliff
- Undertake surveys for the species within identified suitable habitat
- Implement management strategies that reduce the prevalence of bush rock removal, including surveillance – Bushrock will be relocated to rehabilitation areas, as detailed in the VFMP

## Discussion of Habitat Utilisation

Rosenberg's Goanna is a Hawkesbury/Narrabeen sandstone outcrop specialist (Wellington and Wells 1990). It is found in woodlands, forests, and heathland and shelters in hollow logs, burrows, rock crevices, and sandstone outcrops (Wilson and Knowles 1988). Eggs are laid in active termite mounds (Green and King 1993). Based on studies conducted on Kangaroo Island, the Rosenberg's goanna has a relatively small home range, averaging 19 ha.

Habitat for the species exists in the Study Area where sandstone outcropping occurs. The number of local records of the species nearby suggests that the species is likely to occur in the Study Area. In addition the Study Area could support a discreet local population. The species is a specialist of sandstone outcropping, and it is therefore likely that the habitat in the Study Area is important to the local population of the species.

## Discussion of Local and Regional Abundance

### *Local*

The Rosenberg's Goanna has been recorded in the study area. It has also been recorded in Dharawal State Conservation Area and Darkes Forest, adjacent to the Study Area. Additionally, numerous records exist within 10 km of the Subject Site, and within the Locality, most of which occur to the east and north of the Study Area. The species appears to be moderately common in the Locality.

### *Regional*

Most records in the region tend to occur close to the coast with the exception of several records northwards in the Blue Mountains. Otherwise, the distribution is scattered and patchy.

The species appears to be uncommon in the region.

|                           |                                  |
|---------------------------|----------------------------------|
| <b>Broad-headed Snake</b> | <i>Hoplocephalus bungaroides</i> |
|---------------------------|----------------------------------|

## Discussion of Conservation Status

The Broad-headed Snake *Hoplocephalus bungaroides* is listed as Endangered on the TSC Act and as Vulnerable on the EPBC Act.

The species is not widespread within NSW, with records restricted to the Sydney Basin Bioregion.



This species is probably reasonably well represented within conservation reserves. The species is currently known from Blue Mountains, Heathcote, Morton, Royal, Wollemi and Yengo National Parks and Parr State Recreation Area. It is thought to be present in Dharug and Popran National Parks and was historically known from areas now within Garigal, Ku-ring-gai, Lane Cove and Marramarra National Parks. Other important areas of distribution in which the species is believed to be afforded some level of security include: Avon, Cataract, Cordeaux, Nepean and Woronora Catchment areas and the Holsworthy Military Lands on the southern outskirts of Sydney (NPWS 1999c).

The conservation status of this species may also be affected by Key Threatening Processes as listed under Schedule 3 of the TSC Act (1995). Key Threatening Processes relevant to the Proposal that may impact on actual and potential habitat for the Broad-headed Snake include:

- ‘Bushrock removal’ - the Proposal would involve the removal of Bushrock, including large rock platforms and outcrops which provide potential habitat for the species
- ‘Clearing of native vegetation’
- ‘Loss of Hollow-bearing Trees’ has been proposed as a Key Threatening Process by the NSW Scientific Committee. Hollow-bearing trees would be removed by the Proposal resulting in the loss of potential roosting habitat for the Broad-headed Snake

To date, no recovery plan or threat abatement plan has been prepared for the Broad-headed Snake. However, the DECC lists a number of actions to help recover the species. Those relevant to the Proposal include:

- Retain woodland adjacent to sandstone escarpments, particularly large hollow-bearing trees – Species requirements will be considered in the VFMP prepared for West Cliff
- Retain sandstone rock in bushland on escarpment areas; implement LEPs, DCPs with suitable restrictions on the removal of Bushrock – Bushrock will be relocated to rehabilitation areas to promote habitat for the species, as detailed in the VFMP
- Restore rocky habitat to escarpments that have been disturbed – Bushrock will be relocated to rehabilitation areas to promote habitat for the species, as detailed in the VFMP

### **Habitat Requirements**

The species mainly occurs in association with communities occurring on Triassic sandstone within the Sydney Basin, and is typically found among exposed sandstone outcrops within 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 and Shine, 1998).

The Study Area contains good habitat for the species in the Sandstone Scribbly Gum Woodland, Sandstone Gully Apple Peppermint Forest, and Sandstone Gully Peppermint Forest. These vegetation units contain exposed sandstone outcrops where Broad-headed Snakes spend winter months, as well as hollow-bearing trees, which regularly occur at known Broad-headed Snake summer sites. It is expected that common prey species, such as geckoes, are also present within the Study Area.

### **Discussion of Local and Regional Abundance**

#### ***Local***

The species has been recorded in the Study Area and the Locality. Several records of the species exist within 10 km of the Study Area. Most of these records are from Dharawal State Conservation Area to the north and east of the Study Area. Locally, the species has a patchy distribution, probably reflecting its specific habitat requirements.

#### ***Regional***

The species has a patchy distribution within the region, with most records concentrated in reserves.

|                           |                                    |
|---------------------------|------------------------------------|
| <b>Long-nosed Potoroo</b> | <b><i>Potorous tridactylus</i></b> |
|---------------------------|------------------------------------|

### **Discussion of Conservation Status**

The Long-nosed Potoroo *Potorous tridactylus* is listed as Vulnerable on the TSC and EPBC Act.

This species has a disjointed distribution along coastal regions of NSW.

The conservation status of this species may also be affected by Key Threatening Processes as listed under Schedule 3 of the TSC Act. Key Threatening Processes relevant to the Proposal that may impact on potential habitat for the Long-nosed Potoroo include:

- 'Clearing of native vegetation'
- 'Removal of dead wood and dead trees'

- ‘Ecological consequences of high frequency fires’
- ‘Predation by feral cats’
- ‘Predation by the European Red Fox’

The threat abatement plan relevant to this species is ‘Predation by the Red Fox’. The plan aims to reduce predation on native animals by the European Red Fox. No recovery plan has been prepared, but the DECC has prepared a list of priority actions to assist in the species’ recovery in NSW. Those relevant to the Proposal are outlined below:

- Control weeds, particularly those that affect the understorey layer, in Long-nosed Potoroo habitat – weed management is detailed in the VFMP
- Increase habitat via revegetation work and/or establishing corridors to link multiple patches of suitable habitat to expand the effective area of habitat – Species requirements will be considered in the VFMP prepared for West Cliff
- Reserve Fire Management Strategy(s) include operational guidelines that undertake control burns using a mosaic pattern to ensure adequate vegetation cover – Fire management issues are detailed in the VFMP prepared for West Cliff
- Using survey methods such as hair-tubing, trapping, scat analysis and the abundance of diggings, estimate the population sizes and relative densities of populations – The species was not recorded in the Study Area

### **Discussion of Habitat Utilisation**

The species inhabits coastal heath and wet and dry sclerophyll forests. It generally occurs in areas with rainfall greater than 760 mm. The species also requires relatively thick ground cover where the soil is light and sandy (Johnston, 1995).

Potential habitat for this species occurs within the Study Area in Ridgetop Woodland and Gully Forest. These vegetation types contain understorey providing foraging habitat for this species.

### **Discussion Local and Regional Abundance**

#### ***Local***

This species has been recorded in the Dharawal Nature Reserve and Dharawal State Conservation Area, although it has not been recorded for many years.

## ***Regional***

The species is rare in the region. The nearest records to the Study Area are a cluster of records around Kiama approximately 35 km south. The species has also been recorded at Darkes Forest, bordering O'Hares Creek and Woronora catchments and in the upper Cordeaux Catchment (Robinson, 1985).

### **Large-eared Pied Bat**

*Chalinolobus dwyeri*

#### **Discussion of Conservation Status**

The Large-eared Pied Bat *Chalinolobus dwyeri* is listed as Vulnerable on the TSC and the EPBC Acts.

The distribution of this species extends from the northern border of NSW to the south coast as far inland as the western slopes of the Great Dividing Range. The Study Area is not situated at the limits of the known distribution of this species.

The majority of records for this species are within conservation reserves. However, due to a lack of knowledge of the species, it is unknown whether the species is adequately represented in conservation reserves.

Threatening processes for populations of bats are generally not well known due to a lack of research in this area. However, they are thought to include the following processes that are relevant to the Proposal:

- 'Clearing of native vegetation'
- 'Removal of dead wood and dead trees'
- 'Loss of Hollow-bearing Trees' has been proposed as a Key Threatening Process by the NSW Scientific Committee

To this date, there is no threat abatement or recovery plan for the species. However, DECC has developed a list of priority actions to help recover this species in NSW. Those that are relevant to the Proposal include:

- Determine location and attributes of maternity sites and restrict access where possible. (e.g. signage; bat-friendly, preferably external, gating of caves) – No known maternity sites/caves exist in the Study Area
- Identify and protect roost habitat artificial structures (e.g. culverts, old buildings and derelict mines) – No known artificial structures suitable for roosting occur in the Study Area

- Restrict access where possible to known maternity sites (e.g. signage; bat-friendly, preferably external, gating of caves) – No known maternity sites/caves exist in the Study Area
- Undertake a targeted survey to determine distribution and status in parts of their range, such as the western edge of range

### **Discussion of Habitat Utilisation**

The species is 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). The species can also be found on the edges of rainforests and in wet sclerophyll forests (Churchill, 1988). This species roosts in caves and mines in groups of between 3 and 37 individuals (Churchill, 1988).

It is unlikely that roosting resources exist in the Study Area, as there are no caves present; however, foraging habitat is present within the Study Area. Due to the large extent of potential foraging habitat available to this species nearby, it is unlikely that the species relies upon the habitat in the Study Area.

### **Discussion of Local and Regional Abundance**

#### ***Local***

The species is known locally from 3 records at the northern boundary of Dharawal State Conservation Area, approximately 10 km north of the Study Area.

#### ***Regional***

Most records within the region occur in the Blue Mountains to the west of the Study Area. The species is also known to inhabit the Royal National Park to the north of the Study Area. The species appears to be uncommon in the Locality, but slightly more common within the region, with most records in reserves. Records concentrated around the Princes Highway suggest a sampling bias.

|                             |                                  |
|-----------------------------|----------------------------------|
| <b>Spotted-tailed Quoll</b> | <b><i>Dasyurus maculatus</i></b> |
|-----------------------------|----------------------------------|

### **Discussion of Conservation Status**

The Spotted-tailed Quoll *Dasyurus maculatus* is listed as Vulnerable on the TSC and EPBC Acts.

This species occurs on both sides of the Great Dividing Range, with a strong hold in the north-east of the State (NPWS 1999h). The Study Area is not at the limits of

the known distribution for this species.

The Spotted-tailed Quoll has been recorded at various reserves throughout eastern NSW including Dharawal State Conservation Area, Royal, Heathcote, Nattai, Kanangra-Boyd and Blue Mountains National Parks. It is not known if this species is adequately represented within conservation reserves.

The conservation status of this species may also be affected by Key Threatening Processes as listed under Schedule 3 of the TSC Act. Key Threatening Processes relevant to the Proposal that may impact on potential habitat for the Spotted-tailed Quoll include:

- 'Clearing of native vegetation'
- 'Removal of dead wood and dead trees'

There is no threat abatement plan or recovery plan for this species to date. However, DECC has developed a list of priority actions to help recover this species in NSW. Those actions relevant to the Proposal include:

- Conduct systematic monitoring at key sites. Monitoring sites will be distributed across the NSW range of the Spotted-tailed Quoll and within different habitat types such as Kosciusko NP, Limeburner's Creek NR, northern tablelands and the Blue Mountains – The VFMP prepared for the West Cliff Colliery includes provisions to address this issue
- Develop environmental impact assessment guidelines for the Spotted-tailed Quoll, which includes information on adequate survey methods, survey effort, inappropriate development Proposals, impact mitigation measures – The VFMP prepared for the West Cliff Colliery includes provisions to address this issue
- Habitat requirements of Spotted-tailed Quolls to be adequately conserved within environmental planning instruments and through other legislative protection mechanisms, including property vegetation plans – The VFMP prepared for the West Cliff Colliery includes provisions to address this issue
- Identify sites across the NSW range and within different habitat types at which long-term population monitoring can be undertaken
- Reserve Fire management Strategy(s) include operational guidelines that protect rocky outcrops and riparian zones within areas of known habitat – The VFMP prepared for the West Cliff Colliery includes provisions to address this issue

## Discussion of Habitat Utilisation

The species 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, and abundance of food and an area of intact vegetation in which to forage (Edgar and Belcher, 1995).

The Study Area contains suitable foraging habitat as well as suitable den sites.

## Discussion of Local and Regional Abundance

### *Local*

Records exist to the north of West Cliff within a 10 km radius, including the upper Cataract, Cordeaux and Avon Rivers (Robinson, 1985). The species has been recorded within 10 km of the Subject Site and in the Locality, but no records exist from the Study Area. There are two records from Dharawal State Conservation Area and several more from nearby reserves. It appears to be present in typical low numbers in the Locality.

### *Regional*

Records occur throughout the general region. The spotted-tail quoll is an apex predator, and as such, requires a large home range. As a result of this, it is never abundant. It has a scattered distribution throughout the region. It is probably relatively common in the Locality and region, but in low numbers.

|                            |                        |
|----------------------------|------------------------|
| <b>Large-footed Myotis</b> | <i>Myotis adversus</i> |
|----------------------------|------------------------|

## Discussion of Conservation Status

The Large-footed Myotis is listed as Vulnerable on schedule 2 of the TSC Act.

The Large-footed Myotis is a mainly coastal species occurring along the length of NSW. Its distribution can also extend further inland along major rivers such as the Murray (Churchill, 1988). The Study Area is not at the limits of the known distribution for this species.

Many records for this species are from outside of conservation reserves. The extent to which this species is represented in conservation reserves is unclear, but it is probably not represented adequately.

Threatening processes for populations of bats are generally not well known due to a lack of research in this area. The Key Threatening Processes associated with the

Proposal that may have an impact on the Large-footed Myotis are:

- ‘Clearing of native vegetation’
- ‘Removal of dead wood and dead trees’
- ‘Loss of Hollow-bearing Trees’ has been proposed as a Key Threatening Process by the NSW Scientific Committee

No recovery or threat abatement plan exists for this species. However, the DECC has prepared a number of priority actions to help recover this species in NSW. Those that are relevant to the Proposal are outlined below:

- Ensure the largest hollow bearing trees in riparian zones are given highest priority for retention in land clearing assessment tools – The VFMP prepared for the West Cliff Colliery includes provisions to address this issue
- Identify, protect and enhance roost habitat beneath artificial structures (e.g. bridges), especially when due for replacement, and assess effectiveness of the actions – No such structures exist in the Study Area
- Undertake long-term monitoring of populations cross-tenure in conjunction with other bat species to document changes – The VFMP prepared for the West Cliff Colliery includes provisions to address this issue

### **Discussion of Habitat Utilisation**

The Large-footed Myotis occurs in most habitat types as long as they are near permanent water bodies, including streams, lakes and reservoirs. This species commonly roosts in caves, but can also roost in tree hollows, under bridges and in mines (Churchill, 1988, Richards, 1995).

Foraging and roosting habitat for this species occurs within the Study Area around water sources. The species roosts in caves and tree hollows. Tree hollows of a variety of shapes and sizes were recorded in the Subject Site.

### **Discussion of Local and Regional Abundance**

#### ***Local***

The species is known from scattered records throughout the region, especially around rivers. Locally, there are a number of records within 10 km of the Study Area and within the Locality. This species has been recorded in the Study Area and in the Locality. The species is probably moderately common for a threatened species within the Locality and the region, when taking into consideration the



species' reliance on permanent water bodies. Records exist to the north of the Study Area in Dharawal State Conservation Area and south-west in the Metropolitan Water Catchments.

### ***Regional***

The species has been recorded from the Woronora, O'Hares Creek and Metropolitan Water Catchment (Sydney Water 1997).

|                            |                               |
|----------------------------|-------------------------------|
| <b>Red-crowned Toadlet</b> | <i>Pseudophryne australis</i> |
|----------------------------|-------------------------------|

### **Discussion of Conservation Status**

The Red-crowned Toadlet is listed as Vulnerable on Schedule 2 of the TSC Act.

The Red-crowned Toadlet occurs on wetter ridge tops and upper slopes of sandstone formations on which the predominant vegetation is dry open forests and heaths. The Study Area is not at or near the limits of distribution for this species.

The Red-crowned Toadlet has been recorded throughout regional conservation reserves and crown land. It is likely that it is moderately well represented in conservation reserves.

The conservation status of this species may also be affected by Key Threatening Processes as listed under Schedule 3 of the TSC Act. Key Threatening Processes relevant to the Proposal that may impact on potential habitat for the Red-crowned Toadlet include:

- 'Clearing of native vegetation';
- 'Bushrock removal';
- 'Ecological consequences of high frequency fires';
- 'Alteration to the Natural Flow Regimes of Rivers, Streams, Floodplains and Wetlands'; and,
- 'Removal of Dead Wood and Dead Trees'.

No known threat abatement plan exists for this species. However, DECC has prepared 14 priority actions to help recover this species. Those relevant to the Proposal are outlined below.

- Develop best practice habitat management strategies that reduce bushrock removal from important habitat areas – The VFMP prepared for the West

Cliff Colliery includes provisions to address this issue

- 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 – The VFMP prepared for the West Cliff Colliery includes provisions to address this issue
- Prepare a guide to creating, rehabilitating or augmenting habitat for the species; this might include provision of rock/log ground cover, diversion of water, provision of breeding/nesting sites and material – The VFMP prepared for the West Cliff Colliery includes provisions to address this issue

### **Discussion of Habitat Utilisation**

This species typically breeds within small ephemeral creeks that feed into larger semi-perennial streams. These creeks are characterised after rain by a series of shallow pools lined by dense grasses, ferns and low shrubs (Thumm and Mahoney 1997).

Potential habitat for this species occurs in the ephemeral drainage lines within Woodland, Forest and Upland Swamp habitat within the Study Area.

### **Discussion of Local and Regional Abundance**

#### ***Local***

The Red-crowned Toadlet is known to occur throughout the sandstone areas of the local region. There are several records within the Locality. This species has been recorded as present in the Woronora, O'Hares Creek and Metropolitan Water Catchments (Sydney Water 1997) as well as Dharawal NR (NPWS, 1998), all of which surround the Study Area. The species is moderately common in the region and Locality.

The Study Area is close to the southern extremities of the species' known distribution. Records become sparser farther south. The southern-most records are some 50 km away.

#### ***Regional***

The distribution coincides with the Greater Sydney Metropolitan District, largely restricted to Hawkesbury Sandstone formations surrounding Sydney; the area covered by Sydney Triassic Sandstone geological formation (Thumm and Mahoney 1997).

It has been recorded in high numbers in the Illawarra Escarpment State

Conservation Area and adjacent Metropolitan Water Catchment and it has been suggested that it may be considered locally common in suitable habitat along the plateau (NPWS 1998).

### **Giant Burrowing Frog**

*Heleioporus australiacus*

#### **Discussion of Conservation Status**

The Giant Burrowing Frog is listed as Vulnerable on schedule 2 of the *TSC Act* 1995 and as Vulnerable on the *EPBC Act* 1999.

There is limited habitat for this species present in the Study Area. The Giant Burrowing Frog is mostly associated with hanging swamps and rocky outcrops. This habitat is of limited availability in the Study Area. The Study Area is not at or near the limits of the known distribution of this species.

Locally, this species is offered some level of protection within Metropolitan Water Catchments and State Forests. However, it is unclear how adequately represented this species is within conservation reserves.

The Giant Burrowing Frog is believed to be declining at a number of known locations throughout NSW (Rescei, 1997a). The conservation status of this species may be affected by Key Threatening Processes as listed under Schedule 3 of the *TSC Act*. Key Threatening Processes relevant to the Proposal that may impact on potential habitat for the Giant Burrowing Frog include:

- ‘Clearing of native vegetation’
- ‘Bushrock removal’
- ‘Ecological consequences of high frequency fires’

There is currently no threat abatement or recovery plans for the Giant Burrowing Frog, and no critical habitat has been declared under the *TSC Act* for the species. The DECC has developed a number of priority actions to help recover this species. Those that are relevant to the Proposal include:

- Ensure that appropriate erosion, sedimentation and water quality control measures are applied around known locations – The VFMP prepared for the West Cliff Colliery includes provisions to address this issue
- Reserve Fire Management Strategy to include operational guidelines to protect this species from fire – The VFMP prepared for the West Cliff Colliery includes provisions to address this issue

## Discussion of Habitat Utilisation

This species prefers hanging swamps on sandstone shelves adjacent to perennial non-flooding creeks (Daly, 1996; Rescei, 1997a). It can also occur within shale outcrops within sandstone formations. In the southern part of its range the Giant Burrowing Frog 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).

Potential habitat for this species exists in the Study Area within the Upland Swamps, Ridgetop Woodlands, and Gully Forest fauna habitats. Breeding and sheltering/foraging habitat are present in the Study Area, but similar habitat is present in surrounding areas.

## Discussion of Local and Regional Abundance

### *Local*

The species has been recorded within Hawkesbury Sandstone Ridge Forest within Kembla State Forest (NPWS, 1998) within the Metropolitan Water Catchment (Sydney Water, 1997) and within O'Hares Creek Catchment (Harlow and Taylor, 1995). Within the Locality it is moderately common, especially to the north of the Study Area. Within the region, records are localised, but moderately common along the Illawarra Escarpment

Records exist for this species within 10 km of the Subject Site and within the Locality. It has not been recorded in the Study Area.

### *Regional*

This species ranges from Olney State Forest north of Sydney, extending south along the coast into the eastern Highlands of Victoria (Rescei, 1997a).

It is mainly found in the Sydney Basin region. It has been located in Royal National Park to the north of the Study Area (Rescei, 1997a) and just outside the northern limits of Dharawal State Conservation Area to the north.

**Littlejohn's Tree Frog***Litoria littlejohni***Discussion of Conservation Status**

Littlejohn's Tree Frog is listed as Vulnerable on schedule 2 of the *TSC Act* 1995 and as Vulnerable on the *EPBC Act* 1999.

This species has a restricted distribution, extending along the eastern slopes of the Great Dividing Range from Wattagan State Forest near Wyong, NSW to Buchan in north-eastern Victoria (NSW Scientific Committee 2000). The Study Area is not at or near the limits of known distribution for this species.

Littlejohn's Tree Frog is known from 13 locations in New South Wales. Of these locations, six occur in conservation areas: Blue Mountains National Park, Royal National Park, Barren Grounds Nature Reserve, Morton National Park, Budawang National Park and Wadbilliga National Park (Scientific Committee 2000). Given the paucity of records for this species and the lack of scientific knowledge, it is unknown whether the species is adequately represented in conservation reserves.

The conservation status of this species may also be affected by Key Threatening Processes as listed under Schedule 3 of the *TSC Act*. Key Threatening Processes listed on the *TSC Act* that are likely to be relevant to this species and the Proposal include:

- 'Alteration of habitat following subsidence due to longwall mining'
- 'Alteration to the natural flow regimes of rivers, streams, floodplains & wetlands'
- 'Ecological consequences of high frequency fires'
- 'Infection of frogs by amphibian chytrid causing the disease chytridiomycosis'
- 'Predation by the plague minnow (*Gambusia holbrooki*)'

There is currently no Commonwealth or NSW threat abatement plan for Littlejohn's Tree Frog. The DECC has identified a number of priority actions to help recover the Littlejohn's Tree Frog in New South Wales. Those relevant to the Proposal include:

- Develop preferred mitigation measures to minimize impact of wildlife and/or suppression operations – The VFMP prepared for the West Cliff Colliery includes provisions to address this issue
- Develop management strategies where possible that protect existing water

flow and quality or restore natural water flows and water quality – The VFMP prepared for the West Cliff Colliery includes provisions to address this issue

- Develop strategies for providing supplementary breeding habitat at selected locations throughout the species range – The VFMP prepared for the West Cliff Colliery includes provisions to address this issue
- Undertake survey in some of the less surveyed parts of the species distribution – The species was not recorded in the Study Area

### **Discussion of Habitat Utilisation**

Littlejohn's Tree Frog appears to be restricted to sandstone woodland and heath communities from 100 to 950 m above sea level (White and Ehmann 1997) and is not known from coastal habitats (NPWS 2002d). It is not associated with any specific plant communities and appears to breed in wet forest margins (NPWS 2002d).

A variety of breeding habitat has been described, including temporary pools, deep permanent pools in slow creeks and slow, rock-lined rivers and dams (White and Ehmann 1997). It forages in the tree canopy and on the ground (NPWS 2002d). Where the species occurs when it is not breeding is virtually unknown.

### **Discussion of Local and Regional Abundance**

#### ***Local***

The species has not been recorded in the Locality. Records exist within 10 km of the Subject Site, from Dharawal State Conservation Area. Limited habitat for this species is present in the Study Area where sandstone woodland and heath communities dominate.

#### ***Regional***

The species has a scattered distribution in the region, probably reflecting its very specific habitat requirements. Populations are known from Darkes Forest to the north of the Study Area and Sydney Water Special Area to the south-west. It has also been recently reported from the Metropolitan Catchment near Loddon Falls and a tributary of Stony Creek on the Forest Walk above Wombarra (NPWS 2002d). One of the larger populations occurs within Barren Grounds Nature Reserve. It is a rare species, but probably under-surveyed. It appears to be uncommon to rare in the Locality and the region.

## 6.4 Description of feasible alternatives

Ongoing investigations into possible alternative uses for coal wash are being undertaken by BHPBIC to identify opportunities to reduce or eliminate coal wash emplacement. A detailed report describing the findings of these investigations has been completed (Cardno Forbes Rigby 2007b) and accompanies submission of this SIS. The following section provides a brief summary of the reports findings to date.

A number of alternative options to the Proposal have been considered as part of the process of determining whether there is a need to develop Stage 3. Surface emplacement at West Cliff is not a long term sustainable solution and there is a recognised need by BHPBIC to seek alternative coal wash management options. In assessing alternatives, a range of options were examined, including optimising existing emplacement sites, underground stowage of coal wash (for subsidence control), reusing coal wash for brick making or as a general construction fill, and using coal wash as fuel for power generation.

The assessment was based on the technical feasibility, market demand, market competition, costs, and environmental risk. The assessment found that:

- Optimising the West Cliff stage 2 emplacement has been undertaken but will not negate the need for Stage 3, and that there are currently no other alternative emplacement sites available. An additional 3.8 Mt of coal wash will be able to be emplaced in the Stage 2 emplacement above the current design capacity if approval to extend the emplacement to the Stage 3 area is granted.
- During 1985-2005 period, BHPBIC (then BHP Steel) operated a coal wash emplacement at Wongawilli (near West Dapto) for coal wash generated from the processing of run of mine coal from the Elouera Colliery. The development consent for this emplacement expired in 2005. The Wongawilli emplacement has been fully rehabilitated. It is likely that with the ongoing development of the West Dapto urban growth centre that the Wongawilli emplacement will be utilised for residential development.
- Underground disposal (via overburden grout injection and goaf injection) is not yet technically feasible. BHPBIC is committed to undertake further research and trials on these technologies.
- Reuse of coal wash as fill material, and for brick manufacturing is technically feasible, but is subject to intense market competition by other materials, which is exacerbated by the high delivery costs of coal wash. These market factors largely limit reuse of coal wash to the local area and

prevent the utilisation of large quantities of coal wash.

- Coal wash as fuel for power generation requires further research due to the technical, economic and environmental risks involved in the investment, but in any case would result in a similar volume of waste fly and bottom ash that would need to be emplaced.

The assessment found that whilst some options have their own merits to utilise a small percentage of coal wash, none of the current options are capable of utilising sufficient volumes to negate the urgent need for the Stage 3 emplacement. It was concluded that the West Cliff Stage 3 surface emplacement remains the only viable short to medium term option for coal wash disposal, supplemented by a range of possible reuse opportunities negotiated on a project by project basis.



## **7.0 ASSESSMENT OF LIKELY IMPACTS ON ENDANGERED ECOLOGICAL COMMUNITIES**

No Endangered Ecological Communities as listed on the TSC and/or EPBC Acts are present within the Study Area. No Endangered Ecological Communities present within the Locality will be affected by the Proposal (see Section 4.1.6).

## 8.0 DESCRIPTION OF AMELIORATIVE MEASURES

The DGRs specifically require that long term management strategies, compensatory strategies, ongoing monitoring and translocation be considered as ameliorative measures.

Impact mitigation measures will be described in detail in the *Vegetation and Fauna Management Plan - West Cliff Colliery and Stage 3 Coal Wash Emplacement* (Biosis Research 2007a). This report is referred to as the VFMP.

The VFMP is based on the relevant key issues presented in *Mine Rehabilitation: Leading Practice Sustainable Development Program for the Mining Industry* (2006). This handbook was produced as a general reference for the mining industry by the Mine Rehabilitation Working Group of the Leading Practice Sustainable Development Program. The program is an initiative of the Commonwealth of Australia, Department of Industry, Tourism and Resources.

A summary table of the VFMP is included here to address long term management strategies (Section 8.1), ongoing monitoring (Section 8.3) and translocation (Section 8.4). Compensatory measures and the requirement to inform future owners' is not addressed in the VFMP but are outlined in Sections 8.2 and 8.5.

**Table 14. Summary of Mitigation Measures Included in the VFMP**

| Objective 1: The Rehabilitation Of The Stage 3 Emplacement Area |   |
|---|---|
| Management Issue  | Ameliorative Measures/Rehabilitation Strategy   |
| Translocation of threatened species                             | <ul style="list-style-type: none"> <li>There has been little or no success with the translocation of mature Proteaceae. Translocation of <i>Persoonia hirsuta</i> to suitable habitat is likely to be unsuccessful and is not proposed</li> </ul>   |
| Fauna management  | <ul style="list-style-type: none"> <li>Pre-clearing ameliorative measures for fauna (vegetation clearing plan)</li> <li>Fauna habitat features such as logs and tree hollows would be relocated to adjacent woodland where appropriate. Tree hollows of 20 cm diameter or greater would be attached to suitable trees in adjacent habitat or to poles in the regeneration areas of West Cliff Stage 2 or 3 emplacement areas</li> <li>Clearing of vegetation should follow the DECC requirements for fauna rescue. They include procedures for clearing of non-habitat and habitat trees, the relocation of rescued fauna and the involvement of wildlife specialists in the process</li> <li>Where possible, clearing of hollow bearing trees should be performed in a two stage process where surrounding vegetation is cleared separately, one day before the removal of habitat trees to allow fauna an opportunity to move;</li> <li>Where hollow bearing trees are to be removed the operation should be performed by careful felling (i.e. without use of an excavator mounted closed chipper), then leaving felled trees for a short period to allow fauna an opportunity to escape;</li> <li>Where rocky outcrops are to be destroyed a suitably qualified person should identify appropriate candidate boulders and outcrop rock that could be translocated for habitat creation in revegetated areas. Placing boulders on top of replaced soils (on top of emplacement area) will recreate habitat for species dependant on rocky outcrops, such as the Broad-headed Snake.</li> </ul> |

|  |  |
|--|--|
| Soil translocation   | <ul style="list-style-type: none"> <li>• Pre-translocation actions</li> <li>• Compartmentalisation of patches relative to the emplacement benching for staged clearance</li> <li>• Habitat assessment of patches to ensure major habitat features are translocated</li> <li>• Installation of temporary nesting sites</li> <li>• Trapping and relocation of fauna during the tree felling exercise as described above</li> <li>• Preparation of recipient sites including sub-soil translocation and reshaping of landscape</li> </ul> |
|  | <ul style="list-style-type: none"> <li>• Soil salvage and handling</li> <li>• Vegetation clearing, additional seed collection and stockpiling (refer to the vegetation clearing plan)</li> <li>• Stockpiling of habitat features to be retained and translocated (rocks and logs)</li> <li>• Sequential stripping and short-term stockpiling of nominated soil horizons to depth of bedrock</li> </ul>   |
|  | <ul style="list-style-type: none"> <li>• Soil translocation</li> <li>• Gully vegetation to be translocated to sheltered aspects of emplacement</li> <li>• Ridgetop vegetation to be translocated to the surface of the emplacement</li> <li>• Relocation of rocks and logs within translocation (prior to topsoil translocation)</li> <li>• Installation of temporary irrigation equipment where possible</li> </ul>   |
|  | <ul style="list-style-type: none"> <li>• Post-translocation</li> <li>• Irrigation where possible</li> <li>• Maintenance weed control</li> <li>• Implementation of monitoring program</li> <li>• Long-term consideration of the remaining emplacement area at the end of Stage 3 works (i.e. rehabilitation of final landscape)</li> </ul>  |
| Revegetation supplementary to soil translocation   | <ul style="list-style-type: none"> <li>• Pre-clearing seed collection from emplacement area focussing on tree species</li> <li>• Collection of <i>Persoonia hirsuta</i> seed and cuttings by experts from Mt Annan Botanic Gardens</li> <li>• Off-site propagation of tubestock</li> <li>• Installation of tubestock as required depending on success of translocation</li> <li>• Additional brush-matting, mulching or direct seeding as required</li> </ul>  |
| Weed Management  | <ul style="list-style-type: none"> <li>• Minimisation of long term stockpiling</li> <li>• Quarantining of any stockpiled soil so as to prevent infestation by weeds</li> <li>• Post translocation maintenance weeding which is likely to be focussed on the control of perennial grass weeds and noxious weeds.</li> </ul>   |
| Sediment and Erosion Control   | <ul style="list-style-type: none"> <li>• Shaping of emplacement areas built to appropriate standards</li> <li>• Construction of sediment ponds and diversion channel to appropriate standards</li> <li>• Appropriate sediment control</li> <li>• Cross-banks, mitre drains and culverts to be utilised on tracks and haul roads</li> </ul>   |
| Bushfire Management  | <ul style="list-style-type: none"> <li>• In the case that a bushfire management plan is implemented, conservation of threatened species should be a priority</li> </ul>  |
| Maintenance  | <ul style="list-style-type: none"> <li>• Maintaining sediment and erosion control structures, especially after heavy rain as per existing requirements</li> <li>• Maintenance of all drainage and pond structures</li> <li>• Maintenance of all tracks and haul roads and associated mitre drains, cross-banks and culverts</li> <li>• Maintenance weed control</li> </ul>   |
| <b>Objective 2: Management Of Existing Disturbed Areas Within The Entire West Cliff Colliery Lease</b> |  |
| <b>Management Issue</b>  | <b>Ameliorative Measures/Rehabilitation Strategy</b>   |
| Maintenance Weed Management  | <ul style="list-style-type: none"> <li>• Weed control measures designed to prevent the spread of exotic perennial grasses and noxious weeds from disturbed edges</li> </ul>  |
| Re-use of Stage 2 Emplacement Area   | <ul style="list-style-type: none"> <li>• Ameliorative measures as for Stage 3 emplacement</li> </ul>   |
| Rehabilitation   | <ul style="list-style-type: none"> <li>• Revegetation of some disused areas and track edges. A combination of bush regeneration techniques, planting of tubestock, direct seeding and brush-matting may be utilised</li> </ul>   |

|   |   |
|---|---|
| Sediment and Erosion Control  | <ul style="list-style-type: none"> <li>Maintenance of mitre drains, cross-banks and culverts to minimise impacts from the erosion of unconsolidated tracks and haul roads</li> <li>Regular inspections of drainages and sediment ponding to ensure their integrity, especially after heavy rainfall as per existing requirements</li> <li>Haul roads and access tracks to be constructed from benign materials such as crushed sandstone. Non-local road bases or aggregates should not be used.</li> <li>Saline water should not be used for dust suppression activities.</li> </ul>   |
| Bushfire Management   | <ul style="list-style-type: none"> <li>Tracks and haul roads should be maintained as cleared accesses and egresses in case of emergencies</li> </ul>  |
| <b>Objective 3: The Management Of Areas To Be Retained As Native Bushland</b> |   |
| <b>Management Issue</b>   | <b>Ameliorative Measures/Rehabilitation Strategy</b>  |
| Protection Of Existing Threatened Species Populations                         | <ul style="list-style-type: none"> <li><i>Acacia bynoeana</i>, <i>Persoonia hirsuta</i> and <i>Pultenaea aristata</i> populations retained within the colliery lease area to be flagged as construction exclusion zones unless otherwise approved for construction activities.</li> </ul>   |
| Weed Management   | <ul style="list-style-type: none"> <li>Low levels of weed infestation reduce the need for management options for prevention of weeds from track edges and drainages</li> <li>regular inspections of remnant bushland areas and weed management actions implemented as needed.</li> </ul>  |
| Bushfire Management   | <ul style="list-style-type: none"> <li>In the case that a bushfire management plan is implemented, conservation of threatened species should be a priority and a fire regime (frequency, intensity, season and pattern) appropriate to the vegetation type adopted</li> </ul>   |
| Rehabilitation  | <ul style="list-style-type: none"> <li>Rehabilitation of these areas not required</li> <li>Weed management as per the above recommendation</li> <li>These areas are a seed source for future site rehabilitation works</li> </ul>   |
| <b>Objective 4: Staging and Sequencing of Tasks</b>                           |   |
| <b>Management Issue</b>   | <b>Comment</b>  |
| Staging and Sequencing of Tasks   | <ul style="list-style-type: none"> <li>The final staging and sequencing of the VFMP will be determined in consultation with the site manager and on-ground bulk earth works contractors</li> <li>The VFMP broadly follows a required sequencing and prioritisation of tasks</li> </ul>  |
| <b>Objective 5: Monitoring And Performance Evaluation Program</b>             |   |
| <b>Management Issue</b>   | <b>Monitoring Technique</b>   |
| Success of emplacement area rehabilitation                                    | <ul style="list-style-type: none"> <li>Photo-points</li> <li>Monitoring quadrats in translocated patches measuring species richness, structure and composition, condition, death rates and replacement requirements, growth rates of key indicator species</li> <li>Control sites to be set up in remnants</li> <li>Random meanders for threatened flora that may have regenerated from translocation</li> <li>An assessment of areas regenerated per unit effort. A comparison of the environmental outcome to the type and size of the input. The main outcome is condition of the vegetation regenerating from the trans-located topsoil</li> <li>Materials characterisation and testing to ensure success of rehabilitation strategies.</li> <li>A BHPBIC staff member qualified and experienced in natural area restoration to project manage monitoring system</li> </ul> |
| Extant Threatened Flora populations   | <ul style="list-style-type: none"> <li>Monitoring of the success of translocated <i>Persoonia hirsuta</i> if required</li> <li>Inspections of on-site threatened flora populations (<i>Acacia bynoeana</i> and <i>Persoonia hirsuta</i>) to ensure that flagged exclusion zones are maintained</li> </ul>   |
| Fauna Management  | <ul style="list-style-type: none"> <li>Fauna habitat level assessment of rehabilitated areas on an annual basis</li> <li>Fauna Mitigation Monitoring. Fauna safeguards including the translocation of hollow-bearing limbs and rocky outcrops should be monitored periodically to determine the effectiveness of these measures. The results of these surveys would then be used for adaptive management, to improve these structures if necessary</li> </ul>   |
| Reporting   | <ul style="list-style-type: none"> <li>Efficient reporting system via AEMR</li> <li>The possibility of having the results of the survey published in reputable journal, e.g. Environmental Management and Restoration</li> </ul>  |

## 8.1 Long Term Management Strategies

Amelioration measures related to vegetation clearing, edge effects, fauna mortality and weed management are outlined in Table 14.

### *Proposal Design*

Where possible, the proposal has been designed to avoid or minimise negative effects on high conservation value habitats or threatened species. For example, impacts on *Persoonia hirsuta* have been reduced by modifying the footprint to avoid the majority of individuals of this species.

## 8.2 Compensatory Strategies

A Compensatory Measures assessment report has been prepared by Biosis Research (2007). The findings of this report have been summarised below.

The compensatory measure comprises 153.4 ha of land vegetated with rainforest and moist eucalypt communities at Bulli Tops. The freehold ownership of this land will be transferred from BHPBIC to the NSW State Government through one of its agencies or departments. No more than 60.5 ha of native vegetation containing Exposed Sandstone Scribbly Gum Woodland and Sandstone Gully Peppermint Forest will be cleared for the construction and use of the Stage 3 emplacement at West Cliff. The compensatory measure represents a ratio of 2.5:1, in excess of the requirements specified in Condition 5.1 (e) (v) of the Consent. Even where cleared areas of the compensatory measure at Bulli Tops are excluded from the calculations, the compensatory measure still exceeds the requirements of the development consent by 12.5 ha and achieve a compensatory ratio of 2.2:1.

The proposed compensatory measure at Bulli Tops, although occurring within the same bioregion as the West Cliff Stage 3 Emplacement Area, contains some different ecological and cultural heritage values. The Bulli Tops property does not support flora and fauna habitats identical to those that will be cleared at West Cliff. Given that potential for fauna to occur on Study Area is dependant on the presence of suitable habitat it is unlikely that Bulli Tops would support all those threatened species reliant on woodland and finer scale features of those habitats that occur at West Cliff. Threatened species with potential habitat at West Cliff have, however, been recorded or have potential habitats in adjoining conservation areas and the Metropolitan Water Catchments. However, the extent of the populations within these areas is not known.

The vegetation communities present within the Bulli Tops property are not as extensively distributed in the regional landscape as those at West Cliff. Further, some vegetation communities at Bulli Tops represent significant amounts of the total distribution of that community in the regional landscape. As such, the

compensatory measure complies with the ‘like for like or better’ rule for the development of better conservation outcomes.

The Bulli Tops compensatory land and the West Cliff emplacement area are not comparable Aboriginal or historical cultural heritage landscapes. No Aboriginal sites were located in the Bulli Tops study area and it was determined to have low Aboriginal cultural heritage value compared with the moderate cultural value assessed for the West Cliff area. In relation to the historical works located within the Bulli Tops study area, Wollongong City Council should be notified of the relocation of the Throsby track, which is of regional significance.

### 8.3 Ongoing Monitoring

Amelioration measures related to ongoing monitoring are outlined in Table 14.

### 8.4 Translocation

Amelioration measures related to translocation are outlined in Table 14

### 8.5 Informing Future Land Owners

The ongoing management of threatened species, populations or ecological communities will ultimately be the responsibility of future landholders. The proposal falls within Crown Land which is part of a Consolidation Coal Lease 724. On this basis, at the end of West Cliff Colliery’s operational lifespan BHPBIC will seek to relinquish the land (including the Study Area) to the NSW State Government.

Prior to the Study Area being relinquished, BHPBIC must demonstrate the presence of a stable non-polluting landform, thereby facilitating release from the lease and reducing the risk of any future liability. In order to provide for a stable non-polluting landform BHPBIC will implement the appended Vegetation and Fauna Management Plan (Biosis Research 2007a) including the requirement for detailed monitoring programs. Ongoing monitoring and reporting will demonstrate that rehabilitated areas are conforming to predicted successional changes.

## 9.0 ASSESSMENT OF SIGNIFICANCE OF LIKELY EFFECT OF PROPOSED ACTION

A Seven Part Test is provided for each of the Affected Subject Species and endangered communities identified in the SIS.

### 9.1 Assessments of Significance: Affected Flora Species

Unless otherwise stated the information contained in the following Assessment of Significance has been derived from the NSW Government's Bionet database and DECC's Threatened Species profiles and/or Environmental Impact Assessment Guidelines for each species.

#### *Acacia baueri* subsp. *aspera*

*Acacia baueri* subsp. *aspera* is a shrub of heathlands to 30 cm high and is listed as Vulnerable on both the TSC Act and EPBC Act.

*Acacia baueri* subsp. *aspera* was not recorded within the Study Area during the field surveys. The species is considered to have potential habitat within the Study Area and is known to occur in low, damp heathlands, often on exposed rocky outcrops and appears to prefer open conditions; rarely observed where there is any shrub or tree canopy development (NPWS 2000a).

On the Woronora Plateau *Acacia baueri* subsp. *aspera* occurs in sandstone woodland in association with *Eucalyptus sieberi*, *E. rossii*, *Allocasuarina distyla* and *Banksia ericifolia*. The geology is Hawkesbury Sandstone and soil landscapes include Maddens Plains, Bundeena and Lucas Heights (NPWS 2000a).

Specific areas of potential habitat within the Study Area include sites where shallow soils overlay sandstone benches, the base of sandstone benches and boulders and the upslope plateau areas (T. James pers. com). As with other *Acacia* spp., *A. baueri* subsp. *aspera* has been observed in recently burnt areas, a habitat feature that is also well represented along ridge tops of the Study Area.

**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.**

As with most *Acacias* it is likely that *Acacia baueri* subsp. *aspera* is pollinated by insects and dispersed (naturally) by ants. It is also likely that the species requires a major disturbance to crack the hard seed coat to allow germination after being stored in the soil for a period of time. In nature, this disturbance

would normally constitute bushfire and it is almost certain that the germination of *Acacia baueri* subsp. *aspera* is reliant on a specific fire regime (DEC 2005b). This is also supported by the fact that populations of the species are found in early successional habitats (DEC 2005b). The small size and age structure of most populations is indicative of poor levels of recruitment and, as such the species is dependent on low mortality rates between fire events (NPWS 2000c). Germination is considered to be unreliable and losses in seed production or in the soil seedbank are likely to have a significant impact.

The direct impacts associated with the Proposal involve the removal of potential habitat for *Acacia baueri* subsp. *aspera*. Indirect impacts include suppressed fire frequency and increased dust deposition. It is important to note that coal wash emplacements are already present in the Study Area, within 500 m of the Subject Site (Stage 1 and Stage 2). Indirect impacts of the Proposal are therefore already being experienced.

*Acacia baueri* subsp. *aspera* was not recorded within the Study Area during the field surveys and therefore a viable population within the Study Area is not likely to exist. It is therefore considered unlikely that the removal of potential habitat, an altered fire regime or coal dust deposition will have a significant impact on the lifecycle of the species such that a viable local population of *Acacia baueri* subsp. *aspera* is 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 an endangered ecological community or critically endangered ecological community, whether the action proposed:**

- i. is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or**
- ii. is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction.**

NA

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

- i. the extent to which habitat is likely to be removed or modified as a result**



- of the action proposed, and**
- ii. whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and**
  - iii. the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the Locality.**

*Acacia baueri* subsp. *aspera* was not recorded within the Study Area despite current and previous targeted surveys. The species is considered to have potential habitat within the Study Area and is known to occur in low, damp heathlands, often on exposed rocky outcrops and appears to prefer open conditions; rarely observed where there is any shrub or tree canopy development (NPWS 2000a).

Approximately 638.9 ha of potential habitat for *Acacia baueri* subsp. *aspera* exists within the Locality. The area of direct impact constitutes the construction footprint of the emplacement area and the associated infrastructure sites. This will involve the loss of 60.5 ha of native vegetation, 37.8 ha of which is potential habitat for *Acacia baueri* subsp. *aspera*. The zone of indirect impact constitutes a buffer of 500 metres outside the area of direct impact and is approximately 180.4 ha (excluding Subject Site), of which 159.4 ha is potential habitat for *Acacia baueri* subsp. *aspera*. The area of habitat in the Study Area to be impacted (directly and indirectly) by the Proposal equates to 4.8 % of similar habitat types in the Locality and this is not considered to be a significant amount of habitat.

As no populations of *Acacia baueri* subsp. *aspera* were recorded within the Study Area during the field surveys it is unlikely that a significant population of the species will be fragmented within the Locality. However, potential habitat for *Acacia baueri* subsp. *aspera* will be fragmented by the removal of 37.8 ha of native vegetation within the Study Area, all of which is potential habitat for *Acacia baueri* subsp. *aspera*.

The Proposal will result in the fragmentation of potential habitat for *Acacia baueri* subsp. *aspera*. However, no specimens or populations of the species were recorded within the Study Area or Locality during the field surveys, and the 4.8 per cent of the potential habitat in the Locality that will be removed is not considered to be significant amount of habitat. Therefore the importance of the habitat impacted by the Proposal, to the long term survival of *Acacia baueri* subsp. *aspera* in the Locality, is considered to be low.

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

Under the TSC Act, the Director-General of Department of Environment and Climate Change maintains a Register of Critical Habitat. To date, no critical habitat has been declared for *Acacia baueri* subsp. *aspera*.

The Proposal will not have an adverse effect on critical habitat (directly or indirectly).

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

To date, no recovery plan or threat abatement plan has been prepared for this species. DEC (DEC 2005a) has listed 15 priority actions to help recover this species. *Acacia baueri* subsp. *aspera* was not recorded in the Study Area despite targeted searches, therefore not all priority actions are relevant to the Proposal. Those priority actions that are relevant to the Proposal include:

- Incorporate a suitable fire regime for the species into land management practices –BHPBIC will consider the impacts of any proposed hazard reduction burning on the lifecycle of *Acacia baueri* subsp. *aspera*.
- Identify, map and survey potential habitat –potential habitat for *Acacia baueri* subsp. *aspera* within the Study Area has been mapped Exposed Sandstone Scribbly Gum Woodland and is included in Figure 5. Targeted surveys for this species were undertaken in these areas and the species was not recorded.

*Acacia baueri* subsp. *aspera* was not recorded in the Study Area and therefore the Proposal is not considered likely to interfere with above listed recovery actions.

**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 listed on the TSC Act relevant to the Proposal that may impact on potential habitat for *Acacia baueri* subsp. *aspera* include:

- ‘Clearing of native vegetation’ - approximately 60.5 ha of native vegetation, including approximately 37.8 ha of ESSW, will be cleared for the Proposal;
- ‘Ecological consequences of high frequency fires’ – the Proposal may alter the frequency of fires in the area by reducing fire frequency. A Vegetation and Fauna Management Plan (VFMP) for the West Cliff Colliery has been prepared and includes provisions to address this issue.
- ‘Invasion of native plant communities by exotic perennial grasses’ – the Proposal may increase the threat of weed invasion by exotic perennial grasses, particularly given the presence of exotic perennial grasses in the vicinity of the existing emplacement areas and disturbed edges. A Vegetation

and Fauna Management Plan (VFMP) for the West Cliff Colliery has been prepared and includes provisions to address this issue.

- ‘Bushrock removal’- the Proposal would involve the removal of bushrock including large rock platforms and outcrops which are potential habitat for this species. A VFMP for the West Cliff Colliery has been prepared and includes provisions to address this issue.

The Proposal will increase the impact of some Key Threatening Processes in relation to *Acacia baueri* subsp. *aspera* in the Study Area.

### Conclusion

The Proposal will have the following impacts on *Acacia baueri* subsp. *aspera*:

- Approximately 37.5 ha of habitat for *Acacia baueri* subsp. *aspera* will be cleared as part of the Proposal. There may also be approximately 159.4 ha of potential habitat indirectly impacted by potential weed invasion, trampling, coal dust deposition and edge effects.
- Increase in the impact of some Key Threatening Processes.

The Proposal is **not** considered likely to result in a significant impact on a local population of *Acacia baueri* subsp. *aspera*, as:

- No individuals will be removed by the Proposal and, as a result, an impact on the lifecycle of the species or fragmentation of a population is not likely within the Locality.
- The habitat to be impacted by the Proposal is not considered to be important for the long term survival of the species in the Locality.
- The Proposal will not have an adverse effect on critical habitat (directly or indirectly).
- The Proposal is not inconsistent with a recovery plan for the species.

It is therefore considered unlikely the Proposal will lead to a significant impact on a local population of *Acacia baueri* subsp. *aspera*.

### *Acacia bynoeana*

*Acacia bynoeana* is a small prostrate shrub to 1 m high and is listed as Endangered on the TSC Act and Vulnerable on the EPBC Act.

This species is known to occur in heath and dry sclerophyll forest with a substrate of sand or sandy clay, often with ironstone gravels (NPWS 2000a). The species tends to prefer open sites, which are sometimes slightly disturbed or recently burnt. (NPWS 2000a).

**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.**

Both direct and indirect impacts could potentially affect the lifecycle of *Acacia bynoeana*. Direct impacts will result in the removal of a number of plants and habitat for the species. Indirect impacts are likely to include altered fire frequency and increased deposition of coal dust.

Most Acacias (wattles) require a major disturbance to crack the hard seed coat to allow germination after being stored in the soil for a period of time. In nature, this disturbance would normally constitute bushfire and it is almost certain that the germination of *Acacia bynoeana* is reliant on a specific fire regime. Little is known of the fire ecology of *Acacia bynoeana*, however according to DEC (2005c) it is not likely that the species can cope with more than one fire event every 10-12 years. From observations made by Biosis Research within the Study Area and at other local occurrences, it seems that germination may also be encouraged by the slashing of easements and roadsides when seed is ripe. *Acacia bynoeana* is a clonal species and is known to spread via suckering from underground stems (Driscoll 2006). *Acacia bynoeana* appears to have the capacity to re-shoot from a woody rootstock, both after the natural disturbance of fire and from the slashing of easements and roadsides. The longevity of the species is unknown, however based on other *Acacia* species, it is considered likely that an *Acacia* of its size would reach reproductive maturity within 2-4 years of germination.

The Proposal could potentially alter the existing fire regime of the Study Area, which could impact the lifecycle of *Acacia bynoeana*. However, this is not anticipated to be a significant impact on the species in the Locality as the bulk of the population exists in areas managed as slashed easements and roadside edges. Measures to protect the population of at least 228 individuals approximately 100 metres to the west of the emplacement area will be undertaken, as this represents

the bulk of the population in the Study Area. BHPBIC will consider the requirements of threatened species in any proposed fire regime, in consultation with DECC and in accordance with the VFMP.

As with most Acacias it is likely that *Acacia bynoeana* is pollinated by insects (e.g. small native bees and wasps) and dispersed (naturally) by ants. This was supported by the field observations, with many occurrences adjacent to ant mounds. The action of slashing easements and road-sides is likely to represent an artificial dispersal mechanism at the local scale. It is not anticipated that land clearing, an altered fire regime or coal dust deposition is likely to significantly impact the movements, shelter or foraging opportunities of these insect vectors.

It unlikely that direct clearing, an altered fire regime or coal dust deposition will have a significant impact on the lifecycle of the species such that a viable local population of *Acacia bynoeana* is 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 an endangered ecological community or critically endangered ecological community, whether the action proposed:**

- i. **is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or**
- ii. **is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction.**

NA

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

- i. **the extent to which habitat is likely to be removed or modified as a result of the action proposed, and**
- ii. **whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and**
- iii. **the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the Locality.**

During the field surveys, *Acacia bynoeana* was recorded within the Study Area in Exposed Sandstone Scribbly Gum Woodland. Specifically, the species was most prevalent in sandy washout areas with impeded drainage, burnt areas, previously disturbed tracks, areas disturbed by ants, areas with no trees or leaf litter and bare soil. Individuals within the Study Area reached a maximum height of approximately 30 cm. Many specimens were multi-stemmed and suckered or coppiced from a woody rootstock. Within the Study Area, the distribution of *Acacia bynoeana* corresponds to the Lucas Heights (lu) soil landscape as mapped by Hazelton (1990), which is a residual landscape composed of sandy loams of plateaus and hillcrests.

Though not depicted in the threatened flora mapping (Figure 8), *Acacia bynoeana* had been previously recorded along the Wedderburn Road in Dharawal State Conservation Area to the north of the West Cliff Washery (David Keith, pers. comm.). During the field surveys for the SIS, *Acacia bynoeana* was recorded in comparative abundance within the Locality, constituting a meta-population with several smaller sub-populations. This is illustrated in Figure 8. It is estimated that this meta-population comprises greater than 2,000 plants. Of these, a total of 11 *Acacia bynoeana* individuals will be removed by the proposed works (directly impacted), with an additional 282 plants potentially indirectly impacted. It should be noted, however, that several smaller populations of this species either on Study Area or off Study Area occur within 500 m of existing coal wash emplacement sites (i.e. Stage 1 and Stage 2) emplacements. The single largest population of this species occurs on the graded batter of Wedderburn Road, an area that is heavily affected by coal dust deposition. While this population appears to be healthy, it is unknown if coal dust deposition, particularly in those areas of greatest deposit, is affecting the life cycle of this species.

Approximately 638.9 ha of potential habitat for *Acacia bynoeana* exists within the Locality. The area of direct impact constitutes the construction footprint of the emplacement area and the associated infrastructure sites. This will involve the loss of 60.5 ha of native vegetation, 37.8 ha of which is potential habitat for *Acacia bynoeana*. The zone of indirect impact constitutes a buffer of 500 metres outside the area of direct impact and is approximately 180.4 ha (excluding Subject Site), of which 159.4 ha is potential habitat for *Acacia bynoeana*. The area of habitat in the Study Area to be impacted (directly and indirectly) by the Proposal equates to 4.8 % of similar habitat types in the Locality and this is not considered to be a significant amount of habitat.

As the potential habitat for *Acacia bynoeana* throughout the Locality is confined to Exposed Sandstone Scribbly Gum Woodland along the ridge tops, the sub-populations are naturally isolated from each other by deeply incised sandstone gullies (Sandstone Gully Peppermint Forest). As such the Proposal is unlikely to further exaggerate this isolation or lead to fragmentation of potential habitat for

*Acacia bynoeana*.

The importance of the habitat impacted by the Proposal, to the long term survival of *Acacia bynoeana* in the Locality, is considered to be low.

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

Under the TSC Act, the Director-General of Department of Environment and Climate Change maintains a Register of Critical Habitat. To date, no critical habitat has been declared for *Acacia bynoeana*.

The Proposal will not have an adverse effect on critical habitat (directly or indirectly).

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

To date, no recovery plan has been prepared for this species. DEC (2005a) has listed 13 priority actions to help recover *Acacia bynoeana* in NSW. The following are relevant to this Proposal:

- Liaise with private and public land managers to facilitate the preparation and implementation of management plans that address threatening processes. BHPBIC consulting with experts and ecological consultants as to management options, as identified in the Vegetation and Fauna Management Plan.
- Incorporate Study Area specific threat abatement measures for the species into Plans of Management for on-park sites. A VFMP for the West Cliff Colliery has been prepared and includes provisions to address this issue.
- Develop fire frequency recommendations based on best available knowledge. A VFMP for the West Cliff Colliery has been prepared and includes provisions to address this issue.
- Public authorities undertaking road, trail, or easement maintenance activities in potential habitat are to ensure that planning and maintenance staff are aware of the species and that processes are in place to avoid impacting upon it. BHPBIC maintenance staff and contractors to be made aware of the threats to the species. A VFMP for the West Cliff Colliery has been prepared and includes provisions to address this issue.
- Restrict access to sites, where necessary. Important populations of *Acacia bynoeana* within the Study Area will be managed.

- Undertake targeted bush regeneration works. To implemented as part of a broader VFMP for the Subject Site by BHPBIC.
- Undertake management focused ecological studies. On-going monitoring of potentially impacted populations by BHPBIC.

The Proposal is not inconsistent with the 12 listed priority actions. Management actions as outlined in the recommendations of this report will address some of these. Further, the VFMP will address ongoing management of the vegetation at West Cliff. For example, the sub-population of 228 individuals to the west of the emplacement area should be managed due to its high conservation significance.

**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 listed on the TSC Act relevant to the Proposal include:

- ‘Clearing of native vegetation’ - approximately 60.5 per cent of potential habitat for *Acacia bynoeana* will be cleared for the Proposal. This is not considered to be a significant amount of potential habitat for the species;
- ‘Alteration to the natural flow regimes of river, streams, floodplains and wetlands’ – the Proposal is likely to alter two small, ephemeral drainage lines and Brennans Creek. However, *Acacia bynoeana* is not directly reliant on these drainage lines and creek and is therefore unlikely to be impacted by this Key Threatening Process;
- Human-caused climate change – the Stage 3 coal wash emplacement project will have little impact on climate change. The emplacement area is, however, linked to coal production. Coal Production Activities are addressed under different consent and management regimes.
- ‘Infection of native plants by *Phytophthora cinnamomi*’ – machinery could potentially introduce and spread *Phytophthora cinnamomi* through the Study Area. As a precaution, vehicles will be washed down when transferred to and from the West Cliff site using appropriate procedures to ensure the fungus is not spread.
- ‘Ecological consequences of high frequency fires’ – the Proposal may alter the frequency of fires in the area. BHPBIC will consider the impacts of any proposed hazard reduction program on threatened species, in consultation with DECC and other relevant experts in accordance with the VFMP.
- ‘Invasion of native plant communities by exotic perennial grasses’ – the



Proposal may increase the threat of weed invasion by exotic perennial grasses, particularly given the presence of exotic perennial grasses in the vicinity of the existing emplacement areas and disturbed edges. The VFMP outlines appropriate management of this issue.

The Proposal will increase the impact of at least four Key Threatening Processes in relation to *Acacia bynoeana* in the Study Area.

### Conclusion

The Proposal will have the following impacts on *Acacia bynoeana*:

- Removal of approximately 11 individuals, with an additional 282 potentially indirectly impacted, from a known local population in excess of 2000 individuals.
- Approximately 37.8 ha of habitat for *Acacia bynoeana* will be cleared as part of the Proposal. There may also be approximately 159.4 ha of potential habitat indirectly impacted by potential weed invasion, trampling, coal dust deposition and edge effects.
- Increase in the impact of some Key Threatening Processes.

The Proposal is **not** considered likely to result in a significant impact on the local population at *Acacia bynoeana*, as:

- The removal of 11 individuals is not considered likely to impact on the lifecycle of the species such that the viable local population could be placed at risk of extinction.
- The Proposal will not result in the fragmentation of the population of *Acacia bynoeana* within the Locality.
- The habitat to be impacted is not considered to be important for the long term survival of the species in the Locality.
- The Proposal will not have an adverse effect on critical habitat (directly or indirectly).
- The Proposal is not inconsistent with a recovery plan for the species.

### *Astrotricha crassifolia*

*Astrotricha crassifolia* is a shrub to 2.4 m high and is listed as Vulnerable on both the TSC and EPBC Acts.

*Astrotricha crassifolia* was not recorded within the Study Area despite current and previous targeted surveys. The species is considered to have potential habitat within the Study Area and is known to occur in dry sandstone ridgetop sclerophyll woodland (DEC 2005d).

**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.**

No information currently exists as to whether *Astrotricha crassifolia* has specific pollination, dispersal or germination mechanisms (DEC 2005d). The species has indefinite longevity, resprouts from the basal stem and suckers after fire (Benson and McDougall 1993).

The direct impacts associated with the Proposal involve the removal of potential habitat for *Astrotricha crassifolia*. Indirect impacts include altered fire frequency and increased coal dust deposition on habitat for the species. It is important to note that coal wash emplacements are already present in the Study Area, within 500 m of the Subject Site (Stage 1 and Stage 2). Indirect impacts of the Proposal are therefore already being experienced.

*Astrotricha crassifolia* was not recorded within the Study Area during the field surveys and therefore a viable population within the Study Area is not likely to exist. It is therefore considered unlikely that the removal of potential habitat, an altered fire regime or coal dust deposition will have a significant impact on the lifecycle of the species such that a viable local population of *Astrotricha crassifolia* is 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 an endangered ecological community or critically endangered ecological community, whether the action proposed:**

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

extinction, or

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

NA

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

- i. **the extent to which habitat is likely to be removed or modified as a result of the action proposed, and**
- ii. **whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and**
- iii. **the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the Locality.**

*Astrotricha crassifolia* was not recorded within the Study Area despite current and previous targeted surveys. The species is considered to have potential habitat within the Study Area and is known to occur in dry sandstone ridgetop sclerophyll woodland (DEC 2005d). Vegetation associations include typical sandstone genera such as *Hakea*, *Banksia* and *Xylomelum* (Benson and McDougall 2000c) all of which occur in the Study Area. The species is known to occur on infertile, shallow to deep loamy soils derived from sandstone (Benson and McDougall 2000c). *Astrotricha crassifolia* resprouts following fires (DEC 2005d) and potential habitat in the Study Area is also likely to include all portions of the Study Area that were impacted by fires within the last 5 years.

Approximately 4873.5 ha of potential habitat (ESSW and UGSW) for *Astrotricha crassifolia* exists within the Locality. The area of direct impact constitutes the construction footprint of the emplacement area and the associated infrastructure. This will involve the loss of 60.5 ha of native vegetation, 37.8 ha of which is potential habitat for *Astrotricha crassifolia*. The zone of indirect impact constitutes a buffer of 500 metres outside the area of direct impact and is approximately 180.4 ha, of which 165.8 ha is potential habitat for *Astrotricha crassifolia*. The area of potential habitat in the Study Area to be impacted (directly and indirectly) by the Proposal equates to 5 % of similar habitat types in the Locality and this is not considered to be a significant amount of habitat.

As no populations of *Astrotricha crassifolia* were recorded within the Study Area during the field surveys, it is unlikely that a significant population of the species will be fragmented within the Locality. However, potential habitat for *Astrotricha crassifolia* will be fragmented by the removal of 37.8 ha of native vegetation, which is considered potential habitat for *Astrotricha crassifolia*.

The importance of the habitat impacted by the Proposal, to the long term survival

of *Astrotricha crassifolia* in the Locality, is considered to be low.

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

Under the TSC Act, the Director-General of Department of Environment and Climate Change maintains a Register of Critical Habitat. To date, no critical habitat has been declared for *Astrotricha crassifolia*.

The Proposal will not have an adverse effect on critical habitat (directly or indirectly).

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

To date, no recovery plan or threat abatement plan has been prepared for this species. DEC (DEC 2005d) has listed 12 priority actions to help recover this species. As *Astrotricha crassifolia* was not recorded in the Study Area despite targeted searches, not all of the priority actions are relevant to the Proposal. Those that are considered relevant include:

- Identify, map and survey potential habitat (particularly potential habitat in Ku-ring-gai Chase NP) – potential habitat for *Astrotricha crassifolia* within the Study Area has been identified and mapped and is shown in Figure 5. *Astrotricha crassifolia* was not recorded in the potential habitat for the species in the Study Area during the field surveys.

*Astrotricha crassifolia* was not recorded in the Study Area and therefore the Proposal is not considered likely to interfere with above listed recovery actions.

**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 listed on the TSC Act relevant to the Proposal that may impact on potential habitat for *Astrotricha crassifolia* include:

- ‘Clearing of native vegetation’ - approximately 60.5 ha of native vegetation, including 37.8 ha of ESSW will be cleared for the Proposal.
- ‘Ecological consequences of high frequency fires’ – the Proposal may alter the frequency of fires in the area. In consultation with DECC and relevant experts, BHPBIC will consider the impact of any proposed hazard reduction program on threatened species in accordance with the VFMP.

- ‘Invasion of native plant communities by exotic perennial grasses’ – the Proposal may increase the threat of weed invasion by exotic perennial grasses, particularly given the presence of exotic perennial grasses in the vicinity of the existing emplacement areas and disturbed edges. The VFMP outlines appropriate management of this issue.
- The Proposal will increase the impact of some Key Threatening Processes in the Study Area.

### Conclusion

The Proposal will have the following impacts on *Astrotricha crassifolia*:

- Approximately 37.8 ha of habitat for *Astrotricha crassifolia* will be cleared as part of the Proposal. There may also be approximately 241.4 ha of potential habitat indirectly impacted by potential weed invasion, trampling, coal dust deposition and edge effects.
- Increase in the impact of some Key Threatening Processes.

The Proposal is **not** considered likely to result in a significant impact on a local population of *Astrotricha crassifolia*, as:

- No individuals will be removed by the Proposal and, as a result, an impact on the lifecycle of the species or fragmentation of a population is not likely within the Locality.
- The habitat to be impacted by the Proposal is not considered to be important for the long term survival of the species in the Locality.
- The Proposal will not have an adverse effect on critical habitat (directly or indirectly).
- The Proposal is not inconsistent with a recovery plan for the species.

### *Boronia deanei*

*Boronia deanei* is a small erect shrub to 1.5 m listed as Vulnerable on both the TSC and EPBC Acts. The species has a ROTAP listing of 2VC (Briggs and Leigh 1995) suggesting a distribution ranging less than 100 km.

*Boronia deanei* was not recorded within the Study Area despite current and previous targeted surveys. The species is considered to have potential habitat within the Study Area and is known to occur in wet heathlands, swamps and

alongside streams (DEC 2005e).

Potential habitat within the Study Area is within and adjacent to upland swamps. Typical habitat includes species such as *Gymnoschoenus sphaerocephalus*, *Grevillea acanthifolia*, *Lepidosperma limicola*, *Baeckea utilis* and *Leptospermum lanigerum* (Benson 2001). Three of these species are present within upland swamp habitats of the Study Area.

**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.**

Little is known about the life cycle of *Boronia deanei*. The little information there is suggests that the seed is dispersed ballistically from dehiscent capsules and that it resprouts and flowers after fire (Benson and McDougall 2001). Given its preference for swamp like habitats, it is likely to prefer a moist substrate for germination.

*Boronia deanei* was not recorded within the Study Area and, as such, it is unlikely that the life cycle of a local population of the species will be significantly impacted by the Proposal.

**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**

N/A

**In the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:**

- i. is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or
- ii. is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction.

N/A

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

- i. the extent to which habitat is likely to be removed or modified as a result of the action proposed, and
- ii. whether an area of habitat is likely to become fragmented or isolated

**from other areas of habitat as a result of the proposed action, and**  
**iii. the importance of the habitat to be removed, modified, fragmented or**  
**isolated to the long-term survival of the species, population or ecological**  
**community in the Locality.**

*Boronia deanei* was not recorded within the Study Area during the field surveys. Potential habitat within the Study Area is within and adjacent to upland swamps. Approximately 407.5 ha of potential habitat for *Boronia deanei* exists within the Locality. Potential habitat for this species is not present within the Subject Site. The zone of indirect impact constitutes a buffer of 500 metres outside the area of direct impact and is approximately 180.4 ha, of which approximately 2.4 ha is potential habitat for *Boronia deanei*. The area of potential habitat in the Study Area to be impacted (indirectly only) by the Proposal equates to 0.6 per cent of similar habitat types in the Locality and this is not considered to be a significant amount of habitat.

As no populations of *Boronia deanei* were recorded within the Study Area during the field surveys it is unlikely that a significant population of the species will be fragmented within the Locality. Additionally, the 60.5 ha of native vegetation to be removed by the Proposal does not constitute potential habitat for *Boronia deanei*.

The Proposal will result in the fragmentation of potential habitat for *Boronia deanei*. However, no specimens or populations of the species were recorded within the Study Area or the Locality during the field surveys, and the 0.6 per cent of the potential habitat that will be indirectly impacted is not considered to be a significant amount of habitat. Therefore the importance of the habitat impacted by the Proposal, to the long term survival of *Boronia deanei* in the Locality, is considered to be low.

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

Under the TSC Act, the Director-General of Department of Environment and Climate Change maintains a Register of Critical Habitat. To date, no critical habitat has been declared for *Boronia deanei*.

The Proposal will not have an adverse effect on critical habitat (directly or indirectly).

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

To date, no recovery plan or threat abatement plan has been prepared for *Boronia deanei*. DEC (DEC 2005e) has listed five recommendations to help recover this

species. *Boronia deanei* was not recorded in the Study Area, and therefore the Proposal is not considered likely to interfere with the recommendations by DECC to recover the species.

**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 listed on the TSC Act relevant to the Proposal that may impact on potential habitat for *B. deanei* in the Study Area include:

- ‘Clearing of native vegetation’ – no potential habitat for *Boronia deanei* will be impacted by the Proposal;
- ‘Ecological consequences of high frequency fires’ – the Proposal may alter the frequency of fires in the area. In consultation with DECC and relevant experts, BHPBIC will consider the impacts of any proposed hazard reduction program on threatened species occurring in the Study Area. The VMFP prepared for the West Cliff Colliery includes provisions to address this issue.
- ‘Alteration to the natural flow regimes of rivers, streams, floodplains & wetlands’ – the Proposal is likely to impact on two small ephemeral drainage lines and Brennans Creek. The VMFP prepared for the West Cliff Colliery includes provisions to address this issue.
- ‘Invasion of native plant communities by exotic perennial grasses’ – the Proposal may increase the threat of weed invasion by exotic perennial grasses, particularly given the presence of exotic perennial grasses in the vicinity of the existing emplacement areas and disturbed edges. The VMFP prepared for the West Cliff Colliery includes provisions to address this issue.

The Proposal will increase the impact of some Key Threatening Processes in relation to *Boronia deanei* in the Study Area.

**Conclusion**

The Proposal will have the following impacts on *Boronia deanei*:

- Approximately 2.4 ha of potential habitat may be indirectly impacted by potential weed invasion, trampling, coal dust deposition and edge effects.
- Increase in the impact of some Key Threatening Processes.

The Proposal is **not** considered likely to result in a significant impact on a local population of *Boronia deanei*, as:



- No individuals will be removed by the Proposal and, as a result, an impact on the lifecycle of the species or fragmentation of a population is not likely within the Locality.
- The habitat to be impacted by the Proposal is not considered to be important for the long term survival of the species in the Locality.
- The Proposal will not have an adverse effect on critical habitat (directly or indirectly).
- The Proposal is not inconsistent with a recovery plan for the species.

### *Cryptostylis hunteriana*

*Cryptostylis hunteriana* is a leafless saprophytic terrestrial orchid with the only above-ground growth being 15-45 cm long green inflorescences from December to February. It is listed as a Vulnerable species on Schedule 2 of the TSC Act. It is not listed on the EPBC Act.

*Cryptostylis hunteriana* was not recorded within the Study Area during the field surveys despite the surveys being carried out in the flowering period for the species. All plant communities within the Study Area are considered to be potential habitat for this species.

**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.**

*Cryptostylis hunteriana* is pollinated by pseudocopulation by the Ichneumid wasp *Lissopimpla excelsa*. The dispersal method is unknown, though the numerous winged seeds produced by the capsules are probably dispersed by wind. Germination requirements are unknown but the species does grow from seed and prefers dry sandy loams on Narrabeen shales with low nutrient value. Being saprophytic, its nutritional requirements are probably met by an unknown fungal associate. The species is known to exist as vegetative colonies and usually appears in areas burnt one to three years previously.

The direct impacts associated with the Proposal involve the removal of potential habitat for *Cryptostylis hunteriana*. Indirect impacts include altered fire frequency and increased coal dust deposition. It is important to note that coal wash emplacements are already present in the Study Area, within 500 m of the Subject Site (Stage 1 and Stage 2). Indirect impacts of the Proposal are therefore

already being experienced.

*Cryptostylis hunteriana* was not recorded within the Study Area during the field surveys and therefore a viable population within the Study Area is not likely to exist. It is therefore considered unlikely that the removal of potential habitat, an altered fire regime or coal dust deposition will have a significant impact on the lifecycle of the species such that a viable local population of *Cryptostylis hunteriana* is 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**

N/A

**In the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:**

- i. **is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or**
- ii. **is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction.**

N/A

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

- i. **the extent to which habitat is likely to be removed or modified as a result of the action proposed, and**
- ii. **whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and**
- iii. **the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the Locality.**

During the field surveys, *Cryptostylis hunteriana* was not recorded within the Study Area. All plant communities within the Study Area are considered to be potential habitat for this species.

Approximately 7008.9 ha of potential habitat for *Cryptostylis hunteriana* exists within the Locality. The area of direct impact constitutes the construction footprint of the emplacement area and the associated infrastructure sites. This will involve the loss of 60.5 ha of native vegetation, all of which is considered potential habitat for *Cryptostylis hunteriana*. The zone of indirect impact

constitutes a buffer of 500 metres outside the area of direct impact and is approximately 180.4 ha. The area of habitat in the Study Area to be impacted (directly and indirectly) by the Proposal equates to 3.4 % of similar habitat types in the Locality. This is not considered to be a significant amount of habitat.

As no populations of *Cryptostylis hunteriana* were recorded within the Study Area during the field surveys it is unlikely that a significant population of the species will be fragmented within the Locality. However, potential habitat for *Cryptostylis hunteriana* will be fragmented by the removal of 60.5 ha of native vegetation within the Study Area.

The Proposal will result in the fragmentation of potential habitat for *Cryptostylis hunteriana*. However, no specimens or populations of the species were recorded within the Study Area or the Locality during the field surveys, and the 3.4 per cent of the potential habitat that will be removed is not considered to be significant amount of habitat. Therefore the importance of the habitat impacted by the Proposal, to the long term survival of *Cryptostylis hunteriana* in the Locality, is considered to be low.

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

Under the TSC Act, the Director-General of Department of Environment and Climate Change maintains a Register of Critical Habitat. To date, no critical habitat has been declared for *Cryptostylis hunteriana*.

The Proposal will not have an adverse effect on critical habitat (directly or indirectly).

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

To date, no NSW threat or recovery plans have been published for *Cryptostylis hunteriana*. DEC (DEC 2005g) has listed three priority actions to help recover this species, these are:

- Co-operatively develop (local governments and DECC) guidelines for survey and assessment, to be followed by developers, consultants and approval authorities.
- Alert road maintenance staff to the presence of this species.
- Monitor populations to determine the most appropriate timing and frequency of burning.

These are not relevant to the Proposal as the species was not recorded in the Study Area. On the basis that *Cryptostylis hunteriana* was not recorded in the Study Area the Proposal is not considered likely to interfere with above listed recommendations.

**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 listed on the TSC Act relevant to the Proposal that may impact on potential habitat for *Cryptostylis hunteriana* include:

- ‘Clearing of native vegetation’ – the Proposal will involve clearing native vegetation that is potential habitat for *Cryptostylis hunteriana*.
- ‘Ecological consequences of high frequency fires’ – the Proposal may alter the frequency of fire within areas that are potential habitat for *Cryptostylis hunteriana*. BHPBIC will consider the impacts of any proposed hazard reduction program on threatened species, in consultation with DECC. The VMFP prepared for the West Cliff Colliery includes provisions to address this issue.
- ‘Invasion of native plant communities by exotic perennial grasses’ – the Proposal may increase the threat of weed invasion by exotic perennial grasses, particularly given the presence of exotic perennial grasses in the vicinity of the existing emplacement areas and disturbed edges. The VMFP prepared for the West Cliff Colliery includes provisions to address this issue.

The Proposal will increase the impact of some Key Threatening Processes in relation to *Cryptostylis hunteriana* in the Study Area.

**Conclusion**

The Proposal will have the following impacts on *Cryptostylis hunteriana*:

- Approximately 60.5 ha of habitat for *Cryptostylis hunteriana* will be lost as part of the Proposal. There may also be approximately 180.4 ha of potential habitat indirectly impacted by potential weed invasion, trampling, coal dust deposition and edge effects.
- Increase in the impact of some Key Threatening Processes.

The Proposal is **not** considered likely to result in a significant impact on a local population of *Cryptostylis hunteriana*, as:

- No individuals will be removed by the Proposal and, as a result, an impact on

the lifecycle of the species or fragmentation of a population is not likely within the Locality.

- The habitat to be impacted by the Proposal is not considered to be important for the long term survival of the species in the Locality.
- The Proposal will not have an adverse effect on critical habitat (directly or indirectly).
- The Proposal is not inconsistent with a recovery plan for the species.

### *Darwinia peduncularis*

*Darwinia peduncularis* is a divaricate shrub to 1.5 m high and is listed as Vulnerable the TSC Act. The species is not listed on the EPBC Act.

*Darwinia peduncularis* was not recorded within the Study Area during the field surveys. The species is considered to have potential habitat within the Study Area and usually grows on or near rocky outcrops on sandy, well drained, low nutrient soil over sandstone (DEC 2005i). Specific areas of potential habitat within the Study Area are considered to be on and near rocky areas within Exposed Sandstone Scribbly Gum Woodland (ESSW). Potential habitat for this species is considered to be well represented in the Study Area and Locality.

**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.**

All information on the life cycle of *Darwinia peduncularis* has been taken from Benson (1998) unless otherwise stated.

*Darwinia peduncularis* has a specialised flower structure in addition to a successional maturing for pollination by honey-eaters (birds). The successional flowering is thought to aid genetic cross-over. The fruit is indehiscent and plants are probably killed by fire. Feral honeybees are reported to take nectar from the base of the flower without removing pollen or touching the stigma. DEC (2005i) suggests that the species is incapable of vegetative spread but may resprout after some disturbance.

The direct impacts associated with the Proposal involve the removal of potential habitat for *Darwinia peduncularis*. Indirect impacts include altered fire frequency and increased coal dust deposition. It is important to note that coal wash emplacements are already present in the Study Area, within 500 m of the

Subject Site (Stage 1 and Stage 2). Indirect impacts of the Proposal are therefore already being experienced.

*Darwinia peduncularis* was not recorded within the Study Area during the field surveys and therefore a viable population within the Study Area is not likely to exist. It is therefore considered unlikely that the removal of potential habitat, a suppressed fire regime or coal dust deposition will have a significant impact on the lifecycle of the species such that a viable local population of *Darwinia peduncularis* is 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**

N/A

**In the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:**

- i. is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or**
- ii. is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction.**

N/A

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

- i. the extent to which habitat is likely to be removed or modified as a result of the action proposed, and**
- ii. whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and**
- iii. the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the Locality.**

*Darwinia peduncularis* was not recorded within the Study Area during the field surveys. The species is considered to have potential habitat within the Study Area and usually grows on or near rocky outcrops on sandy, well drained, low nutrient soil over sandstone (DEC 2005i). Specific areas of potential habitat within the Study Area are considered to be on and near rocky areas within ESSW.

Approximately 638.9 ha of potential habitat for *Darwinia peduncularis* exists

within the Locality. The area of direct impact constitutes the construction footprint of the emplacement area and the associated infrastructure sites. This will involve the loss of 60.5 ha of native vegetation, 37.8 ha of which is potential habitat for *Darwinia peduncularis*. The zone of indirect impact constitutes a buffer of 500 metres outside the area of direct impact and is approximately 180.4 ha (excluding Subject Site), of which 159.4 ha is potential habitat for *Darwinia peduncularis*. The area of habitat in the Study Area to be impacted (directly and indirectly) by the Proposal equates to 4.8 per cent of similar habitat types in the Locality and this is not considered to be a significant amount of habitat.

As no populations of *Darwinia peduncularis* were recorded within the Study Area during the field surveys it is unlikely that a significant population of the species will be fragmented within the Locality. However, potential habitat for *Darwinia peduncularis* will be fragmented by the removal of 60.5 ha of native vegetation within the Study Area, 37.8 ha of which is potential habitat for *Darwinia peduncularis*.

The Proposal will result in the fragmentation of potential habitat for *Darwinia peduncularis*. However, no specimens or populations of the species were recorded within the Study Area or the Locality during the field surveys, and the 4.8 per cent of the potential habitat that will be removed is not considered to be a significant amount of habitat. Therefore the importance of the habitat impacted by the Proposal, to the long term survival of *Darwinia peduncularis* in the Locality, is considered to be low.

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

Under the TSC Act, the Director-General of Department of Environment and Climate Change maintains a Register of Critical Habitat. To date, no critical habitat has been declared for *Darwinia peduncularis*.

The Proposal will not have an adverse effect on critical habitat (directly or indirectly).

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

To date, no recovery plan or threat abatement plan has been prepared for this species. DEC (DEC 2005i) has listed five priority actions to help recover this species, of these, the following one considered relevant to the Proposal:

- Identify and survey potential habitat, particularly in the Blue Mountains and Bargo areas. - Potential habitat for *Darwinia peduncularis* within the Study Area (ESSW) has been mapped and is included in Figure 5. Targeted

surveys for this species were undertaken in these areas and the species was not recorded.

This species is not considered a cryptic species and if present would have been recorded in the Study Area. On this basis the Proposal is not considered likely to interfere with the recovery of *Darwinia peduncularis*.

**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 listed on the TSC Act relevant to the Proposal that may impact on potential habitat for *Darwinia peduncularis* include:

- ‘Clearing of native vegetation’ - approximately 37.8 ha of ESSW will be cleared for the Proposal;
- ‘Ecological consequences of high frequency fires’ – the Proposal may alter the frequency of fires in the area. In consultation with DECC and other experts, BHPBIC will consider the impact of any hazard reduction burn programs on the lifecycle of threatened species known to occur in the Study Area. The VMFP prepared for the West Cliff Colliery includes provisions to address this issue.
- ‘Invasion of native plant communities by exotic perennial grasses’ – the Proposal may increase the threat of weed invasion by exotic perennial grasses, particularly given the presence of exotic perennial grasses in the vicinity of the existing emplacement areas and disturbed edges. The VMFP prepared for the West Cliff Colliery includes provisions to address this issue.

The Proposal will increase the impact of some Key Threatening Processes in relation to *Darwinia peduncularis* in the Study Area.

**Conclusion**

The Proposal will have the following impacts on *Darwinia peduncularis*:

- Approximately 37.8 ha of habitat for *Darwinia peduncularis* will be cleared as part of the Proposal. There may also be approximately 159.4 ha of potential habitat indirectly impacted by potential weed invasion, trampling, coal dust deposition and edge effects.
- An increase in the impact of some Key Threatening Processes.

The Proposal is **not** considered likely to result in a significant impact on a local



population of *Darwinia peduncularis*, as:

- No individuals will be removed by the Proposal and, as a result, an impact on the lifecycle of the species or fragmentation of a population is not likely within the Locality.
- The habitat to be impacted by the Proposal is not considered to be important for the long term survival of the species in the Locality.
- The Proposal will not have an adverse effect on critical habitat (directly or indirectly).
- The Proposal is not inconsistent with a recovery plan for the species.

***Epacris purpurascens* var. *purpurascens***

*Epacris purpurascens* var. *purpurascens* is listed as a Vulnerable species on Schedule 2 of the TSC Act. It is not listed on the EPBC Act.

*Epacris purpurascens* var. *purpurascens* was not recorded within the Study Area during the field surveys. The species is known to occur in a range of habitat types, most of which have a strong clay influence, including ridgetop drainage depressions supporting wet heath within or adjoining shale cap communities, riparian zones draining into sandstone gully forest, shale lenses within sandstone habitats and colluvial areas overlying or adjoining sandstone or tertiary alluvium (DEC 2005e).

**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.**

*Epacris purpurascens* var. *purpurascens* takes two to four years to reach maturity and can live for up to 50 years. The species is killed by fire and re-establishes itself from a soil-stored seedbank (DEC 2005x). Individuals grow quickly after fire where light is available (Benson and McDougall 1995).

The direct impacts associated with the Proposal involve the removal of potential habitat for *Epacris purpurascens* var. *purpurascens*. Indirect impacts include altered fire frequency and increased coal dust deposition. It is important to note that coal wash emplacements are already present in the Study Area, within 500 m of the Subject Site (Stage 1 and Stage 2). Indirect impacts of the Proposal are therefore already being experienced.

*Epacris purpurascens* var. *purpurascens* was not recorded within the Study Area

during the field surveys and therefore a viable population within the Study Area is not likely to exist. It is therefore considered unlikely that the removal of potential habitat, an altered fire regime or coal dust deposition will have a significant impact on the lifecycle of the species such that a viable local population of *Epacris purpurascens* var. *purpurascens* is 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**

N/A

**In the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:**

- i. is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or**
- ii. is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction.**

N/A

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

- i. the extent to which habitat is likely to be removed or modified as a result of the action proposed, and**
- ii. whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and**
- iii. the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the Locality.**

*Epacris purpurascens* var. *purpurascens* was not recorded within the Study Area during the field survey. However the species is considered to have potential habitat present within all plant communities in the Study Area.

Approximately 7008.8 ha of potential habitat for *Epacris purpurascens* var. *purpurascens* exists within the Locality. The area of direct impact constitutes the construction footprint of the emplacement area and the associated infrastructure. This will involve the loss of 60.5 ha of native vegetation, all of which is considered potential habitat for *Epacris purpurascens* var. *purpurascens*. The zone of indirect impact constitutes a buffer of 500 metres outside the area of direct impact and is approximately 180.4 ha. The area of habitat in the Study

Area to be impacted (directly and indirectly) by the Proposal equates to 3.4 per cent of similar habitat types in the Locality and this is not considered to be a significant amount of habitat.

As no populations of *Epacris purpurascens* var. *purpurascens* were recorded within the Study Area during the field surveys it is unlikely that a significant population of the species will be fragmented within the Locality. However, potential habitat for *Epacris purpurascens* var. *purpurascens* will be fragmented by the removal of 60.5 ha of native vegetation within the Study Area.

The Proposal will result in the fragmentation of potential habitat for *Epacris purpurascens* var. *purpurascens*. However, no specimens or populations of the species were recorded within the Study Area or the Locality during the field surveys, and the 3.4 per cent of the potential habitat that will be removed is not considered to be significant amount of habitat. Therefore the importance of the habitat impacted by the Proposal, to the long term survival of *Epacris purpurascens* var. *purpurascens* in the Locality, is considered to be low.

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

Under the TSC Act, the Director-General of Department of Environment and Climate Change maintains a Register of Critical Habitat. To date, no critical habitat has been declared for *Epacris purpurascens* var. *purpurascens*.

The Proposal will not have an adverse effect on critical habitat (directly or indirectly).

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

To date, no recovery plan or threat abatement plan has been prepared for this species. DECC has listed five priority actions to help recover this species (DEC 2005m). As the species was not recorded in the Study Area despite targeted surveys, not all of these priority actions are relevant to the Proposal. Those that are considered relevant include:

- Identify and survey potential habitat to detect new populations – potential habitat for the species in the Study Area has been identified and mapped Figure 5. The species was not recorded in these areas despite targeted surveys.

*E. purpurascens* var. *purpurascens* was not recorded in the Study Area and therefore the Proposal is not considered likely to interfere with above listed

recovery actions.

**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 listed on the TSC Act relevant to the Proposal that may impact on potential habitat for *E. purpurascens* var. *purpurascens* in the Study Area include:

- ‘Clearing of native vegetation’ – potential habitat within drainage lines and creeks are likely to be cleared as part of this Proposal.
- ‘Ecological consequences of high frequency fires’ – the Proposal may alter the frequency of fires in the area. BHPBIC will consider the impacts of any proposed hazard reduction program on threatened species, in consultation with DECC. The VMFP prepared for the West Cliff Colliery includes provisions to address this issue.
- ‘Alteration to the natural flow regimes of rivers, streams, floodplains and wetlands’ – the Proposal is likely to impact on two small ephemeral drainage lines and Brennans Creek. The VMFP prepared for the West Cliff Colliery includes provisions to address this issue.
- ‘Invasion of native plant communities by exotic perennial grasses’ – the Proposal may increase the threat of weed invasion by exotic perennial grasses, particularly given the presence of exotic perennial grasses in the vicinity of the existing emplacement areas and disturbed edges. The VMFP prepared for the West Cliff Colliery includes provisions to address this issue.

The Proposal will increase the impact of some Key Threatening Processes in relation to *Epacris purpurascens* var. *purpurascens* in the Study Area.

**Conclusion**

The Proposal will have the following impacts on *Epacris purpurascens* var. *purpurascens*:

- Approximately 60.5 ha of habitat for *Epacris purpurascens* var. *purpurascens* will be cleared as part of the Proposal. There may also be approximately 180.4 ha of potential habitat indirectly impacted by potential weed invasion, trampling, coal dust deposition and edge effects.
- Increase in the impact of some Key Threatening Processes.

The Proposal is **not** considered likely to result in a significant impact on a local population of *Epacris purpurascens* var. *purpurascens*, as:

- It is unlikely individuals will be removed by the Proposal and, as a result, an impact on the lifecycle of the species or fragmentation of a population is not likely within the Locality.
- The habitat to be impacted by the Proposal is not considered to be important for the long term survival of the species in the Locality.
- The Proposal will not have an adverse effect on critical habitat (directly or indirectly).
- The Proposal is not inconsistent with a recovery plan for the species.

### *Eucalyptus camfieldii*

*Eucalyptus camfieldii* is mostly a mallee to 4 m tall though can grow to a straggly tree to 9 m high with stringy, red or dark grey-brown bark. The species is listed as Vulnerable on both the TSC and EPBC Acts.

*Eucalyptus camfieldii* was not recorded within the Study Area during the field surveys. Potential habitat within the Study Area is considered to be within Exposed Sandstone Scribbly Gum Woodland.

**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.**

All information on the life cycle of *Eucalyptus camfieldii* has been taken from Benson (1998) unless otherwise stated.

*Eucalyptus camfieldii* is thought to live for up to 100 years. Its large lignotuber means that a standing population could potentially be only a few or even one plant. It flowers irregularly (DEC 2005n) and the fruit is retained for up to a year and seed is dispersed by wind or by gravity. The species germinates readily from seed but seedlings are rare. Vegetative regrowth post-fire is from the lignotuber and epicormic buds. A population on North Head was observed to be senescing in the 1980s due to unburnt competing vegetation.

The direct impacts associated with the Proposal involve the removal of potential habitat for *Eucalyptus camfieldii*. Indirect impacts include altered fire frequency and increased coal dust deposition. It is important to note that coal wash emplacements are already present in the Study Area, within 500 m of the Subject

Site (Stage 1 and Stage 2). Indirect impacts of the Proposal are therefore already being experienced.

*Eucalyptus camfieldii* was not recorded within the Study Area during the field surveys and therefore a viable population within the Study Area is not likely to exist. It is therefore considered unlikely that the removal of potential habitat, an altered fire regime or coal dust deposition will have a significant impact on the lifecycle of the species such that a viable local population of *Eucalyptus camfieldii* is 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**

N/A

**In the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:**

- i. is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or**
- ii. is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction.**

N/A

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

- i. the extent to which habitat is likely to be removed or modified as a result of the action proposed, and**
- ii. whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and**
- iii. the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the Locality.**

*Eucalyptus camfieldii* was not recorded within the Study Area during the field surveys. Habitat for *Eucalyptus camfieldii* includes Shallow soiled sandstone or lateric tops amongst *Angophora hispida*, *Eucalyptus haemastoma*, and *E. oblonga* (Robinson 1994). Potential habitat within the Study Area is considered to be within ESSW.

Approximately 4109.2 ha of potential habitat for *Eucalyptus camfieldii* exists within the Locality. The area of direct impact constitutes the construction footprint of

the emplacement area and the associated infrastructure sites. This will involve the loss of 60.5 ha of native vegetation, 37.8 ha of which is potential habitat for *Eucalyptus camfieldii*. The zone of indirect impact constitutes a buffer of 500 metres outside the area of direct impact and is approximately 180.4 ha, of which 159.4 ha is potential habitat for *Eucalyptus camfieldii*. The area of habitat in the Study Area to be impacted (directly and indirectly) by the Proposal equates to 4.8 per cent of similar habitat types in the Locality and this is not considered to be a significant amount of habitat.

As no populations of *Eucalyptus camfieldii* were recorded within the Study Area during the field surveys it is unlikely that a significant population of the species will be fragmented within the Locality. However, potential habitat for *Eucalyptus camfieldii* will be fragmented by the removal of 37.8 ha of native vegetation within the Study Area.

The Proposal will result in the fragmentation of potential habitat for *Eucalyptus camfieldii*. However, no specimens or populations of the species were recorded within the Study Area or the Locality during the field surveys, and the 4.8 per cent of the potential habitat that will be removed is not considered to be significant amount of habitat. Therefore the importance of the habitat impacted by the Proposal, to the long term survival of *Eucalyptus camfieldii* in the Locality, is considered to be low.

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

Under the TSC Act, the Director-General of Department of Environment and Climate Change maintains a Register of Critical Habitat. To date, no critical habitat has been declared for *Eucalyptus camfieldii*.

The Proposal will not have an adverse effect on critical habitat (directly or indirectly).

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

To date, no recovery plan or threat abatement plan has been prepared for this species.

This species is not considered a cryptic species and if present should have been recorded in the Study Area. On the basis that *Eucalyptus camfieldii* was not recorded in the Study Area, the Proposal is not considered likely to interfere with the recovery of the species.

**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 listed on the TSC Act relevant to the Proposal that may impact on potential habitat for *Eucalyptus camfieldii* include:

- ‘Clearing of native vegetation’ – approximately 37.8 ha of ESSW will be cleared for the Proposal.
- ‘Ecological consequences of high frequency fires’ – the Proposal may alter the frequency of fires in the area. In consultation with DECC and other experts, BHPBIC will consider the impact of any hazard reduction burn programs on the lifecycle of threatened species known to occur in the Study Area in accordance with the VFMP.
- ‘Invasion of native plant communities by exotic perennial grasses’ – the Proposal may increase the threat of weed invasion by exotic perennial grasses, particularly given the presence of exotic perennial grasses in the vicinity of the existing emplacement areas and disturbed edges. The VMFP prepared for the West Cliff Colliery includes provisions to address this issue.

The Proposal will increase the impact of some Key Threatening Processes in relation to *Eucalyptus camfieldii* in the Study Area.

**Conclusion**

The Proposal will have the following impacts on *Eucalyptus camfieldii*:

- Approximately 37.8 ha of habitat for *Eucalyptus camfieldii* will be cleared as part of the Proposal. There may also be approximately 159.4 ha of potential habitat indirectly impacted by potential weed invasion, trampling, coal dust deposition and edge effects.
- Increase in the impact of some Key Threatening Processes.

The Proposal is **not** considered likely to result in a significant impact on a local population of *Eucalyptus camfieldii*, as:

- No individuals will be removed by the Proposal and, as a result, an impact on the lifecycle of the species or fragmentation of a population is not likely within the Locality.
- The habitat to be impacted by the Proposal is not considered to be important for the long term survival of the species in the Locality.
- The Proposal will not have an adverse effect on critical habitat (directly or indirectly).



- The Proposal is not inconsistent with a recovery plan for the species.

### *Grevillea parviflora ssp. parviflora*

*Grevillea parviflora ssp. parviflora* is listed as Vulnerable on Schedule 2 of the TSC Act. This species is also listed as Vulnerable on the EPBC Act.

*Grevillea parviflora ssp. parviflora* is a low open to erect shrub, 0.3-1 m tall. It occurs in light clayey soils in woodlands and most plants appear capable of suckering from a rootstock (NSW Scientific Committee 1998a).

*Grevillea parviflora ssp. parviflora* was not recorded in the Study Area; however, potential habitat for the species exists in the Exposed Sandstone Scribbly Gum Woodland (ESSW) and Upper Georges River Sandstone Woodland (UGRSW) and along the existing power line easement in the Study Area.

**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.**

*Grevillea parviflora ssp. parviflora* is insect pollinated and seed is dispersed by gravity when the fruit splits at maturity (Benson and McDougall 2000b). The seed is thought to have a food body for ant dispersal (Benson and McDougall 2000b). There is recruitment from a soil stored seedbank after fire (Benson and McDougall 2000b), the species suckers from a rootstock and there is likely vegetative spread after fire (DEC 2005r). Plants are thought to live for between 20 and 60 years.

The direct impacts associated with the Proposal involve the removal of potential habitat for *Grevillea parviflora ssp. parviflora*. Indirect impacts include altered fire frequency and increased coal dust deposition. It is important to note that coal wash emplacements are already present in the Study Area, within 500 m of the Subject Site (Stage 1 and Stage 2). Indirect impacts of the Proposal are therefore already being experienced.

*Grevillea parviflora ssp. parviflora* was not recorded within the Study Area during the field surveys and therefore a viable population within the Study Area is not likely to exist. It is therefore considered unlikely that the removal of potential habitat, an altered fire regime or coal dust deposition will have a significant impact on the lifecycle of the species such that a viable local population of *Grevillea parviflora ssp. parviflora* is 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**

N/A

**In the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:**

- i. is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or**
- ii. is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction.**

N/A

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

- i. the extent to which habitat is likely to be removed or modified as a result of the action proposed, and**
- ii. whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and**
- iii. the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the Locality.**

*Grevillea parviflora* ssp. *parviflora* was not recorded in the Study Area, however, potential habitat for the species exists within UGRSW and ESSW which is present within the Study Area.

Approximately 4873.5 ha of potential habitat for *Grevillea parviflora* ssp. *parviflora* exists within the Locality. The area of direct impact constitutes the construction footprint of the emplacement area and the associated infrastructure sites. This will involve the loss of 60.5 ha of native vegetation, of which 37.8 ha is considered potential habitat for *Grevillea parviflora* ssp. *parviflora*. The zone of indirect impact constitutes a buffer of 500 metres outside the area of direct impact and is approximately 180.4 ha, of which 165.8 ha is potential habitat for *Grevillea parviflora* ssp. *parviflora*. The area of habitat in the Study Area to be impacted (directly and indirectly) by the Proposal equates to 4.9 per cent of similar habitat types in the Locality and this is not considered to be a significant amount of habitat.

As no populations of *Grevillea parviflora* ssp. *parviflora* were recorded within the Study Area during the field surveys it is unlikely that a significant population

of the species will be fragmented within the Locality. However, potential habitat for *Grevillea parviflora* ssp. *parviflora* will be fragmented by the removal of 60.5 ha of native vegetation within the Study Area, of which 37.8 ha is potential habitat for *Grevillea parviflora* ssp. *parviflora*.

The Proposal will result in the fragmentation of potential habitat for *Grevillea parviflora* ssp. *parviflora*. However, no specimens or populations of the species were recorded within the Study Area or the Locality during the field surveys, and the 4.9 per cent of the potential habitat that will be impacted is not considered to be significant amount of habitat. Therefore the importance of the habitat impacted by the Proposal, to the long term survival of *Grevillea parviflora* ssp. *parviflora* in the Locality, is considered to be low.

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

Under the TSC Act, the Director-General of Department of Environment and Climate Change maintains a Register of Critical Habitat. To date, no critical habitat has been declared for *Grevillea parviflora* spp. *parviflora*.

The Proposal will not have an adverse effect on critical habitat (directly or indirectly).

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

To date, no recovery plan has been prepared for this species. DEC (2005a) has listed five priority actions to help recover *Grevillea parviflora* ssp. *parviflora* in NSW. The following three are relevant to the Proposal:

- Liaise with land managers to encourage the preparation of Study Area management plans and the implementation of appropriate threat abatement measures, particularly in fire management, bush regeneration, roadside management, weed control and fencing and signage.
- Monitor known populations, so that potential local extinctions are detected before they occur and mechanisms can be put in place to reverse trends.
- Identify and survey potential habitat to detect new populations.

The Proposal is not inconsistent with the listed priority actions for *Grevillea parviflora* ssp. *parviflora*. Management actions as outlined in the recommendations of this report will address some of these.

**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 listed on the TSC Act relevant to the Proposal include:

- ‘Clearing of native vegetation’ – approximately 4.9 per cent of potential habitat for *Grevillea parviflora* ssp. *parviflora* will be impacted (directly and indirectly) for the Proposal. This is not considered to be a significant amount of potential habitat for the species;
- Alteration to the natural flow regimes of river, streams, floodplains and wetlands – the Proposal is likely to impact on two small ephemeral drainage lines and Brennans Creek. However, *Grevillea parviflora* ssp. *parviflora* is not directly reliant on these drainage lines and rivers and is therefore unlikely to be impacted by this Key Threatening Process. The VMFP prepared for the West Cliff Colliery includes provisions to address this issue.
- Infection of native plants by *Phytophthora cinnamomi* – machinery could potentially introduce and spread *Phytophthora cinnamomi* through the Study Area. As a precaution, vehicles will be washed down using appropriate procedures to ensure the fungus is not spread. The VMFP prepared for the West Cliff Colliery includes provisions to address this issue.
- ‘Ecological consequences of high frequency fires’ – the Proposal may alter the frequency of fires in the area. BHPBIC will consider the impacts of any proposed hazard reduction program on threatened species, in consultation with DECC and other relevant experts in accordance with the VFMP for West Cliff.
- ‘Invasion of native plant communities by exotic perennial grasses’ – the Proposal may increase the threat of weed invasion by exotic perennial grasses, particularly given the presence of exotic perennial grasses in the vicinity of the existing emplacement areas and disturbed edges. The VMFP prepared for the West Cliff Colliery includes provisions to address this issue.

The Proposal will increase the impact of some Key Threatening Processes in relation to *Grevillea parviflora* ssp. *parviflora* in the Study Area.

### Conclusion

The Proposal will have the following impacts on *Grevillea parviflora* ssp. *parviflora*:

- Approximately 37.8 ha of habitat for *Grevillea parviflora* ssp. *parviflora* will be cleared as part of the Proposal. There may also be approximately 165.8 ha of potential habitat indirectly impacted by potential weed invasion, trampling, coal dust deposition and edge effects.
- Increase in the impact of some Key Threatening Processes.

The Proposal is **not** considered likely to result in a significant impact on a local

population of *Grevillea parviflora* ssp. *parviflora*, as:

- No individuals will be removed by the Proposal and, as a result, an impact on the lifecycle of the species or fragmentation of a population is not likely within the Locality.
- The habitat to be impacted by the Proposal is not considered to be important for the long term survival of the species in the Locality.
- The Proposal will not have an adverse effect on critical habitat (directly or indirectly).
- The Proposal is not inconsistent with a recovery plan for the species.

### *Gyrostemon thesioides*

*Gyrostemon thesioides* is a shrub with several stems to 70 cm high and is listed as a Vulnerable species on Schedule 2 of the TSC Act. It is not listed on the EPBC Act.

*Gyrostemon thesioides* not recorded within the Study Area despite current and previous targeted surveys. The species is considered to have potential habitat in the Study Area within Sandstone Gully Peppermint Forest (SGPF) and Sandstone Gully Apple Peppermint Forest (SGAPF).

**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 methods of pollination and dispersal for *Gyrostemon thesioides* are largely unknown. It is known as an obligate seeder and germinates readily after fire while the parent plants are killed (DEC 2005t). It is short-lived in infertile sandy alluvium (Benson and McDougall 1997).

The direct impacts associated with the Proposal involve the removal of potential habitat for *Gyrostemon thesioides*. Indirect impacts include altered fire frequency and increased coal dust deposition. It is important to note that coal wash emplacements are already present in the Study Area, within 500 m of the Subject Site (Stage 1 and Stage 2). Indirect impacts of the Proposal are therefore already being experienced.

*Gyrostemon thesioides* was not recorded within the Study Area during the field surveys and therefore a viable population within the Study Area is not likely to exist. It is therefore considered unlikely that the removal of potential habitat, an

altered fire regime or coal dust deposition will have a significant impact on the lifecycle of the species such that a viable local population of *Gyrostemon thesioides* is 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**

N/A

**In the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:**

- i. is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or**
- ii. is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction.**

N/A

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

- i. the extent to which habitat is likely to be removed or modified as a result of the action proposed, and**
- ii. whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and**
- iii. the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the Locality.**

*Gyrostemon thesioides* was not recorded within the Study Area despite current and previous targeted surveys. Potential habitat for this species exists in the Study Area within SGPF and SGAPF.

Approximately 1727.8 ha of potential habitat for *Gyrostemon thesioides* exists within the Locality. The area of direct impact constitutes the construction footprint of the emplacement area and the associated infrastructure sites. This will involve the loss of 60.5 ha of native vegetation, 22.7 ha of which is potential habitat for *Gyrostemon thesioides*. The zone of indirect impact constitutes a buffer of 500 metres outside the area of direct impact and is approximately 180.4 ha, of which 12.2 ha is potential habitat for *Gyrostemon thesioides*. The area of habitat in the Study Area to be impacted (directly and indirectly) by the Proposal equates to 3.3 % of similar habitat types in the Locality and this is not considered

to be a significant amount of habitat.

As no populations of *Gyrostemon thesioides* were recorded within the Study Area during the field surveys it is unlikely that a significant population of the species will be fragmented within the Locality. However, potential habitat for *Gyrostemon thesioides* will be fragmented by the removal of 22.7 ha of native vegetation within the Study Area.

The Proposal will result in the fragmentation of potential habitat for *Gyrostemon thesioides*. However, no specimens or populations of the species were recorded within the Study Area or the Locality during the field surveys, and the 3.3 per cent of the potential habitat that will be impacted is not considered to be significant amount of habitat. Therefore the importance of the habitat impacted by the Proposal, to the long term survival of *Gyrostemon thesioides* in the Locality, is considered to be low.

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

Under the TSC Act, the Director-General of Department of Environment and Climate Change maintains a Register of Critical Habitat. To date, no critical habitat has been declared for *Gyrostemon thesioides*.

The Proposal will not have an adverse effect on critical habitat (directly or indirectly).

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

To date, no recovery plan or threat abatement plan has been prepared for this species. DECC has listed five priority actions to help recover this species. As the species has not been recorded in the Study Area, not all of these are relevant to the Proposal. Those that are relevant include:

- Conduct targeted surveys within likely habitat, especially along the Nepean, Georges and Colo Rivers, to locate new populations – Potential habitat for the species in the Study Area has been identified and mapped (Figure 5). The species has not been recorded in the Study Area despite targeted searches within the identified potential habitat.

On the basis *Gyrostemon thesioides* was not recorded in the Study Area the Proposal is not considered likely to interfere with the above priority actions.

**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 listed on the TSC Act relevant to the Proposal that may impact on potential habitat for *Gyrostemon thesioides* in the Study Area include:

- ‘Clearing of native vegetation’ – potential habitat within drainage lines and creeks are likely to be cleared as part of this Proposal;
- ‘Ecological consequences of high frequency fires’ – the Proposal may alter the frequency of fires in the area. BHPBIC will consider the impacts of any proposed hazard reduction program on threatened species, in consultation with DECC and in accordance with the VFMP provided for West Cliff.
- ‘Alteration to the natural flow regimes of rivers, streams, floodplains and wetlands’ – the Proposal is likely to impact on two small ephemeral drainage lines and Brennans Creek. The VMFP prepared for the West Cliff Colliery includes provisions to address this issue.
- ‘Invasion of native plant communities by exotic perennial grasses’ – the Proposal may increase the threat of weed invasion by exotic perennial grasses, particularly given the presence of exotic perennial grasses in the vicinity of the existing emplacement areas and disturbed edges. The VMFP prepared for the West Cliff Colliery includes provisions to address this issue.

The Proposal will increase the impact of some Key Threatening Processes in relation to *Gyrostemon thesioides* in the Study Area.

### Conclusion

The Proposal will have the following impacts on *Gyrostemon thesioides*:

- Approximately 22.7 ha of habitat for *Gyrostemon thesioides* will be cleared as part of the Proposal. There may also be approximately 12.2 ha of potential habitat indirectly impacted by potential weed invasion, trampling, coal dust deposition and edge effects.
- Increase in the impact of some Key Threatening Processes.

The Proposal is **not** considered likely to result in a significant impact on a local population of *Gyrostemon thesioides*, as:

- No individuals will be removed by the Proposal and, as a result, an impact on the lifecycle of the species or fragmentation of a population is not likely within the Locality.
- The habitat to be impacted by the Proposal is not considered to be important for the long term survival of the species in the Locality.
- The Proposal will not have an adverse effect on critical habitat (directly or



indirectly).

- The Proposal is not inconsistent with a recovery plan for the species.

### *Leucopogon exolasius*

*Leucopogon exolasius* is an erect shrub to 1 m high listed as a Vulnerable species on both the TSC and EPBC Acts.

*Leucopogon exolasius* was not recorded within the Study Area during the field surveys. The species is considered to have potential habitat in the Study Area in gullies within Sandstone Gully Peppermint Forest (SGPF) and Sandstone Gully Apple Peppermint Forest (SGAPF).

**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.**

Little is known of the life cycle of *Leucopogon exolasius*. The species flowers from August through to October and the fruit is a drupe (Benson and McDougall 1995) and therefore probably dispersed by fruit eating birds. It has an alluvial distribution and, being an Epacridaceae is likely to require fire for germination (DEC 2005§).

The direct impacts associated with the Proposal involve the removal of potential habitat for *Leucopogon exolasius*. Indirect impacts include altered fire frequency and increased coal dust deposition. It is important to note that coal wash emplacements are already present in the Study Area, within 500 m of the Subject Site (Stage 1 and Stage 2). Indirect impacts of the Proposal are therefore already being experienced.

*Leucopogon exolasius* was not recorded within the Study Area during the field surveys and therefore a viable population within the Study Area is not likely to exist. It is therefore considered unlikely that the removal of potential habitat, an altered fire regime or coal dust deposition will have a significant impact on the lifecycle of the species such that a viable local population of *Leucopogon exolasius* is 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**

N/A

**In the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:**

- i. is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or**
- ii. is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction.**

N/A

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

- i. the extent to which habitat is likely to be removed or modified as a result of the action proposed, and**
- ii. whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and**
- iii. the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the Locality.**

*Leucopogon exolasius* was not recorded within the Study Area despite current and previous targeted surveys. Locally this species has been recorded from the Woronora River where it occurred within the rocky, bare riparian zone where alluvial soils were almost absent (M. Richardson, Biosis Research Pty. Ltd., pers. comm.). The species is considered to have potential habitat in the Study Area in gullies within SGPF and SGAPF.

Approximately 1727.8 ha of potential habitat for *Leucopogon exolasius* exists within the Locality. The area of direct impact constitutes the construction footprint of the emplacement area and the associated infrastructure sites. This will involve the loss of 60.5 ha of native vegetation, 22.7 ha of which is potential habitat for *Leucopogon exolasius*. The zone of indirect impact constitutes a buffer of 500 metres outside the area of direct impact and is approximately 180.4 ha, of which 12.2 ha is potential habitat for *Leucopogon exolasius*. The area of potential habitat in the Study Area to be impacted (directly and indirectly) by the Proposal equates to 3.3 % of similar habitat types in the Locality and this is not considered to be a significant amount of habitat.

As no populations of *Leucopogon exolasius* were recorded within the Study Area during the field surveys it is unlikely that a significant population of the species will be fragmented within the Locality. However, potential habitat for *Leucopogon exolasius* will be fragmented by the removal of 22.7 ha of native

vegetation within the Study Area.

The Proposal will result in the fragmentation of potential habitat for *Leucopogon exolasius*. However, no specimens or populations of the species were recorded within the Study Area or the Locality during the field surveys, and the 3.3 per cent of the potential habitat that will be impacted is not considered to be significant amount of habitat. Therefore the importance of the habitat impacted by the Proposal, to the long term survival of *Leucopogon exolasius* in the Locality, is considered to be low.

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

Under the TSC Act, the Director-General of Department of Environment and Climate Change maintains a Register of Critical Habitat. To date, no critical habitat has been declared for *Leucopogon exolasius*.

The Proposal will not have an adverse effect on critical habitat (directly or indirectly).

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

To date, no recovery plan or threat abatement plan has been prepared for this species. DECC has listed six priority actions to help recover this species. Those that are considered relevant to the Proposal include:

- Undertake surveys of known sites and potential habitat, particularly on Department of Defence land and along Georges River – potential habitat for the species within the Study Area has been identified and mapped (Figure 5). The species has not been recorded in the Study Area despite targeted surveys within potential habitat.

On the basis *Leucopogon exolasius* was not recorded in the Study Area during the current survey, the Proposal is not considered likely to interfere with the priority actions to assist in recovery of the species.

**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 listed on the TSC Act relevant to the Proposal that may impact on potential habitat for *Leucopogon exolasius* in the Study Area include:

- ‘Clearing of native vegetation’ – potential habitat within drainage lines and

creeks will be cleared as part of this Proposal;

- ‘Ecological consequences of high frequency fires’ – the Proposal may alter the frequency of fires in the area. BHPBIC will consider the impacts of any proposed hazard reduction program on threatened species, in consultation with DECC and in accordance with the VFMP provided for West Cliff Colliery.
- ‘Alteration to the natural flow regimes of rivers, streams, floodplains and wetlands’ – the Proposal is likely to impact on two small ephemeral drainage lines and Brennans Creek. The VMFP prepared for the West Cliff Colliery includes provisions to address this issue.
- ‘Invasion of native plant communities by exotic perennial grasses’ – the Proposal may increase the threat of weed invasion by exotic perennial grasses, particularly given the presence of exotic perennial grasses in the vicinity of the existing emplacement areas and disturbed edges. The VMFP prepared for the West Cliff Colliery includes provisions to address this issue.
- ‘Bushrock removal’ – the Proposal would involve the removal of bushrock including large rock platforms and outcrops which are potential habitat for this species. Although the listing of bushrock removal under the TSC Act makes no specific reference to *Leucopogon exolasius*, potential habitat for this species is known to be associated with rocky areas. The VMFP prepared for the West Cliff Colliery includes provisions to address this issue.

The Proposal will increase the impact of some Key Threatening Processes in relation to *Leucopogon exolasius* in the Study Area.

## Conclusion

The Proposal will have the following impacts on *Leucopogon exolasius*:

- Approximately 22.7 ha of habitat for *Leucopogon exolasius* will be cleared as part of the Proposal. There may also be approximately 12.2 ha of potential habitat indirectly impacted by potential weed invasion, trampling, coal dust deposition and edge effects.
- Increase in the impact of some Key Threatening Processes.

The Proposal is **not** likely to result in a significant impact on a local population of *Leucopogon exolasius*, as:

- No individuals will be removed by the Proposal and, as a result, an impact on the lifecycle of the species or fragmentation of a population is not likely within the Locality.
- The habitat to be impacted by the Proposal is not considered to be important for the long term survival of the species in the Locality.

- The Proposal will not have an adverse effect on critical habitat (directly or indirectly).
- The Proposal is not inconsistent with a recovery plan for the species.

### *Melaleuca deanei*

*Melaleuca deanei* is a shrub to 3 m high, with fibrous-flaky bark, and is listed as Vulnerable on both the TSC and EPBC Acts.

*Melaleuca deanei* was not recorded within the Study Area during the field surveys. The species is considered to have potential habitat within Exposed Sandstone Scribbly Gum Woodland (ESSW) of the Study Area and is known to occur in dry heathlands (DEC 2005w) and woodlands on sandy and lateritic soils (Fairley 2004). *Melaleuca deanei* resprouts following fires (DEC 2005w) and potential habitat in the Study Area is also likely to include all portions of the Study Area that were impacted by fires within the last five years.

**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.**

All information on the life cycle of *Melaleuca deanei* has been taken from Benson (1998).

*Melaleuca deanei* is thought to live for up to 100 years. It has a low incidence of flowering and therefore may require a specific environmental trigger for flower initiation and development. The seed is held on the plant until dehydration or fire but the species has low seed production possibly as a result of parent plant allelopathy. The higher the amount of seed set in large populations indicates that the species may require genetic cross-over. Germination and establishment requires high light and moisture availability and optimal germination occurs at 30 degrees Celsius. Foliage is killed by fire but the species suckers, coppices and has epicormic growth. It is also thought that fire might be required to stimulate flowering.

The direct impacts associated with the Proposal involve the removal of potential habitat for *Melaleuca deanei*. Indirect impacts include altered fire frequency and increased coal dust deposition. It is important to note that coal wash emplacements are already present in the Study Area, within 500 m of the Subject Site (Stage 1 and Stage 2). Indirect impacts of the Proposal are therefore already being experienced.

*Melaleuca deanei* was not recorded within the Study Area during the field

surveys and therefore a viable population within the Study Area is not likely to exist. It is therefore considered unlikely that the removal of potential habitat, an altered fire regime or coal dust deposition will have a significant impact on the lifecycle of the species such that a viable local population of *Melaleuca deanei* is 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**

N/A

**In the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:**

- i. is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or**
- ii. is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction.**

N/A

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

- i. the extent to which habitat is likely to be removed or modified as a result of the action proposed, and**
- ii. whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and**
- iii. the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the Locality.**

*Melaleuca deanei* was not recorded within the Study Area despite current and previous targeted surveys. The species is considered to have potential habitat within the Study Area and is known to occur in dry heathlands (DEC 2005w) and woodlands on sandy and lateritic soils (Fairley 2004). *Melaleuca deanei* resprouts following fires (DEC 2005w) and potential habitat in the Study Area is also likely to include all portions of the Study Area that were impacted by fires within the last five years.

Approximately 4109.2 ha of potential habitat for *Melaleuca deanei* exists within the Locality. The area of direct impact constitutes the construction footprint of the emplacement area and the associated infrastructure sites. This will involve the loss of 60.5 ha of native vegetation, 37.8 ha of which is potential habitat for

*Melaleuca deanei*. The zone of indirect impact constitutes a buffer of 500 metres outside the area of direct impact and is approximately 180.4 ha, of which 159.4 ha is potential habitat for *Melaleuca deanei*. The area of habitat in the Study Area to be impacted (directly and indirectly) by the Proposal equates to 4.8 % of similar habitat types in the Locality, and this is not considered to be a significant amount of habitat.

As no populations of *Melaleuca deanei* were recorded within the Study Area during the field surveys it is unlikely that a significant population of the species will be fragmented within the Locality. However, potential habitat for *Melaleuca deanei* will be fragmented by the removal of 37.8 ha of native vegetation within the Study Area.

The Proposal will result in the fragmentation of potential habitat for *Melaleuca deanei*. However, no specimens or populations of the species were recorded within the Study Area or the Locality during the field surveys, and the 4.8 per cent of the potential habitat that will be impacted (directly and indirectly) is not considered to be significant amount of habitat. Therefore the importance of the habitat impacted by the Proposal, to the long term survival of *Melaleuca deanei* in the Locality, is considered to be low.

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

Under the TSC Act, the Director-General of Department of Environment and Climate Change maintains a Register of Critical Habitat. To date, no critical habitat has been declared for *Melaleuca deanei*.

The Proposal will not have an adverse effect on critical habitat (directly or indirectly).

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

To date, no recovery plan or threat abatement plan has been prepared for this species. DEC (DEC 2005w) has listed 14 priority actions to help recover this species. Since the species was not recorded in the Study Area despite targeted searches, these priority actions are not considered relevant to the Proposal.

On the basis *Melaleuca deanei* was not recorded in the Study Area, the Proposal is not considered likely to interfere with the priority actions to assist in the recovery of the species

**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 listed on the TSC Act relevant to the Proposal that may impact on potential habitat for *M. deanei* include:

- ‘Clearing of native vegetation’ – approximately 37.8 ha of potential habitat will be cleared for the Proposal;
- ‘Ecological consequences of high frequency fires’ – the Proposal may alter the frequency of fires in the area. BHPBIC will consider the impacts of any proposed hazard reduction program on threatened species, in consultation with DECC and in accordance with the VFMP provided for West Cliff.
- ‘Invasion of native plant communities by exotic perennial grasses’ – the Proposal may increase the threat of weed invasion by exotic perennial grasses, particularly given the presence of exotic perennial grasses in the vicinity of the existing emplacement areas and disturbed edges. The VMFP prepared for the West Cliff Colliery includes provisions to address this issue.

The Proposal will increase the impact of some Key Threatening Processes in relation to *Melaleuca deanei* in the Study Area.

**Conclusion**

The Proposal will have the following impacts on *Melaleuca deanei*:

- Approximately 37.8 ha of habitat for *Melaleuca deanei* will be cleared as part of the Proposal. There may also be approximately 159.4 ha of potential habitat indirectly impacted by potential weed invasion, trampling, coal dust deposition and edge effects.
- Increase in the impact of some Key Threatening Processes.

The Proposal is **not** considered likely to result in a significant impact on a local population of *Melaleuca deanei*, as:

- No individuals will be removed by the Proposal and, as a result, an impact on the lifecycle of the species or fragmentation of a population is not likely within the Locality.
- The habitat to be impacted by the Proposal is not considered to be important for the long term survival of the species in the Locality.
- The Proposal will not have an adverse effect on critical habitat (directly or indirectly).
- The Proposal is not inconsistent with a recovery plan for the species.



### *Persoonia hirsuta*

*Persoonia hirsuta* is a spreading to decumbent shrub with moderate to densely hairy young branchlets and is listed as Endangered on Schedule 1 of the TSC Act. This species is also listed as Endangered on the EPBC Act and has been given a ROTAP conservation rating of 3Ki (Briggs and Leigh 1996b). It occurs in woodlands and dry sclerophyll forest on sandstone or very rarely on shale (NSW Scientific Committee 1998). Typical vegetation associations included a dominant canopy of *Eucalyptus sieberi*, *Corymbia gummifera* and *E. oblonga* with a dense understorey of shrubs to 3 m high including *Leptomeria acida*, *Lambertia formosa* and *Banksia serrata*.

A population of *Persoonia hirsuta* was recorded in the Study Area, supporting 156 plants. Forty-seven (47) *Persoonia hirsuta* individuals will be directly impacted by the Proposal, with an additional 109 plants occurring within the indirect impact zone. Further, 60.5 ha of potential habitat for *Persoonia hirsuta* will be cleared as part of the Proposal. 168.8 ha of potential habitat may be indirectly impacted by potential weed invasion, erosion, edge effects and coal dust deposition. With regards to indirect impacts on this species, it is important to recognise that individuals of this species in the Study Area are most often found in areas heavily affected by coal dust deposition from existing coal wash emplacements (Stage 1 and Stage 2) and other operations at West Cliff.

Potential habitat for the species exists in Exposed Sandstone Scribbly Gum Woodland (ESSW) and Sandstone Gully Peppermint Forest (SGPF). The species was recorded in both deep and shallow lateritic soils on the margins between the broad ridges and sandstone gullies, often in areas where sandstone outcropping was present.

**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.**

Given the proximity of the population of *Persoonia hirsuta* to the Proposal, it is considered likely that both direct and indirect impacts could potentially impact on the lifecycle of the individuals in the Study Area. Direct impacts will result in the removal of plants and habitat for the species. Indirect impacts on the lifecycle of the species are likely to include an altered fire regime and increased coal dust deposition. It is unknown whether the coal dust deposition is affecting the lifecycle of this species and, therefore, it is assumed that coal dust has an adverse impact on the life cycle of the species (application of the precautionary principle).

*Persoonia hirsuta* is usually present as isolated individuals or very small

populations (DEC 2005). Known occurrences of this species generally support one to three plants (DEC 2005). Occurrences of this size are unlikely to be viable populations. Within the Locality (not including the Study Area) there are four known populations, the largest of which supported four plants (DECC Atlas of NSW Wildlife data, Figure 8).

The local population (as defined in Section 1.1 of this report) of *Persoonia hirsuta* recorded during the field surveys supports 156 individuals, which is considered to be a significant and viable population in the Locality.

Direct impacts will result in the removal of 47 individuals from this population and 60.5 ha of potential habitat. The removal of 47 individuals of *Persoonia hirsuta* represents 28 per cent of a significant and viable population within the Locality. Translocation of these individuals has not been recommended in the VFMP, and it is therefore considered that the loss of 28 per cent of the population in the study area will significantly affect the local genetic diversity of the species. This loss is likely to have an impact on the life cycle, and therefore the viability, of this local population.

Plants of *Persoonia hirsuta* are likely to be killed by fire but the species will regenerate from seed (DEC 2005). Therefore the survival of the species is dependent on an appropriate fire regime. The proposed fire exclusion policy that will be implemented around the Stage 3 Emplacement is, therefore, likely to impact the long term viability of the local population of *Persoonia hirsuta* within the Study Area. This indirect impact is likely to have a significant impact on the germination, and therefore the lifecycle, of *Persoonia hirsuta* within the Study Area.

Pollinators of *Persoonia hirsuta* are likely to be insects such as native bees. Dispersers are likely to be large birds and mammals (Benson and McDougall 2000a). Pollination and dispersal are considered important stages of the lifecycle of *Persoonia hirsuta*. Impacts from coal dust deposition during flowering and fragmentation of habitat are considered likely to have a significant impact on the pollinators and dispersers of *Persoonia hirsuta* in the Study Area. An impact on pollination implies an impact on the genetic diversity and therefore the resilience of the local population of *Persoonia hirsuta*.

It is therefore considered likely that the proposal will have an adverse effect on the life cycle of the species such that a viable local population of *Persoonia hirsuta* is 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.**

N/A

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

- i. i. is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or**
- ii. ii. is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction.**

N/A

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

- i. the extent to which habitat is likely to be removed or modified as a result of the action proposed, and**
- ii. whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and**
- iii. the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the Locality.**

In the Study Area, ESSW and SGPF are considered to be habitat for *Persoonia hirsuta*. Approximately 4748 ha of ESSW and SGPF exist within the Locality (NPWS 2003a) and 229 ha within the Study Area. The habitat to be affected in the Study Area was considered to be in good condition, with few weed species and relatively high species diversity. *Persoonia hirsuta* habitat adjacent to existing emplacement area and haul roads were covered in a layer of coal dust deposition.

Approximately 60.5 ha of the habitat in the Study Area will be directly impacted by the Proposal, with 168.8 ha being indirectly impacted from edge effects such as dust impacts and weed invasion. The amount of habitat in the Study Area to be impacted (directly and indirectly) by the Proposal equates to 4.8 % of similar habitat types in the Locality.

The Proposal will involve clearing of native vegetation for the Proposal and will result in the fragmentation and isolation of a currently continuous potential habitat for *Persoonia hirsuta*. The required vegetation clearing for the Proposal will result in two distinct sub-populations of *Persoonia hirsuta* separated by the Stage 3 Emplacement. This fragmentation is likely to impact on the pollination of the plants and the dispersal of *Persoonia hirsuta* seed, with pollinators and dispersers inhibited from crossing the cleared Subject Site.

The population of *Persoonia hirsuta* in the Study Area is considered to be a locally significant and viable population. Therefore the habitat to be impacted by the Proposal is considered to be important for the long term survival of *Persoonia hirsuta* in the Locality.

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

Under the TSC Act, the Director-General of Department of Environment and Climate Change maintains a Register of Critical Habitat. To date, no critical habitat has been declared for *Persoonia hirsuta*.

The Proposal will not have an adverse effect on critical habitat (directly or indirectly).

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

To date, no recovery plan or threat abatement plan has been prepared for this species. DEC (2005y) has listed 21 priority actions to help recover this species. Those considered relevant to the Proposal include:

- Assess the relative conservation significance of sites to determine recovery priorities – the Study Area is likely to be of high conservation significance for this species, given the relatively high abundance of the species. Particularly since the number of individuals within populations is typically 1-3 plants (NSW Scientific Committee 1998) and approximately 156 plants were recorded in the Study Area.
- Advise and liaise with private land managers to facilitate the preparation and implementation of Study Area management plans that address threatening processes – The VMFP prepared for the West Cliff Colliery includes provisions to address this issue.
- Incorporate best knowledge regarding appropriate fire regime into land management practices – The VMFP prepared for the West Cliff Colliery includes guidelines to consider any proposed fire regime. This is particularly important for *Persoonia hirsuta* as the species is thought to be killed by fire (DEC 2005l).
- Develop and implement site awareness and protection procedures for use by land owners/managers and public utilities and their contractors when undertaking road, trail, or easement maintenance – Many of the recorded *Persoonia hirsuta* within the Study Area occurred along and adjoining existing roads and power line easements. The VMFP prepared for the West Cliff Colliery includes provisions to address this issue.

- Restrict vehicular and pedestrian access to sites, where necessary – plants occurring near roads, underneath easements and in the vicinity of the Subject Site may need to be fenced to ensure protection from maintenance activities and clearing.
- Undertake targeted bush regeneration works, where required – targeted bush regeneration may be required, given that a number of plants occurs in the vicinity of the Subject Site and may be subjected to indirect impacts such as weed invasion. The VMFP prepared for the West Cliff Colliery includes provisions to address this issue.
- Seek to increase the level of legislative protection for sites through land-use planning mechanisms and conservation agreements – this is a matter for the NSW Scientific Committee and NSW agencies.
- Retain or re-establish vegetation and fauna movement linkages between sites – the Proposal is likely to fragment the existing population in the Study Area and impact on existing fauna linkages. The VFMP and progressive rehabilitation of the Study Area will support this management option.
- Consider inclusion in SeedQuest NSW program for research on seed viability and requirements for successful conservation storage – collection of seed and cuttings from plants that are directly impacted by the Proposal for research purposes should be considered. The VMFP prepared for the West Cliff Colliery includes provisions to address this issue.
- Carry out targeted surveys in potential habitat, particularly freehold lands, Crown land that may be alienated and council-managed lands – potential habitat for the species in the Study Area has been identified and mapped (Figure 5). The species was recorded in the Study Area, mainly within ESSW. Off Study Area surveys in areas identified as potential habitat is the responsibility of the adjacent land managers, including the DECC and SCA.

It is considered likely that the Proposal may interfere with the recovery of the species.

**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 listed on the TSC Act relevant to the Proposal include:

- ‘Clearing of native vegetation’ – approximately 60.5 ha of known habitat will be cleared for the Proposal.
- Alteration to the natural flow regimes of river, streams, floodplains and wetlands – the Proposal is likely to impact on at least two small ephemeral drainage lines and Brennans Creek. However, *Persoonia hirsuta* is not

directly reliant on these drainage lines and rivers and is therefore unlikely to be impacted by this Key Threatening Process;

- Infection of native plants by *Phytophthora cinnamomi* – machinery operating in the Subject Site could potentially introduce and spread *Phytophthora cinnamomi* through the Study Area. As a precaution, vehicles are being washed down when transported from or to the West Cliff site using appropriate procedures to ensure the fungus is not spread.
- ‘Ecological consequences of high frequency fires’ – the Proposal may alter the frequency of fires in the area. BHPBIC will consider the impacts of any proposed hazard reduction program on threatened species, in consultation with DECC and in accordance with the VFMP provided for West Cliff.
- ‘Invasion of native plant communities by exotic perennial grasses’ – the Proposal may increase the threat of weed invasion by exotic perennial grasses, particularly given the presence of exotic perennial grasses in the vicinity of the existing emplacement areas and disturbed edges. The VMFP prepared for the West Cliff Colliery includes provisions to address this issue.

The Proposal will increase the impact of Key Threatening Processes on *Persoonia hirsuta* in the Study Area.

## Conclusion

The population of *Persoonia hirsuta* in the Study Area represents the largest in the Locality. It is considered to be a significant and viable local population of the species. The Proposal will result in a number of impacts on the local population of *Persoonia hirsuta*, including:

- Direct loss of 47 plants (28 per cent of the local population).
- Indirect, though unquantifiable, impacts to a further 109 plants;
- Direct loss of 60.5 ha of habitat;
- Indirect impacts to 168.8 ha of habitat;
- Altered fire frequency through fire suppression;
- Potential impacts of coal dust deposition and fragmentation of potential habitat on pollinators and the movement of dispersers, which the species may rely on for important lifecycle stages;
- Fragmentation and isolation of a currently continuous population,
- An increase in the impact of Key Threatening Processes listed under the TSC Act.

It is therefore considered **likely** the Proposal will lead to a significant impact on a

local population of *Persoonia hirsuta*.

### *Pomaderris adnata*

*Pomaderris adnata* is a spreading shrub 1-2 m high and is listed as Vulnerable on both the TSC and EPBC Acts.

*Pomaderris adnata* was not recorded within the Study Area during the field surveys. Potential habitat within the Study Area is considered to be within Exposed Sandstone Scribbly Gum Woodland (ESSW).

**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.**

*Pomaderris adnata* is thought to live for 10-25 years, flowers in September and the fruit matures November – December (Benson and McDougall 2000b). The species does not spread vegetatively and is probably killed by fire (Benson and McDougall 2000b).

The direct impacts associated with the Proposal involve the removal of potential habitat for *Pomaderris adnata*. Indirect impacts include altered fire frequency and increased coal dust deposition. It is important to note that coal wash emplacements are already present in the Study Area, within 500 m of the Subject Site (Stage 1 and Stage 2). Indirect impacts of the Proposal are therefore already being experienced.

*Pomaderris adnata* was not recorded within the Study Area during the field surveys and therefore a viable population within the Study Area is not likely to exist. It is therefore considered unlikely that the removal of potential habitat, an altered fire regime or coal dust deposition will have a significant impact on the lifecycle of the species such that a viable local population of *Pomaderris adnata* is 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**

N/A

**In the case of an endangered ecological community or critically endangered**

**ecological community, whether the action proposed:**

- i. is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or**
- ii. is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction.**

N/A

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

- i. the extent to which habitat is likely to be removed or modified as a result of the action proposed, and**
- ii. whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and**
- iii. the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the Locality.**

*Pomaderris adnata* was not recorded within the Study Area during the field surveys. Potential habitat within the Study Area is considered to be within ESSW.

*Pomaderris adnata* occurs outside the Locality at Sublime Point, approximately 11 km from the Study Area. The total number of individuals recorded at the Sublime Point population is thought to include approximately five individuals (Fairley 2004). During the January 2002 bushfires, the population was burnt and no regeneration had occurred when observed in July 2003 (Fairley 2004).

Unconfirmed records of this species suggest that a further 200 individuals may be present from six locations on Illawarra Escarpment near Sublime Point (NPA 2006). *Pomaderris adnata* occurs in heathy woodland and dry sclerophyll forest vegetation that is dominated by *Eucalyptus sieberi* and *Corymbia gummifera* (DEC 2005~).

Approximately 4109.2 ha of potential habitat for *Pomaderris adnata* exists within the Locality. The area of direct impact constitutes the construction footprint of the emplacement area and the associated infrastructure. This will involve the loss of 60.5 ha of native vegetation, 37.8 ha of which is potential habitat for *Pomaderris adnata*. The zone of indirect impact constitutes a buffer of 500 metres outside the area of direct impact and is approximately 180.4 ha, of which 159.4 ha is potential habitat for *Pomaderris adnata*. The area of habitat in the Study Area to be impacted (directly and indirectly) by the Proposal equates to 4.8 % of similar habitat types in the Locality and this is not considered to be a significant amount of habitat.



As no populations of *Pomaderris adnata* were recorded within the Study Area during the field surveys it is unlikely that a significant population of the species will be fragmented within the Locality. However, potential habitat for *Pomaderris adnata* will be fragmented by the removal of 37.8 ha of native vegetation within the Study Area.

The Proposal will result in the fragmentation of potential habitat for *Pomaderris adnata*. However, no specimens or populations of the species were recorded within the Study Area or the Locality during the field surveys, and the 0.9 per cent of the potential habitat that will be removed is not considered to be significant amount of habitat. Therefore the importance of the habitat impacted by the Proposal, to the long term survival of *Pomaderris adnata* in the Locality, is considered to be low.

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

Under the TSC Act, the Director-General of Department of Environment and Climate Change maintains a Register of Critical Habitat. To date, no critical habitat has been declared for *Pomaderris adnata*.

The Proposal will not have an adverse effect on critical habitat (directly or indirectly).

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

To date, no recovery plan or threat abatement plan has been prepared for *Pomaderris adnata*. DECC has listed 10 priority actions to help recover this species. One is considered relevant to the current Proposal and involves the following.

- Conduct targeted surveys of potential habitat and identify and map potential habitat for the species – Potential habitat for this species is considered to be within ridgetop vegetation present within the Study Area and mapped as ESSW.

This species is not considered a cryptic species and if present should have been recorded in the Study Area. On the basis that *Pomaderris adnata* was not recorded in the Study Area during the current and previous survey, the Proposal is not considered likely to interfere with the priority actions to assist in recovery of the species.

**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 listed on the TSC Act relevant to the Proposal that may impact on potential habitat for *Pomaderris adnata* in the Study Area include:

- ‘Clearing of native vegetation’ – potential habitat within ESSW are likely to be cleared as part of this Proposal.
- ‘Ecological consequences of high frequency fires’ – the Proposal may alter the frequency of fires in the area. BHPBIC will consider the impacts of any proposed hazard reduction program on threatened species, in consultation with DECC and in accordance with the VFMP provided for West Cliff.
- ‘Invasion of native plant communities by exotic perennial grasses’ – the Proposal may increase the threat of weed invasion by exotic perennial grasses, particularly given the presence of exotic perennial grasses in the vicinity of the existing emplacement areas and disturbed edges. The VMFP prepared for the West Cliff Colliery includes provisions to address this issue.

The Proposal will increase the impact of some Key Threatening Processes in relation to *Pomaderris adnata* in the Study Area.

### Conclusion

The Proposal will have the following impacts on *Pomaderris adnata*:

- Approximately 37.8 ha of habitat for *Pomaderris adnata* will be cleared as part of the Proposal. There may also be approximately 159.4 ha of potential habitat indirectly impacted by potential weed invasion, coal dust deposition and edge effects.
- Increase in the impact of some Key Threatening Processes.

The Proposal is **not** considered likely to result in a significant impact on a local population of *Pomaderris adnata*, as:

- No individuals will be removed by the Proposal and, as a result, an impact on the lifecycle of the species or fragmentation of a population is not likely within the Locality.
- The habitat to be impacted by the Proposal is not considered to be important for the long term survival of the species in the Locality.
- The Proposal will not have an adverse effect on critical habitat (directly or indirectly).
- The Proposal is not inconsistent with a recovery plan for the species.

***Pultenaea aristata***

*Pultenaea aristata* is a small shrub, up to 1 m tall, and is listed as Vulnerable on both the TSC and EPBC Acts. It occurs in either dry sclerophyll woodland or wet heath on sandstone (DEC 2005€).

During current and previous surveys of the Study Area, *P. aristata* was recorded within the Upland Swamps and along drainage lines within Exposed Sandstone Scribbly Gum Woodland (ESSW) and Sandstone Gully Peppermint Forest (SGPF). Within these vegetation communities the species typically occurred near drainage lines or areas of impeded drainage. Within the Upland Swamps, common associate species included a sparse shrub layer dominated by *Banksia oblongifolia*, *Hakea dactyloides*, *Petrophile sessilis* and *Banksia ericifolia*, with a dense ground layer dominated by *Cyathochaeta diandra*, *Lepyrodia scariosa* and *Leptocarpus tenax*.

A total of 50 individuals were recorded within the Study Area, 25 of which will be directly impacted by the Proposal, with an additional 25 plants indirectly impacted. Approximately 60.5 ha of habitat for *Pultenaea aristata* will be cleared as part of the Proposal. There may also be approximately 168.8 ha of potential habitat indirectly impacted by potential weed invasion, trampling, coal dust deposition and edge effects.

**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.**

Both direct and indirect impacts could potentially impact on the lifecycle of *Pultenaea aristata*. Direct impacts will result in the removal of a number of plants and habitat for the species. Indirect impacts on the lifecycle of the species are likely to include altered fire frequency and increased coal dust deposition.

*Pultenaea aristata* is commonly recorded as a dominant shrub in Upland Swamps, with hundreds and sometimes thousands of individuals recorded at one location. The plants recorded within the Study Area are part of a larger local population of the species supporting at least 226 plants (based on proximity within 1 km), including those recorded in the adjoining Dharawal State Conservation Area. This number is likely to be an underestimate of the abundance of the species in the local area, as it was recorded as the dominant shrub in one nearby Upland Swamp in Dharawal State Conservation Area, likely to represent 1000's of plants. Direct impacts will result in the removal of approximately 25 individuals from this local population. Further 60.5 ha of

habitat for the species will be directly removed.

*Pultenaea aristata* is probably killed by fire (as other *Pultenaea* species are) (DEC 2005€). The Proposal could potentially alter the existing fire regime of the local area, which could potentially impact on the lifecycle of *Pultenaea aristata* within the Study Area. BHPBIC will consider the requirements of threatened species in any proposed fire regime, in consultation with DECC and in accordance with the VFMP provided for West Cliff.

Pollination and dispersal are considered important stages of the lifecycle of *Pultenaea aristata*. Based on the ecology of the species, pollinators and dispersers for the species are likely to be insects and ants. It is not anticipated that land clearing, an altered fire regime or coal dust deposition is likely to significantly impact the movements, shelter or foraging opportunities of these insect vectors.

Given the large portion of the *Pultenaea aristata* population occurring in the Dharawal State Conservation Area, direct and indirect impacts to 50 plants of the species is not considered likely to impact on the lifecycle of the species such that the viable local population could 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.**

N/A

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

- i. is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or**
- ii. is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction.**

N/A

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

- i. the extent to which habitat is likely to be removed or modified as a result of the action proposed, and**
- ii. whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and**

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

*Pultenaea aristata* is known to occur in both dry sclerophyll woodlands and wet heath on sandstone (DEC 2005€). *P. aristata* was recorded within the Upland Swamps and along drainage lines within ESSW and SGPF in the Study Area. Within ESSW, the species typically occurred near drainage lines or areas of impeded drainage. These habitat types were not commonly recorded in the Subject Site.

*Pultenaea aristata* habitat adjacent to the existing emplacement area and haul roads were covered in a layer of coal dust deposition. The majority of the plants recorded in the Study Area were recorded within smaller fragmented patches of native vegetation in the vicinity of the existing emplacement areas and haul roads. Some weed species were recorded in these areas, particularly where smaller patches of vegetation adjoined access roads.

Habitat and populations of *Pultenaea aristata* in the Locality include:

- A population of a least 226 plants, including those recorded in the Study Area where recorded locations ranged from one to 20 plants (Figure 10).
- Approximately 229.3 ha of habitat in good condition within the Study Area.
- Thousands of *Pultenaea aristata* recorded within Upland Swamps in Dharawal State Conservation Area, immediately adjoining the West Cliff Site.
- Two additional populations of the species within the Locality, to the east and west of the Study Area (Figure 3). The population occurring approximately 5 km to the west of the Study Area supports at least 1,000 plants.
- 5,156.6 ha of ESSW, SGPF and Upland Swamps within the Locality (NPWS REF);

Approximately 60.5 ha of the habitat in the Study Area will be directly impacted by the Proposal, with 168.8 ha being indirectly impacted. The area of habitat in the Study Area to be impacted (directly and indirectly) by the Proposal equates to 4.4 per cent of similar habitat types in the Locality.

Habitat for *Pultenaea aristata* is part of a larger expanse of native vegetation that is in good condition. The Proposal will involve clearing of some of this native vegetation. The Proposal will not result in the fragmentation of the existing population of *Pultenaea aristata*, as the bulk of the population in the Locality occurs to the east of the Study Area. The clearing required for the Proposal will result in the removal of 50 individuals that occur at the western edge of the

known population.

Given the disturbed nature of the areas of known habitat within the Study Area that will be impacted and the extensive population of *Pultenaea aristata* occurring to the east of West Cliff in the Dharawal State Conservation Area, the habitat to be impacted is not considered to be important for the long term survival of the species in the Locality.

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

Under the TSC Act, the Director-General of Department of Environment and Climate Change maintains a Register of Critical Habitat. To date, no critical habitat has been declared for *Pultenaea aristata*.

The Proposal will not have an adverse effect on critical habitat (directly or indirectly).

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

To date, no recovery plan or threat abatement plan has been prepared for this species. DEC (DEC 2005€) has listed two priority actions to help recover this species, these are:

- Review fire management requirements – The requirements of threatened species known to occur in the Study Area will be considered in any proposed fire regime. This is particularly important for *Pultenaea aristata* as it is thought to be killed by fire.
- Confirm location details of existing records – Potential habitat for the species in the Study Area has been identified and mapped (Figure 5). The species is known to occur in the Study Area along drainage lines within ESSW and SGPF and within Upland Swamps.

The Proposal is not inconsistent with the two listed priority actions.

**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 listed on the TSC Act relevant to the Proposal include:

- ‘Clearing of native vegetation’ - approximately 60.5 ha of known habitat will be cleared for the Proposal;

- ‘Alteration to the natural flow regimes of river, streams, floodplains and wetlands’ – the Proposal is likely to impact on at least two small ephemeral drainage lines and Brennans Creek.
- ‘Infection of native plants by *Phytophthora cinnamomi*’ – machinery could potentially introduce and spread *Phytophthora cinnamomi* through the Study Area.
- ‘Ecological consequences of high frequency fires’ – the Proposal may alter the frequency of fires in the area. BHPBIC will consider the impacts of any proposed hazard reduction program on threatened species, in consultation with DECC and in accordance with the VFMP provided for West Cliff.
- ‘Invasion of native plant communities by exotic perennial grasses’ – the Proposal may increase the threat of weed invasion by exotic perennial grasses, particularly given the presence of exotic perennial grasses in the vicinity of the existing emplacement areas and disturbed edges. The VMFP prepared for the West Cliff Colliery includes provisions to address this issue.

The Proposal will increase the impact of Key Threatening Processes on *Pultenaea aristata* in the Study Area.

## Conclusion

The Proposal will have the following impacts on *Pultenaea aristata*:

- Removal of approximately 25 *Pultenaea aristata*, with an additional 25 plants indirectly impacted.
- Approximately 60.5 ha of habitat for *Pultenaea aristata* will be cleared as part of the Proposal. There may also be approximately 168.8 ha of potential habitat indirectly impacted by potential weed invasion, trampling, coal dust deposition and edge effects.
- Increase in the impact of Key Threatening Processes.

The Proposal is **not** considered likely to result in a significant impact on the local population at *Pultenaea aristata*, as:

- The removal of 25 individuals is not considered likely to impact on the lifecycle of the species such that the viable local population could be placed at risk of extinction.
- The Proposal will not result in the fragmentation of the existing population of *Pultenaea aristata* within the Locality.
- The habitat to be impacted is not considered to be important for the long term survival of the species in the Locality.
- The Proposal will not have an adverse effect on critical habitat (directly or

indirectly).

- The Proposal is not inconsistent with a recovery plan for the species.

## 9.2 Assessments of Significance: Affected Animal Species

Unless otherwise stated the information contained in the following Assessment of Significance has been derived from the NSW Governments Bionet database and DECC's Threatened Species profiles and/or Environmental Impact Assessment Guidelines for each species.

### Broad-headed Snake

### *Hoplocephalus bungaroides*

The Broad-headed Snake *Hoplocephalus bungaroides* is listed as Endangered on Schedule 1 of the TSC Act and as Vulnerable on the EPBC Act. This species mainly occurs in association with communities occurring on Triassic sandstone within the Sydney Basin and is typically found among exposed sandstone outcrops with west or north-westerly aspects with vegetation types ranging from woodland to heath. Within these habitats it generally utilises rock crevices and exfoliating rock during the cooler months and tree hollows during summer (Webb and Shine, 1998). Suitable rock crevices are important in order to maintain thermoregulatory functions such as maximising temperatures for evening feeding periods (Webb and Shine, 1998). While little is known of the Broad-headed Snake's arboreal habits during the warmer months, trees which are known to regularly co-occur with known Broad-headed Snake sites include *Corymbia gummifera*, *Eucalyptus sieberi*, and *E. piperita*. These tree species commonly occur within the Study Area. The Broad-headed Snake has restricted mobility, with recorded home ranges averaging 1.88-2.21 ha in males and 0.56-2.33 ha in females (Webb and and Shine 1994) and mean total distance travelled during their most active month have been recorded as 400 m for males per month (females move less distance) (Webb and and Shine 1994).

Habitat for this species occurs within the Study Area in both the Ridgetop Woodland and Gully Forest. These vegetation units contain exposed sandstone outcrops where Broad-headed Snakes spend winter months as well as hollow-bearing trees of the species which regularly occur at known Broad-headed Snake summer sites. The Proposal will remove 60.5 ha of these vegetation types combined resulting in a loss of seasonal sheltering and foraging sites as well as loss of habitat for major prey items. Expressed as a proportion of the broader distribution of this habitat within the Locality, the Proposal would remove <1 per cent of available habitat.



**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 Broad-headed Snake has been recorded within the Study Area and also within in the Locality. The Proposal will remove 60.5 ha of known habitat for this species including hollow-bearing trees where Broad-headed Snakes are resident during warmer months. These trees also contain habitat for the Broad-headed Snake's presumed summer diet which consists of small mammals (Webb and Shine 1998) and arboreal skinks (NPWS 1999c). Exposed sandstone rocky outcrops where the species spends the cooler months will also be removed as part of the Proposal. This also results in removal of habitat for the Broad-headed Snake's preferred winter prey item, small geckos. Further, juvenile snakes are almost totally dependent on small geckos for food and so rock removal is likely to reduce recruitment and hence disrupt the life cycle of this species (Webb and Shine 1998). Combined with slow growth rates, slow maturation and a breeding cycle that is less frequent every year (Webb 1996, Webb and Shine 1998), any impact to this species' life cycle is likely to have a significant effect on population numbers.

Although both clearing and emplacement are proposed to be gradual, individual snakes return to specific locations and do not move large distances (Webb and Shine 1998). This suggests that individuals may have difficulty moving as the development proceeds. The proportion of Broad-headed Snake habitat to be cleared is part of a larger continuous area in the region of similar vegetation of similar habitat quality. However, it is likely that given the small home range of these snakes and their dependence on suitable rocky outcrops to provide shelter and food resources, the individuals inhabiting the Subject Site of Brennans Creek gully could be a discreet population. In this way, the Proposal could place this viable population 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**

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

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

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

- ii. **whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and**
- iii. **the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the Locality**

The Proposal will remove 60.5 ha of known habitat for this species which is 25.4 per cent of the distribution of this habitat within the Study Area. Habitat for this species occurs within the Study Area in both the Ridgetop Woodland and Gully Forest. These vegetation types are continuous into the greater region and as such, the cleared area represents <1 per cent of the distribution of the specified habitat within the Locality (6,600 ha). However, gully edge habitat with rocky outcrops is much less abundant than general foraging habitat in the Locality. Therefore, the area of winter sheltering habitat removed represents a larger proportion than indicated by the figures.

The proposed emplacement area may fragment potential habitat for the Broad-headed Snake and potentially reduce the movement of these animals. The vegetation types which provide habitat for the Broad-headed Snake are continuous in the greater Locality and habitat surrounding the Study Area is of similar quality to the habitat within the Study Area. As such, the Proposal is unlikely to cause significant isolation or fragmentation of the habitat.

The Broad-headed Snake habitat within the Study Area is good quality. It contains exposed ridges with west-facing sandstone outcrops as well as forest and woodland containing hollow-bearing trees of the species which the Broad-headed Snake has been recorded in association with. Limited surveys indicate that the habitat in similar vegetation outside the directly impacted Study Area is of similar quality, therefore the overall quality of Broad-headed Snake habitat within the greater region is unlikely to be affected by the Proposal. In this way, the Proposal is unlikely to result in the extinction of the species within the entire Locality. However, as the Broad-headed Snake has a small home-range and is limited by the availability of suitable rocky outcrops for sheltering and prey, it is likely that the individuals inhabiting the Study Area are a discreet population restricted to Brennans Creek gully. The closest adjacent gully which has been mapped as potential habitat by NPWS (Webb and Shine 1994) is approximately 700 m to the north. As the Broad-headed Snake records mean movements of 400 m in its most active season, it is unlikely that there would be movement between the populations of the two gullies. This further indicates that the population in the Study Area could represent a discreet population and suggests removal of the habitat entailed in the Proposal is likely to place this local population at risk of extinction.

**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 or ecological communities. Under the TSC Act, the Director-General maintains a register of critical habitat. To date, no critical habitat has been declared for this species (DECC Threatened Species Unit).

**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 Broad-headed Snake.

**Whether the action proposed is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process**

Key Threatening Processes (KTP) are listed under Schedule 3 of the TSC Act. The proposed activities will involve the operation of three KTPs and one proposed KTP. These include: 'Bushrock Removal', 'Clearing of Native Vegetation' and 'Removal of dead wood and dead trees' and 'Loss of hollow-bearing trees' (proposed Key threatening process). In addition, the Broad-headed Snake is listed as a threatened species which is identified as being adversely affected by bushrock removal.

Bushrock removal would result in the loss of shelter for both the Broad-headed Snake and its prey. As juvenile snakes are almost entirely dependent on small geckos for food, rock removal is likely to reduce recruitment. Similarly, clearing of native vegetation, removal of dead wood and dead trees and the loss of hollow-bearing trees would result in the loss of sheltering/thermoregulatory habitat for both the Broad-headed Snake and loss of habitat for its arboreal mammal and arboreal skink prey.

**Conclusion:**

The Broad-headed Snake has been recorded within the Study Area as well as within the Locality. The Proposal will constitute the removal of 60.5 ha of potential Broad-headed Snake habitat which constitutes <1 per cent of the greater distribution of this vegetation type in the greater Locality.

The Proposal will result in the operation of KTPs 'Bushrock removal', 'Removal of Dead Wood and Trees' and 'Clearing of Native Vegetation' as well as 'Loss of Hollow Bearing Trees' (proposed KTP) which will result in loss of sheltering,

foraging and key prey species habitat. Furthermore, removal of prey habitat upon which juvenile snakes are dependent during development could affect recruitment.

While gradual clearing may be employed, individual snakes do not move across large distances and may have difficulty moving as the development proceeds. The Broad-headed Snake potential habitat within the Locality is good quality and the Proposal is unlikely to result in fragmentation or isolation of this potential habitat. However, it is likely that given the small home range of these snakes and their dependence on suitable rocky outcrops to provide shelter and food resources, the individuals inhabiting the Study Area could be a discreet population. In this way, the Proposal could place this viable population at risk of extinction.

For the reasons given above it is considered **likely** the Proposal will lead to a significant impact on a local population of the Broad-headed Snake.

#### Eastern Pygmy-possum

#### *Cercartetus nanus*

The Eastern Pygmy-possum, *Cercartetus nanus*, is listed as Vulnerable on Schedule 2 of the TSC Act. This species is found in a range of habitats from rainforest through sclerophyll forest and woodland to heath. In most areas woodlands and heath appear to be preferred habitat. They forage along escarpments and within woodlands, heath and forests containing Banksias or other Proteaceous or Myrtaceous shrubs, feeding largely on nectar and pollen; with insects and soft fruits are eaten when flowers are less available. Although the Eastern Pygmy-possum is broadly distributed, within its range the species appears to be patchily distributed and its overall abundance is low.

Eastern Pygmy-possums will often nest and shelter in tree hollows, rotten stumps, holes in the ground, abandoned bird-nests, Common Ringtail Possum (*Pseudocheirus peregrinus*) dreys or thickets of vegetation (e.g. grass-tree skirts) and they can also construct their own nest (Turner 1995). Because of its small size the species is able to utilise a range of hollow sizes including very small hollows (Gibbons 1997). The species appears to be mainly solitary, each individual using several nests, with males having non-exclusive home-ranges of about 0.68 hectares and females about 0.35 hectares (DECC Threatened Species Unit). Young can be born whenever food sources are readily available, with most births occurring between late spring and early autumn.

Potential habitat for this species occurs within the Study Area in the Ridgetop Woodland, Gully Forest and Upland Swamp fauna habitat types. These vegetation units contain escarpment edge forest, heath and woodland including

Proteaceous or Myrtaceous shrubs which provide foraging and feeding habitat for Eastern Pygmy-possums, as well as hollow-bearing trees which the species may use for nesting.

**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.**

No individuals of these species have been recorded within the Study Area; however, there are records of the Eastern Pygmy-possum within a 10 km radius of the Study Area (DECC Atlas of NSW Wildlife). It has also been recorded within the adjacent Dharawal Nature Reserve/Dharawal State Conservation Area. Potential habitat for this species occurs within the Woodland, Forest and Upland Swamp habitats types.

The Proposal is likely to remove and/or modify approximately 241 ha (60.5 ha directly and 180.5 ha due to indirect impacts) of potential habitat for this species, including important pollen and nectar bearing trees; hollow-bearing trees; rotten stumps and vegetation thickets where Eastern Pygmy-possums may shelter and nest. In total 74.9 per cent of potential habitat within the Study Area may be indirectly impacted. The Proposal would directly impact on <1% and indirectly impact on a further 2.6 per cent of potential habitat within the Locality.

Although both clearing and emplacement is proposed to be gradual, the small home range of this species indicates individuals do not normally move large distances. Introduced predatory species such as Cats *Felis catus*, Dogs *Canis familiaris*, and Foxes *Vulpes vulpes* have been recorded within the Subject Site, Study Area and Locality. Given the susceptibility of Eastern Pygmy-possums to predation by these introduced species (DECC Threatened Species Unit), individuals may have difficulty relocating as the development proceeds.

Research has indicated that within the Eastern Pygmy-possum's patchy distribution, individuals exist at low abundance. Such a population may be significantly affected through the loss of only a comparatively small number of individuals. Given the species' solitary nature, small home range, patchy distribution, low overall abundance and dependence on a constant food source for reproduction, clearing that results in the loss of habitat, food availability and nest sites, increases the risk of local population 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.**

An endangered population is defined under the TSC Act as 'a population

specified in Part 2 of Schedule 1'. At the present time, there are no endangered populations of this species listed under the Act.

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

- i. the extent to which habitat is likely to be removed or modified as a result of the action proposed, and**
- ii. whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and**
- iii. the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the Locality.**

Potential habitat for this species occurs in the Woodland, Forest and Upland Swamp habitats types. The Proposal is likely to impact approximately 240.9 ha (60.5 directly and 180.4 ha due to indirect impacts) of potential habitat for this species. These habitat types are widely distributed within the Locality. The removal and/or modification of potential habitat for Eastern Pygmy-possum represents approximately 3.4 per cent of the available habitat within the Locality.

The vegetation types which provide habitat for the Eastern Pygmy-possum within the Subject Site are continuous in the greater Locality and habitat surrounding the Study Area is of similar quality to the habitat within the Study Area. As such, the Proposal is unlikely to cause significant long-term isolation or fragmentation of the habitat. However, the Eastern Pygmy-possum has a small home range and the proposed emplacement area may temporarily fragment potential habitat for the Eastern Pygmy-possum and remove entire home ranges.

The Eastern Pygmy-possum habitat within the Study Area is considered to be in good condition with finer scale habitat features including proteaceous and myrtaceous shrubs, hollow-bearing trees and vegetation thickets that provide shelter and foraging habitat. These habitat features are widely distributed within the Locality and are considered to be in good condition. The Proposal may increase exposure of the species to predators during their displacement to other areas following the removal of their small home ranges, thus limiting successful dispersal. This suggests the loss of the habitat within the Subject Site is likely to result in the loss of a local population, which could significantly affect the long term survival of an Eastern Pygmy-possum population in the Locality.

**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 or ecological communities. Under the TSC Act, the Director-General maintains a register of critical habitat. To date, no critical habitat has been declared for this species (DECC Threatened Species Unit).

**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 Eastern Pygmy-possum.

The DECC has identified seven priority actions to help recover the Eastern Pygmy-possum in NSW. Those most applicable to the Proposal include:

- Habitat management: Feral Control: Control and monitor abundance of feral predators, especially Cats, where there are known populations of Eastern Pygmy-possum in areas of high quality habitat; and,
- Survey/Mapping and Habitat assessment: Conduct field surveys using "Elliot" traps in trees and on the ground and pitfall traps to further delineate distribution and key populations.

**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. The proposed activities will involve the operation of two KTPs and one proposed KTP likely to affect the Eastern Pygmy-possum. These include: 'Clearing of Native Vegetation' and 'Removal of dead wood and dead trees' and 'Loss of Hollow-bearing trees' (proposed Key threatening process). In addition, the Proposal is likely to increase the impact of 'Predation by feral cats' and 'Predation by the European Red Fox', also listed KTPs.

Clearing of native vegetation, removal of dead wood and dead trees and loss of hollow-bearing trees results in the direct removal of vital food resources, and loss of sheltering and foraging habitat for both the Eastern Pygmy-possum and the loss of habitat for its alternative diet of insects. In addition, the removal of vegetation may result in greater risk of direct predation of Eastern Pygmy-possums, particularly from introduced Cats, Foxes and Dogs, while individuals attempt to move and establish new home ranges and feeding areas.

**Conclusion**

The Eastern Pygmy-possum has not been recorded within the Study Area. However the species has been documented within the adjacent Dharawal

Nature Reserve/Dharawal State Conservation Area. It is highly cryptic and difficult to capture and good quality potential habitat exists in within the Study Area. As such, using the precautionary principle, it is likely that the Study Area supports a population of the Eastern Pygmy Possum. The Proposal is likely to impact on approximately 241 ha of potential foraging, nesting and sheltering habitat within the Study Area.

The Proposal will result in the operation of KTPs which will result in loss of key food resources as well as sheltering, nesting and foraging habitat for a local population. While gradual clearing may be employed, Eastern Pygmy-possums inhabit small home ranges suggesting they do not move across large distances and may have difficulty relocating as the development proceeds. This factor may increase the risk of predation on individuals, particularly to introduced predators.

Potential habitat for the Eastern Pygmy-possum within the Locality is in good quality and the Proposal is unlikely to result in the long-term fragmentation or isolation of this potential habitat. However, it is likely that given this species solitary nature, small home range and dependence on a constant food source for breeding, a population inhabiting the Subject Site could be at risk of extinction.

Based on this information, it is **likely** that the Proposal would have a significant impact on the local population of Eastern Pygmy-possum.

#### **Brush-tailed Rock-wallaby**

#### *Petrogale penicillata*

The Brush-tailed Rock-wallaby is listed as Endangered on Schedule 1 of the TSC Act and as Vulnerable under the EPBC Act.

Potential habitat of the Brush-tailed Rock-wallaby includes rocky outcrops, cliffs and ridgelines in forest and woodlands. They tend to prefer north facing habitats with numerous caves and hollows.

**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 Brush-tailed Rock-wallaby was not recorded in this study and has not recently been recorded within the locality or within the 10 km search area. Brush-tailed Rock-wallabies are dependant upon large rocky outcrops and cliffs with good surrounding vegetation. Potential habitat for this species occurs in the woodland and forest habitat types within the Study Area.

The Proposal is likely to remove and/or modify approximately 238.6 ha of potential Woodland and Forest habitat for this species including sections of



rocky outcrop and along the Brennans Creek Gully. These habitat features are present within the Woodland and Forest habitat types within the locality (6,600 ha).

It is considered unlikely that a local population of Brush-tailed Rock-wallabies occurs in the Locality and though potential habitat does exist for this species it is considered unlikely that a viable local population would be in placed at the risk of extinction. Furthermore suitable habitat for this species is contiguous with greater areas of potential habitat within the immediate vicinity of the Study Area.

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

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

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

- i. the extent to which habitat is likely to be removed or modified as a result of the action proposed, and**
- ii. whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and**
- iii. the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality.**

Potential habitat for this species occurs in the Ridgetop Woodland and Gully Forest fauna habitats in rocky outcrops and cliffs. The proposal is likely to modify and/or remove approximately 238.6 ha of potential habitat for the Brush-tailed Rock-wallaby, although not all of which contain rocky outcrop suitable for this species. This represents 3.6 per cent of the distribution of the potential habitat within the locality.

The rocky outcrops, which provide potential habitat for the Brush-tailed Rock-wallabies, are naturally isolated from the surrounding areas of rocky habitat on a variety of levels. They are isolated outcrops and isolated from ridgelines and other creek gullies. However these features occur within the Woodland and Forest Habitat that are contiguous in the greater locality (6,600 ha), hence the Brush-tailed Rock-wallaby is able to move between these habitat features. It is

unlikely that the potential habitat for this species would be further fragmented and/or isolated as a result of the Proposal.

The rocky outcrops within the Study Area were considered to be of moderate quality for the Brush-tailed Rock-wallaby. The amount of rocky habitat available is limited to Brennans Gully and although it contains some north-facing overhangs and complex boulder habitat that are suitable for the Brush-tailed Rock-wallaby, with good quality surrounding vegetation, the outcrops are generally located on the lower shaded slopes of the gully and thus of lower preference to this species. Therefore, it is considered unlikely that the removal of the rocky habitat within Brennans Creek gully will impact upon the long term survival of the species.

**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 or ecological communities. Under the TSC Act, the Director General maintains a register of critical habitat. To date, no critical habitat has been declared for this species (DECC Threatened Species Unit).

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

A draft recovery plan for the Brush-tailed Rock-Wallaby (DEC 2005□) is currently in preparation.

The recovery plan's objectives are:

- To increase recruitment at priority sites;
- To decrease the rate of decline in range and abundance; and,
- To prevent the decline of the species to a level at which it would be at risk of becoming extinct in the wild.

In addition the loss of refuge and feeding habitat and surrounding vegetation are listed as threats to the species.

**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. The proposed activities will involve the operation of two KTPs with potential to affect the Brush-tailed Rock-wallaby: 'Clearing of Native Vegetation' and 'Bushrock Removal'.

## Conclusion

The Brush-tailed Rock-Wallaby has not been recorded within the Study Area or recently documented within the Locality and no records exist within the 10 km search area. The Proposal is likely to remove and/or modify approximately 238.6 ha of potential habitat for this species. Important habitat features such as rocky outcrops are likely to occur within these habitat types, however these are widely represented within the Locality (6,600 ha).

Potential habitat for this species is unlikely to be fragmented and/or isolated by the Proposal, and given the extant of suitable habitat within the Locality it is **unlikely** that a population of Brush-tailed Rock-wallabies would be significantly impacted.

### Gang-gang Cockatoo

### *Callocephalon fimbriatum*

The Gang-gang Cockatoo *Callocephalon fimbriatum* occurs in a variety of forest and woodland habitats dominated by *Eucalyptus* species. The Gang-gang Cockatoo is listed as Vulnerable on the TSC Act. Potential habitat for this species occurs in forest and woodland habitat within the Study Area, including both Sandstone Woodland and Forest habitat types.

**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.**

Gang-gang Cockatoos were recorded within the Study Area during the current surveys. Additionally, numerous observations have been recorded within the Locality at the Dharawal State Conservation Area and at Lake Cataract. The species is considered moderately common in the Locality.

The Proposal is likely to impact approximately 238.6 ha (60.5 ha directly and 178.1 ha due to indirect impacts) of potential habitat for this species. This habitat may provide foraging resources and contains hollows that may be suitable for breeding purposes. The Gang-gang Cockatoo feeds mainly on the seeds of trees, especially *Eucalyptus* species. The removal of native vegetation, especially *Eucalyptus* species, may affect food availability for the species in the Subject Site. Gang-gang Cockatoos are also dependent on tree hollows for breeding purposes, nesting in large trunks or large limbs (Gibbons and Lindenmayer 1997). Trees with hollows of a suitable size and orientation to be used by Gang-gang Cockatoos for nesting have been observed in the Subject Site. The Proposal will involve the removal of many of these trees, which may have an impact on this species breeding in the Locality. However, given the comparatively small area that is to be removed, the high mobility of the species and the extant of

potential habitat remaining, the Proposal is unlikely to place a local population of the species 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.**

An endangered population is defined under the TSC Act as ‘a population specified in Part 2 of Schedule 1’. There is one known endangered population of Gang-gang Cockatoos in the Ku-ring-gai and Hornsby Local Government Areas. There are no endangered populations within the West Cliff region.

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

- i. the extent to which habitat is likely to be removed or modified as a result of the action proposed, and**
- ii. whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and**
- iii. the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the Locality.**

The Proposal is likely to impact 238.6 ha (60.5 ha directly and 178.1 ha due to indirect impacts) of potential habitat for this species. This potential habitat contains native vegetation that may provide the species with both foraging opportunities and nesting resources. The habitat types are widely distributed within the Locality (6,600 ha) hence, the Proposal is likely to modify and/or remove 3.6 per cent of these suitable habitat types in the Locality (6,600 ha).

The vegetation types which provide habitat for the Gang-gang Cockatoo within the Subject Site and Study Area are continuous and of similar quality in the Locality. Given the mobility of this species, it is unlikely that the Proposal will fragment any potential or known habitat. For these same reasons, it is also unlikely that the Proposal will create a barrier to the movement of the species in the area or isolate portions of potential habitat for the Gang-gang Cockatoo.

The Gang-gang Cockatoo is a very mobile species and the habitat surrounding the Study Area is continuous and of similar quality. It is therefore unlikely that the Proposal will have any long-term impacts on its use of the Locality’s foraging resources. Some potential nesting sites would be lost permanently, however, given the mobility of the species and the likely occurrence of nesting sites in the wider Locality and Study Area, this is unlikely to have a

significant effect on the long-term viability of the Gang-gang Cockatoo in this Locality.

**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 or ecological communities. Under the TSC Act, the Director-General maintains a register of critical habitat. To date, no critical habitat has been declared for this species (DECC Threatened Species Unit).

**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 Gang-gang Cockatoo

**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 defined under Schedule 3 of the TSC Act. The Proposal will involve two KTPs and one proposed KTP. These are: 'Clearing of Native Vegetation', 'Removal of Dead Wood and Dead Trees' and 'Loss of Hollow-bearing Trees' (proposed KTP).

Clearing of native vegetation would reduce the availability of foraging resources for the Gang-gang Cockatoo in the Locality. Loss of hollow-bearing trees and removal of dead wood and dead trees would reduce the availability of nesting sites for this species, as it nests only in hollows of live or dead trees.

**Conclusion**

The Proposal is likely to impact approximately 238.6 ha (60.5 ha directly and 178.1 ha due to indirect impacts) of potential habitat for this species, which constitutes 3.6 per cent of the distribution of these habitat types in the greater Locality. The habitat to be lost or modified contains foraging and nesting resources for the Gang-gang Cockatoo.

Given the mobility of this species and extent of potential habitat within the local region, it is **unlikely** that the Proposal would have a significant impact on a local population of the Gang-gang Cockatoo.

**Giant Burrowing Frog***Heleioporus australiacus*

The Giant Burrowing Frog *Heleioporus australiacus* is listed as Vulnerable on both Schedule 2 of the TSC Act and on the EPBC Act. The species occurs from the NSW Central Coast to eastern Victoria, but is most common on the Sydney sandstone.

Potential habitat may exist for this species within the Upland Swamps, Ridgetop Woodlands and Gully Forest fauna habitat types within the Study Area. Whilst this species has not been recorded within the Study Area, it is known to occur in the adjacent Dharawal State Conservation Area (DEC 2006a) and at other locations within the Locality (DECC Atlas of NSW Wildlife).

**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 Giant Burrowing Frog was not recorded within the Study Area during the current survey. The species has previously been recorded within the Locality and in the adjacent Dharawal State Conservation Area. Potential habitat for this species occurs within the Upland Swamp, Woodland and Forest habitats which contain potential breeding habitat such as creeks, drainage ponds, and ridge top structures containing water.

The Proposal may have both direct and indirect impacts on this species, direct impacts may occur due to the proposed clearing of potential Giant Burrowing Frog habitat. Indirect impacts caused by dust movement are also possible on the individuals existing in Dharawal State Conservation Area. Another potential impact is the restriction of movement between local populations if present. In addition, the Proposal could potentially affect water quality and flow in habitats downstream of the Study Area which may affect both adult frogs and tadpoles, if present. However, Brennans Creek is already dammed downstream and upstream of the Study Area which would already alter its natural flow regime. There are other creek lines within the Locality which could also act as potential habitat for movement and breeding and the vegetation types present are continuous within the broader Locality. This suggests the Proposal is unlikely to significantly impact the life cycle of the Giant Burrowing Frog.

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

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

populations of this species listed under the Act.

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

- i. the extent to which habitat is likely to be removed or modified as a result of the action proposed, and**
- ii. whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and**
- iii. the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the Locality.**

The Proposal is likely to impact 241 ha (directly remove 60.5 ha and 180.5 ha due to indirect impact) of forest, woodland and gully vegetation along Brennans Creek and fill the creek line within the Subject Site resulting in a loss of sheltering, foraging and breeding sites. This modification and/or removal of 241 ha of potential habitat represents 3.4 per cent of potential foraging, sheltering and breeding habitat in the Locality. Although the potential breeding habitat within the Study Area is considered to be limited with only one small creek present, sandstone gully outcrop habitat is much less abundant than general foraging habitat in the Locality.

The Proposal is likely to fragment the upper section of Brennans Creek. Potential habitat for the Giant Burrowing Frog present in the surrounding area is of similar continuous vegetation and contains many creek lines. Given the degraded nature of the creek upstream of the Study Area, the continuous nature of the surrounding vegetation and the potential for large travelling distances in this species, the Proposal is unlikely to fragment or isolate the area for the Giant Burrowing Frog.

As populations of this species are widely scattered and similar breeding, sheltering and foraging habitat exists within the Locality it is considered unlikely that the Proposal would significantly impact the long term viability of the species in the Locality unless a large population breed preferentially on Brennans Creek and this is also considered unlikely.

**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 or ecological communities. Under the TSC Act, the Director-General maintains a register of critical habitat. To date, no critical

habitat has been declared for this species (DECC Threatened Species Unit).

**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 this species.

The DECC has identified 24 priority actions to help recover the Giant Burrowing Frog. Those most applicable to the current Proposal include:

- Develop and implement protocols and guidelines: Develop best practice guidelines for road/drain construction and maintenance within reserves, forests and utility access easements;
- Habitat management: Other: Develop and implement IFOA prescriptions;
- Habitat management: Water: Ensure that appropriate erosion, sedimentation and water quality control measures are applied around known locations;
- Recovery Plan Preparation: Single species: Prepare state and national priority recovery plan in accordance with contractual obligations between DECC and DEH by December 2007; and,
- Monitoring.

**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. The Proposal would involve the operation of two KTPs with the potential to affect this species: 'Clearing of Native Vegetation', and 'Alteration to the Natural Flow Regimes of Rivers, Streams, Floodplains and Wetlands'.

Clearing of native vegetation may result in the removal of both breeding and possible foraging and sheltering habitat types. The Proposal may alter the flow regime of Brennans Creek and could impact on both breeding and foraging habitat.

Priority actions required to assist in the recovery of the Giant Burrowing Frog identified by the DECC include:

- Where bush fire hazard reduction is necessary, apply mosaic, low frequency, low intensity burns;
- Apply post-harvest burns only when habitat assessments have been carried out;



- Retain native vegetation and minimise ground disturbance where the species occurs; and,
- Protect breeding sites from disturbance, sedimentation and pollution.

### Conclusion:

The Giant Burrowing Frog was not recorded within the Study Area during the current survey but there are records in the Locality and in the neighbouring Dharawal State Conservation Area. Potential foraging and sheltering habitat does exist through the area including limited potential breeding habitat in Brennans Creek and drainage lines within gully habitat. The Proposal is likely to modify and/or remove 241 ha of potential habitat; this represents 3.4 per cent of the suitable habitat within the Locality. In addition the flow and water quality of Brennans Creek may be impacted.

Suitable habitat is present in the surrounding areas and given limited breeding habitat in the Study Area; the species' ability to travel large distances to breed and that no populations of the frog are known in the Brennans Creek system it is considered **unlikely** that the Proposal will result in a significant impact to the Giant Burrowing Frog.

|                              |                                |
|------------------------------|--------------------------------|
| <b>Glossy Black-cockatoo</b> | <i>Calyptorhynchus lathami</i> |
|------------------------------|--------------------------------|

The Glossy Black-cockatoo *Calyptorhynchus lathami* relies almost entirely on the seeds of a few species of *Allocasuarina* spp. for food, these being *A. littoralis*, *A. torulosa* and *A. stricta*. They also forage on *Angophora* fruit, sunflower seeds, pine cones and grubs found within *Acacia* and *Allocasuarina*. This species is entirely arboreal coming to ground only to drink (Higgins 1999). They are dependent on large hollow-bearing trees in mature eucalypt trees for nesting.

Potential habitat for this species occurs in Ridgetop Woodland and Gully Forest fauna habitat types within the Study Area. These vegetation units contain hollow-bearing trees which are suitable as nesting habitat for the species. The Proposal would remove 60.5 ha of these vegetation types combined, resulting in a loss of nesting hollows and foraging trees.

**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.**

No Glossy Black-cockatoos were recorded during the current survey, although

they have been previously recorded at six locations within a 10 km radius of the Study Area (DECC Atlas of NSW Wildlife).

The Proposal would remove approximately 60.5 ha of potential habitat for this species. This habitat may provide foraging resources and contains hollows that may be suitable for breeding. The Glossy Black-cockatoo has a distribution reflecting that of the *Allocasuarina* species that grow on sites characterised by low soil nutrients (Tanton 1994). This highlights their dependence on this food source. They are also dependent on large tree hollows for nesting purposes. The removal of native vegetation may limit the availability of food and nesting sites for this species in the Locality.

The Proposal will remove 60.5 ha of potential habitat, which represents <1 per cent of similar habitat in the Locality. *Allocasuarina* stands and hollow-bearing trees are common in the Locality as well as in the region. This species is highly mobile, meaning it can avoid disturbed areas and travel to other suitable areas of habitat nearby with ease. It is therefore unlikely that the Proposal would have a significant impact on the life cycle of a viable local population of the Glossy Black-cockatoo such that it was 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.**

An endangered population is defined under the TSC Act as ‘a population specified in Part 2 of Schedule 1’. At the present time, there is one population of this species, based in the Riverina, which is listed as an endangered population. This population is not represented within the Study Area or Locality.

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

- i. the extent to which habitat is likely to be removed or modified as a result of the action proposed, and**
- ii. whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and**
- iii. the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the Locality.**

The Proposal will remove approximately 60.5 ha of potential habitat for this species. This potential habitat contains native trees that may provide the species with both foraging opportunities and nesting resources. The vegetation

types present in the area of Proposal are continuous and abundant within the wider region. The Proposal will remove <1 per cent of these habitat types in the Locality. Habitat for the Glossy Black-cockatoo within the Study Area is of good quality, but is not critical to the survival of the population in the Locality because other habitat for this species in the region is abundant and also of good quality.

Given the mobility of this species and the abundance of similar habitat surrounding the Study Area, it is unlikely that the Proposal will create a barrier to the movement of or isolate areas of potential habitat for the Glossy Black-cockatoo.

The Glossy Black-cockatoo is a very mobile species. It is unlikely that the Proposal will have any long-term impacts on its use of the Locality's foraging resources, as *Allocasuarina* stands are widespread in surrounding areas. Some potential nesting sites would be lost permanently however, given the mobility of the species and the likely occurrence of nesting sites in the wider Locality and Study Area, this is unlikely to have a significant effect on the long-term viability of the Glossy Black-cockatoo population in the Locality.

**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 or ecological communities. Under the TSC Act, the Director-General maintains a register of critical habitat. To date, no critical habitat has been declared for this species (DECC Threatened Species Unit).

**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 Glossy Black-cockatoo.

**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 defined under Schedule 3 of the TSC Act. The Proposal will involve three KTPs and one proposed KTP. These are: 'Bushrock Removal', 'Clearing of Native Vegetation', 'Removal of Dead Wood and Dead Trees' and 'Loss of Hollow-bearing Trees' (proposed KTP).

Clearing of native vegetation would reduce the availability of foraging resources for the Glossy Black-cockatoo in the Locality. Loss of hollow-bearing trees and removal of dead wood and dead trees would reduce the availability of nesting

sites for this species, as it nests only in hollows of live or dead trees.

### Conclusion

The Glossy Black-cockatoo has been recorded at six locations within 10 km of the Study Area. The Proposal would remove approximately 60.5 ha of potential habitat for this species, which constitutes <1 per cent of the distribution of these habitats in the Locality. The habitat to be removed or modified contains foraging and nesting resources for the Glossy Black-cockatoo. However, given the mobility of this species and the extent of good quality potential habitat within the local region, it is **unlikely** that the Proposal would have a significant impact on a local population of the Glossy Black-cockatoo.

### Grey-headed Flying-fox

### *Pteropus poliocephalus*

The Grey-headed Flying-fox *Pteropus poliocephalus* is listed as Vulnerable on both the TSC and EPBC Acts. It is a canopy-feeding frugivore, blossom-eater and nectarivore of rainforests, open forests, woodlands, *Melaleuca* swamps and *Banksia* woodlands (Eby 1995).

The Grey-headed Flying-fox has been widely recorded within the Locality and in the broader region. They have also been recorded foraging within the Subject Site, but no known camps exist in the Locality. Potential habitat for this species occurs in the Subject Site in Ridgetop Woodland and Gully Forest vegetation communities.

**In the case of a threatened species, whether the life cycle of the species is likely to be disrupted such that a viable population of the species is likely to be placed at risk of extinction.**

The Grey-headed Flying-fox has been recorded within the Subject Site and was observed foraging within the Locality. This species forages opportunistically, often at distances up to 30 km from camps, and occasionally up to 60–70 km per night (NSW Scientific Committee, 2001). The Proposal is likely to remove and/or modify approximately 238.6 ha (60.5 ha directly and 178.1 ha due to indirect impacts) of known foraging habitat for this species. This habitat is widely distributed throughout the Locality (6,600 ha) and is considered to be in good condition. Given the mobility of this species and lack of camps within the Study Area, it is considered unlikely that a viable local population of Grey-headed Flying-fox would be placed at risk of extinction.

**In the case of an endangered population, whether the life cycle of the species that constitutes the endangered population is likely to be disrupted such that**

**the viability of the population is likely to be significantly compromised.**

There are no endangered populations of this species listed under Schedule 1 Part 2 of the TSC Act in the Wollondilly and Wollongong LGAs.

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

- i. the extent to which habitat is likely to be removed or modified as a result of the action proposed, and**
- ii. whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and**
- iii. the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the Locality.**

The Proposal is likely to impact 238.6 ha of potential habitat (60.5 ha directly and 178.1 ha due to indirect impacts) for this species. This potential habitat contains native trees that may provide the species with foraging opportunities and is continuous with other areas of potential habitat within the Locality (approximately 6 601.3 ha). The Proposal will remove 3.6 per cent of potential foraging habitat for this species in the Locality. This figure is not considered to represent a significant impact on the Grey-headed Flying-fox.

The Grey-headed Flying-fox may forage at a distance of 60 to 70 km in one night. Given the mobility of this species, and the fact that there have been no camps recorded in the Locality, it is unlikely that the Proposal would fragment or isolate any areas of potential or known habitat for this species.

The Grey-headed Flying Fox has been recorded foraging on the Subject Site. Even so, this species is highly mobile and forages over wide areas. Therefore it is unlikely that the Grey-headed Flying-fox would be dependant upon the foraging resources within the Subject Site. As such the removal of 3.6 per cent of potential foraging habitat is unlikely to significantly impact the long-term survival of this species within the Locality. Furthermore no camps were recorded in the Study Area and/or within the Locality.

**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 or ecological communities. Under the TSC Act, the Director-General maintains a register of critical habitat. To date, no critical

habitat has been declared for this species (DECC Threatened Species Unit).

**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 Grey-headed Flying-fox

**Whether the development or activity proposed is of a class of development or activity that is recognized as a threatening process.**

Key threatening processes are defined under Schedule 3 of the TSC Act. The Proposal will involve the operation of the KTP 'Clearing of Native Vegetation'.

Clearing of native vegetation would result in the loss of potential foraging opportunities for the Grey-headed Flying-fox in the Locality.

**Conclusion**

The Grey-headed Flying-fox has been recorded on the Subject Site and in the Locality. The Proposal is likely to modify and/or remove 238.6 ha of potential foraging habitat in the Locality. However, given the mobility of this species, and the absence of camps recorded within the Locality, it is **unlikely** that the Proposal will have a significant impact on Grey-headed Flying-fox in the Locality.

**Koala**

*Phascolarctos cinereus*

The Koala *Phascolarctos cinereus* is listed as Vulnerable on the TSC Act. It is an arboreal folivore feeding almost exclusively on the leaves of *Eucalyptus*, *Corymbia* and *Angophora* species, although it has been recorded feeding from other tree species including, on occasions, exotic species.

Koalas are known to forage on leaves from a variety of tree species, but they have 'preferred' species for certain regions. The Study Area contains a small number of *Eucalyptus haemastoma* and *E. punctata*, species that are listed as Koala feed trees in Schedule 2 of SEPP 44. Koalas have been recorded in the Study Area, and a large population is known from north of the Study Area. Potential habitat exists in the Study Area in woodlands and forests where feed trees occur.

**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 Koalas have been recorded in the Subject Site, Study Area and in the Locality. A large population is known from approximately 8 km to the north.

Koalas have been recorded in the Exposed Sandstone Scribbly Gum Woodland and the Upper Georges River Sandstone Woodland within the Study Area; these communities provide foraging resources for this species. The Proposal is likely to remove and/or modify approximately 203.6 ha (37.8 ha directly and 165.8 ha due to indirect impacts) of these habitat types, hence loss of foraging habitat for the Koala. This habitat is widely distributed within the Locality (4,873.5 ha) and regionally in the Georges River corridor. Therefore the removal and/or modification of 4.2 per cent of the available habitat for the Koala is unlikely to result in the extinction of a viable population of this species in the Locality.

**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.**

Two populations of Koala (Hawks Nest and Pittwater) are listed under Schedule 1 Part 2 (Endangered Populations) of the TSC Act. Neither population, nor their habitats, have relevance to the Study Area. Furthermore no Koala populations are currently listed under Schedule 1 Part 2 in the Wollondilly and Wollongong LGAs.

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

- i. the extent to which habitat is likely to be removed or modified as a result of the action proposed, and**
- ii. whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and**
- iii. the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the Locality.**

Koalas have been recorded in the Study Area and Locality, and there is a known population within 10 km of the Subject Site. The Study Area contains known Koala feed trees, including *Eucalyptus punctata* and *Eucalyptus haemestoma*, which provide potential foraging resources for this species. The Proposal would remove 37.8 ha of potential Koala habitat with a further 165.8 ha of indirect impacts on potential Koala habitat. This represents approximately 4.2 per cent of potential Koala habitat in the Locality.

It is possible that the Proposal would disrupt movement corridors for Koalas in the Locality. There is a known population of Koalas less than 10 km to the north of the Study Area, and potential Koala habitat exists in the Locality and broader

region. The Proposal may result in some temporary fragmentation of habitat, however given the extant of habitat within the Locality and mobility of this species it is unlikely that the Proposal would result in the permanent fragmentation and/or isolation of habitat for the Koala.

Given the extant of suitable habitat within the Locality the removal and/or modification of 4.2 per cent of potential habitat for the Koala is unlikely to have a significant effect on the long-term survival of this species.

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

No areas of habitat for this species have yet been included on the register of critical habitat (see Section 55 of the TSC Act).

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

A draft recovery plan has been developed for the Koala (NPWS 2003b). The relevant actions of the draft recovery plan are listed below:

- have regard to the regional Koala food tree species lists when assessing the potential impact on koalas as a result of Proposals or activities;
- consider any development or activity involving the loss of primary or secondary (class A or B) koala habitat where koalas are present to be potentially significant and require the preparation of a Species Impact Statement; and,
- assess the potential impacts of a development or activity on tertiary Koala habitat, including buffers, links/movement corridors and refuge habitat and the likely impact of the Proposal on koala movement across the landscape (see Section 7).

The Proposal is consistent with the objectives outlined within the recovery plan.

**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 defined under Schedule 3 of the TSC Act. The Proposal will involve two KTPs and one proposed KTP likely to affect the Koala. These are: 'Clearing of Native Vegetation', 'Removal of Dead Wood and Dead Trees' and 'Loss of Hollow-bearing Trees' (proposed KTP).

The clearing of native vegetation would remove potential habitat for Koalas on



the Subject Site and result in a reduction of available food for Koalas in the immediate area.

### Conclusion

Koalas have been recorded in the Study Area and in the Locality. A large population exists 8 km to the north of the Subject Site. Koala feed-trees were also recorded within the Study Area. The Proposal would remove 37.8 ha of potential Koala habitat with a further 165.8 ha of potential Koala habitat indirectly impacted on. This represents approximately 4.2 per cent of potential Koala habitat in the Locality, hence a reduction in potential Koala habitat.

The potential habitat within the Study Area is contiguous and widespread in the Locality. As such, it is **unlikely** that the potential habitat to be removed by the Proposal would have a significant impact on the long-term survival of Koalas in the Locality.

### Large-footed Myotis

### *Myotis adversus*

The Large-footed Myotis is listed as Vulnerable on Schedule 2 of the TSC Act and occurs in a broad range of habitat types including swamps, rainforest and woodland within close proximity to water sources. This species is currently being separated into three divisions, of these, the southern subspecies, Southern Myotis *Myotis macropus*, is discussed in this assessment.

It was recorded in the Study Area during the current survey and potential roosting and foraging habitat for the Southern Myotis exists in all the vegetation types of the Study Area. Potential habitat for this species occurs within the Study Area in the Upland Swamps, Ridgetop Woodland and Gully Forest fauna habitats. These habitats contain suitable roosting habitat and foraging opportunities along the forested water courses.

**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 Southern Myotis was recorded in the Subject Site as a probable identification during Anabat analysis (see Table 3 for analyst details). Other surveys have also recorded this species within the Locality (DECC Atlas of NSW Wildlife).

Factors likely to disrupt the life cycle of this bat species include the loss, disruption or modification of roost sites, particularly “maternity roosts” and loss of foraging habitat. The Southern Myotis is known to use a number of roosting

sites including caves as well as man-made structures such as mines, culverts and drains and tree-hollows (Hoye & Dwyer 1995). Potential habitat for the Southern Myotis occurs within the woodlands and forest habitats within the Study Area. The Proposal is likely to remove and/or modify approximately 241 ha (60.5 direct removal and 180.5 ha indirectly) of potential habitat for this species. These habitats are widely distributed within the Locality.

The amount of suitable habitat to be removed represents <1 per cent of the habitat within the Locality. Given the mobility of this species and extent of potential habitat within the Locality (6,600 ha) it is unlikely the Proposal would place a viable population of the Southern Myotis 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.**

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

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

- i. the extent to which habitat is likely to be removed or modified as a result of the action proposed, and**
- ii. whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and**
- iii. the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the Locality.**

Potential habitat for the Southern Myotis occurs in Ridgetop Woodland and Gully Forest habitats within the Study Area. The Proposal will remove and/or modify approximately 241 ha (60.5 ha directly and 180.5 ha indirectly) of these habitats. These habitat types are continuous with greater areas of potential habitat within the Locality and cover approximately 6,600 ha. However, habitat containing water sources upon which the Southern Myotis is dependant for foraging sites is much less abundant than general foraging habitat in the Locality. The Proposal may result in the reduction of these water resources which the Southern Myotis is likely to currently use for foraging habitat as this will be removed/re-directed as a result of the Proposal. Water resources are present within the surrounding areas and are considered to be of similar quality. It is anticipated that the plans within the Proposal for water treatment and release will minimise impacts on adjacent water courses.

Given the Study Area is continuous with similar habitat types in the Locality; mobility and wide range of the Southern Myotis, it is unlikely the Proposal would isolate or fragment areas of potential habitat for this species.

The loss and/or modification of 3.4 per cent of potential habitat for this species is not considered to be significant given the mobility and extant of suitable habitat within the Locality (6,600 ha). It is unlikely the Proposal would impact the long-term survival of the Southern Myotis within the Locality.

**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 or ecological communities. Under the TSC Act, the Director-General maintains a register of critical habitat. To date, no critical habitat has been for these species (DECC 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 Southern 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 (KTPs) are listed under Schedule 3 of the TSC Act. The proposed activities will involve the operation of the KTPs 'Clearing of Native Vegetation' and 'Alteration to the Natural Flow Regimes of Rivers, Streams, Floodplains & Wetlands'. In addition, the Southern Myotis is listed as being reliant on tree hollows in the preliminary determination for the proposed KTP declaration for 'Loss of Hollow-bearing Trees'. As the Southern Myotis depends on nearby water sources when selecting roosting sites and utilises these water sources for foraging, the redirection of watercourses specified in the Proposal and the reduction in quality of water courses near the Subject Site could result in a reduction of useful foraging habitat for the Southern Myotis.

Clearing of native vegetation results in a loss of foraging and roosting habitat for the Southern Myotis and also results in the loss of habitat for important insect prey items. The loss of hollow-bearing trees results in the loss of important roosting habitat for this species. The impact of natural flows may influence the availability of foraging resources. However given the extant of habitat in the Locality it is unlikely that the modification and/or removal of approximately 241 ha of potential habitat would have a significant impact on the Southern Myotis.

## Conclusion

The Southern Myotis has been recorded within the Study Area. The Proposal would modify and/or remove approximately 241 ha of potential habitat within the Study Area; this represents 3.4 per cent within the Locality. Although habitat containing water sources upon which the Southern Myotis is dependant for foraging and roost sites is much less abundant than general foraging habitat in the Locality and as such the area of potential habitat removed is likely to represent a larger proportion than indicated by the figures.

The potential woodland and forest habitat within the Study Area is surrounded by continuous habitat of similar quality within the Locality. Given the mobility of this species it is unlikely that the Proposal will result in fragmentation or isolation of habitat. Therefore, it is **unlikely** that the Proposal would have a significant impact on the Southern Myotis within the Locality.

### Littlejohn's Tree Frog

### *Litoria littlejohni*

Littlejohn's Tree Frog *Litoria littlejohni* is listed as Vulnerable on Schedule 2 of the TSC Act and occurs on forest woodland and swamp habitat near flowing creeks with good pool habitat and well developed riparian vegetation. This species typically breeds in pools and creeks during autumn and winter.

Potential habitat for this species occurs within the Study Area in both the Gully Forest and the riparian area along Brennans Creek.

**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 was not recorded within the Study Area during the current survey, although it has been recorded within the Locality. This species generally breeds in and near flowing creeks with clear pools and well developed streamside vegetation.

Potential habitat exists within Brennans Creek, however this habitat is not considered to be prime or core habitat for Littlejohn's Tree Frog given the lack of clear pools and well developed streamside vegetation. The Proposal is likely to remove or modify 37.3 ha of area containing potential habitat, which potentially provide both sheltering and breeding sites for Littlejohn's Tree Frog. In addition, the Proposal could potentially affect water quality and flow in habitats downstream of the Study Area which may affect both adult frogs and tadpoles, if

present.

Given that this species was not recorded in the Study Area and potential habitat within the Study Area is not considered to be core habitat, it is unlikely that the Proposal will result in the extinction of a viable population of Littlejohn's Tree Frog.

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

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

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

- i. the extent to which habitat is likely to be removed or modified as a result of the action proposed, and**
- ii. whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and**
- iii. the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the Locality.**

The Proposal is likely to remove and/or modify 37.3 ha (22.7 ha directly and 14.6 ha due to indirect impacts) of potential habitat for this species. This habitat is widely distributed within the Locality (2,135 ha). Therefore the potential habitats to be removed and/or modified by the Proposal represent 1.7 per cent of the available habitat within the Locality.

The Proposal will fragment the upper section of Brennans Creek. However, the upper zones of the creek, above the Study Area, are not considered suitable breeding habitat for Littlejohn's Tree Frog. The surrounding area is of similar continuous vegetation and contains many creek lines. The dispersal potential of Littlejohn's Tree Frog is unknown however known locations of the frog are widely scattered. It is presumably able to move through at least small areas of riparian and gully forest as it is not known in the riparian areas outside its breeding season. Given the degraded nature of the creek upstream of the Study Area, the continuous nature of the surrounding vegetation and the potential for some degree of dispersal in this species, the Proposal is unlikely to fragment or

isolate areas of potential habitat for this species.

The potential habitat within the Study Area is not considered to be prime or core habitat due to the lack of pools with emergent aquatic or adequate streamside vegetation for breeding. The removal and/or modification of 1.7 per cent of limited potential habitat is unlikely to have a significantly impact on Littlejohn's Tree Frog. Hence as populations of this species are widely scattered it is considered unlikely that the Proposal would significantly impact the long term viability of the species in the Locality unless a large population occurs in Brennans Creek, and this is also considered unlikely.

**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 or ecological communities. Under the TSC Act, the Director-General maintains a register of critical habitat. To date, no critical habitat has been declared for this species (DECC Threatened Species Unit).

**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 this species.

**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. The Proposal would involve the operation of two KTPs with the potential to affect this species: 'Clearing of Native Vegetation', and 'Alteration to the Natural Flow Regimes of Rivers, Streams, Floodplains and Wetlands'.

Clearing of Native Vegetation is likely to reduce the potential habitat for Littlejohn's Tree Frog within the Study Area. The Proposal may alter the flow regime of Brennans Creek which could impact on both breeding and foraging habitat. However, Brennans Creek is already dammed both downstream and upstream of the Study Area which has already altered its natural flow regime.

**Conclusion:**

Littlejohn's Tree Frog was not recorded within the Study Area during the current survey however, limited potential habitat for this species in the Study Area occurs along drainage lines within gully habitat. The Proposal will remove and/or modify approximately 1.7 per cent of gully and riparian habitat and may affect

the flow and water quality of Brennans Creek.

However, suitable habitat is present in the surrounding areas and given the limited quality of habitat in the Study Area; the species dependence upon good breeding habitat; the scattered nature of the known breeding populations outside this Locality; and that no populations of the frog are known in the Brennans Creek system, it is considered **unlikely** that the Proposal will result in a significant impact to Littlejohn's Tree Frog.

### Long-nosed Potoroo

### *Potorous tridactylus*

The Long-nosed Potoroo *Potorous tridactylus* is listed as a Vulnerable Species on Schedule 2 of the TSC Act and as Vulnerable under the EPBC Act.

Potential habitat for this species occurs within the Study Area in Ridgetop Woodland and Gully Forest. These vegetation units contain forest and woodland including healthy understorey which provides foraging habitat for the Long-nosed Potoroo.

**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**

Long-nosed Potoroo adults mature at one year of age and breeding peaks typically occur in late winter to early summer. A single young is born per litter and adults are capable of two reproductive bouts per annum. Long-nosed Potoroos have small home ranges relative to the Subject Site; however they are generally solitary and not strictly territorial.

No Long-nosed Potoroos have been recorded within the Locality or within a further 5 km from this. However potential habitat for this species occurs in the woodlands and forest habitat types within the Study Area. The Proposal is likely to remove and/or modify approximately 238.6 ha of potential potoroo habitat, resulting in loss of nest, sheltering and foraging sources. Potential habitat for this species is widely distributed within the Locality (6,600 ha).

The habitat within the Study Area is continuous with greater areas of suitable habitat within the Locality providing potential for potoroos to relocate. This suggests a viable population of Long-nosed Potoroos, if present within the Study Area, would be unlikely to be placed at risk of extinction as a result of the Proposal.

**In the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes**

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

An Endangered Population is defined under the TSC Act as ‘a population specified in Part 2 of Schedule 1’. The Cobaki Lakes and Tweed Heads West population in the Tweed Local Government Area is listed as an Endangered Population of this species under the Act. The population local to this Proposal is not within this listed population.

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

- i. the extent to which habitat is likely to be removed or modified as a result of the action proposed, and**
- ii. whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and**
- iii. the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the Locality**

Habitat for this species occurs within the Subject Site in both the woodland and forest habitats. The Proposal will remove and/or modify approximately 138.6 ha of potential habitat for this species which represents 3.6 per cent of the distribution of the potential habitat within the Locality (6,600 ha).

Potential habitat for the Long-nosed Potoroo within the Study Area is continuous in the greater Locality and is of similar quality to the habitat within the Study Area. As such, the Proposal is unlikely to cause significant long-term isolation or fragmentation of the potential habitat for this species.

The Long-nosed Potoroo habitat within the Study Area is considered to be in good condition and is continuous with greater areas of potential habitat. Given there are no known local populations of this species within the greater region, and the extant of suitable habitat within the Locality it is unlikely that the removal of 3.6 per cent of potential habitat would have a significant impact on the long term survival of the Long-nosed Potoroo.

**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 or ecological communities. Under the TSC Act, the Director-General maintains a register of critical habitat. To date, no critical



habitat has been declared for this species (DECC Threatened Species Unit).

**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 Long-nosed Potoroo.

The DECC has identified 19 priority actions to help recover the Long-nosed Potoroo in NSW. Those most applicable to the Proposal include:

- **Habitat management: Other:** Minimise damage to lower stratum vegetation and litter layer during forestry operations. For example, minimise clearing pre-logging, reduce construction of roads and tracks, and restrict heavy vehicles to such roads;
- **Recovery Plan Preparation:** Single species; and,
- **Habitat Rehabilitation/Restoration and/or Regeneration:** Increase habitat via revegetation work and/or establishing corridors to link multiple patches of suitable habitat to expand the effective area of habitat.

**Whether the action proposed 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. The proposed activities will involve the operation of the KTP 'Clearing of Native Vegetation' that is likely to affect the Long-nosed Potoroo. In addition, the Proposal is likely to increase the impact of 'Predation by feral cats' and 'Predation by the European Red Fox', also listed as KTPs.

The Long-nosed Potoroo is listed as being vulnerable to the following threats:

- Habitat loss and fragmentation from land clearing for residential and agricultural development;
- Predation from Foxes, Dogs and Cats;
- Too frequent fires or grazing by stock that reduce the density and floristic diversity of understorey vegetation.
- Logging regimes or other disturbances that reduce the availability and abundance of food resources, particularly hypogeous fungi, and ground cover.

The clearing of native vegetation results in the direct removal of potential food resources, and loss of potential sheltering and foraging habitat for the Long-nosed Potoroo.

## Conclusion

The Proposal is likely to modify and/or remove approximately 238.6 ha of potential habitat for this species, hence the loss of the potential foraging and nesting resources. This may result in an increase of KTPs and hence the loss of key nesting and foraging habitat for this species. However given the lack of records for this species within the Locality or within adjacent contiguous habitat, it is considered unlikely that a viable population exists in the Study Area.

Based on this information, it is **unlikely** that the Proposal would have a significant impact on the Long-nosed Potoroo.

### Microchiropteran Bats – Hollow-dependant Species

The Eastern False Pipistrelle *Falsistrellus tasmaniensis*, Greater Broad-nosed Bat *Scoteanax rueppellii*, Eastern Freetail Bat *Mormopterus norfolkensis* and the Yellow-bellied Sheathtail Bat *Saccolaimus flaviventris* have been grouped on the basis of their similar habitat requirements and local recordings. Each of these species uses tree-hollows as primary roosting and maternity habitat (other structures may provide similar microhabitat components) and are therefore dependent upon them for their survival (Churchill 1998). All species forage within forest and woodland habitat, although they use these habitats differently according to their requirements as detailed below.

The Greater Broad-nosed Bat is a slow flyer with low manoeuvrability and tends to forage along gaps and edges of forests and bushland patches, in moist gullies of mature coastal forest or in rainforest (Churchill 1998, Law *et al.* 2000). The Eastern Freetail Bat is fast flying and clutter sensitive and is also associated with open or edge habitats foraging mostly in dry eucalypt forest and woodland (Lloyd *et al.* 2006). Eastern False Pipistrelle's are also fast fliers with greater manoeuvrability. They forage below or within the forest canopy in sclerophyll forests (Churchill 1998). The Yellow-bellied Sheathtail Bat occurs over most habitats and has a high and fast flight, foraging above the canopy (Churchill 1998). The Eastern False Pipistrelle, the Greater Broad-nosed bat and the Yellow-bellied Sheathtail Bat forage on a range of insects including moths and beetles, however little is known of the diet of the Eastern Freetail Bat (Churchill 1998).

Potential habitat for these species occurs within the Subject Site in both the Ridgetop Woodland and Gully Forest habitats in the Study Area. These areas contain trees with hollows and bark suitable for bat roosting as well as forested areas with water courses and cleared areas to provide foraging flyways.

**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.**

None of the four species were detected during current surveys or within the Study Area. The Eastern Freetail Bat and the Greater Broad-nosed Bat have been detected within the Locality. All four bat species have also been detected within the adjacent Dharawal Nature Reserve/Dharawal Conservation Area, although the Yellow-bellied Sheathtail Bat has not been sighted for many years (NPWS 2006a).

Factors likely to disrupt the life cycle of hollow-dependant bat species include the loss, disruption or modification of roost sites, which include tree hollows, as well as bark of trees and other vegetative structures. In addition, the loss of suitable foraging areas and habitat for prey items can disrupt the life cycle of these species. The Proposal will remove and/or modify approximately 238.6 ha (60.5 ha directly and 178.1 ha due to indirect impacts) of potential habitat for these species. However, these habitats are widely distributed throughout the Locality (6,600 ha).

While it is possible that some individuals may find suitable roosting habitat in adjacent areas, it is likely that the Proposal would result in the mortality of some individuals of these species. Given the mobility of these species and extant of potential habitat in the immediate vicinity of the Study Area it is unlikely that a viable local population of any of these species will be placed at risk of extinction by the Proposal.

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

An Endangered Population is defined under the TSC Act as ‘a population specified in Part 2 of Schedule 1’. At the present time, there are no Endangered Populations of any of these species listed under the Act.

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

- i. the extent to which habitat is likely to be removed or modified as a result of the action proposed, and**
- ii. whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and**

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

The Proposal is likely to remove and/or modify approximately 238.6 ha of potential habitat for these species within the Study Area. This includes the direct removal of 60.5 ha of Ridgetop Woodland and Gully Forest habitat in the Subject Site and 178.1 ha due to indirect impacts. These habitat types are continuous into the greater region and as such, the cleared area represents less than 3.6 per cent of the potential habitat within the Locality.

Given the potential habitat for these four bat species within the Study Area is continuous with greater areas of suitable habitat in the Locality and the mobility of these species, it is unlikely that the Proposal would isolate or fragment areas of potential habitat. However, there may be increased mortality to the Greater Broad-nosed Bat caused through collision with vehicles utilising the Study Area at night. This species is a slow-flying bat with low manoeuvrability which tends to forage along gaps and forest edges (Churchill 1998, Law *et al.* 2000).

Potential habitat within the Study Area is considered to be in good condition. Finer scale habitat features such as abundant tree hollows, bark and watercourses provide foraging and roosting habitat for the Eastern False Pipistrelle, Greater Broad-nosed Bat, Eastern Freetail Bat and the Yellow-bellied Sheathtail Bat. These habitat features have also been widely identified in the local area, hence it is considered unlikely that the removal and/or modification of 238.5 ha of woodland and forest habitat will significantly affect the long term survival of any of these species in the Locality.

**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 or ecological communities. Under the TSC Act, the Director-General maintains a register of critical habitat. To date, no critical habitat has been declared for these species (DECC 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 Eastern False Pipistrelle, Greater Broad-nosed Bat, Eastern Freetail Bat and the Yellow-bellied Sheathtail Bat.

**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. The proposed activities will involve the operation of the KTP 'Clearing of Native Vegetation' and the proposed KTP 'Loss of Hollow-bearing Trees'. Clearing of native vegetation is identified as a threat to a number of key threatened and non-threatened species, including the Greater Broad-nosed Bat and the Yellow-bellied Sheathtail Bat and will result in a loss of foraging and roosting habitat for the four bat species. However potential habitat for these species is widely distributed within the Locality, hence the modification and/or removal of 238.6 ha is unlikely to have a significant impact on these four bat species.

All four species are listed as being reliant on tree hollows, for roosting habitat, in the preliminary determination for the proposed KTP declaration for 'Loss of Hollow-bearing Trees'. The removal of hollow-bearing trees is likely to reduce the potential roosting sites for these species. Although individual bats may be impacted by the loss of roosting sites, given the mobility of the Forest Bats and extant of potential roosting habitat within the Locality it is unlikely the Proposal would have a significant impact of these species.

### **Conclusion**

Although the Eastern False Pipistrelle, Greater Broad-nosed Bat, Eastern Freetail Bat and the Yellow-bellied Sheathtail Bat were not detected during the current survey, the Eastern Freetail Bat and the Greater Broad-nosed Bat have been detected within the Locality (DECC Atlas of NSW Wildlife) and all four species have been detected within the adjacent Dharawal Nature Reserve.

The Proposal will constitute the removal and/or modification of 238.6 ha of good quality potential foraging and roosting habitat for these species. This may include the removal of important habitat features such as tree hollows for roosting; hence individual bats may be impacted. However, all four species are highly mobile and able to use wide areas for foraging and roosting (6,600 ha of potential habitat in the Locality) as well as traverse gaps in vegetation. Therefore it is considered **unlikely** that the Proposal will result in a significant impact upon the Greater Bread-nosed Bat, Eastern False Pipistrelle, Yellow-bellied Sheathtail Bat or the Eastern Freetail Bat.

### Microchiropteran Bats – Cave-roosting Species

Potential habitat for two threatened cave-roosting bat species: the Large-eared Pied Bat *Chalinolobus dwyeri* and the Common Bent-wing Bat *Miniopterus schreibersii* (also known as the Eastern Bent-wing Bat) occurs within the Study Area.

The Large-eared Pied Bat, is listed as Vulnerable on both the TSC the EPBC Acts.

The Common Bent-wing Bat is listed as Vulnerable on the TSC Act.

The Large-eared Pied Bat and the Common Bent-wing Bat occur in a variety of habitats, with the Large-eared Pied Bat generally found in timbered areas (forest and woodland), while the Common Bent-wing Bat can be found in a broad range of vegetation types (from rainforest to grassland). Foraging behaviour and flight capability varies between the species; the Common Bent-wing Bat has a fast flight and forages above the canopy in forested areas, while the Large-eared Pied Bat has a relatively slow flight and forages within the canopy (Churchill 1998). Both species utilise caves and derelict mines as their primary roosting habitat (Churchill 1998). The Common Bent-wing Bat is wide-ranging, dispersing within a 300 km range of their maternity sites (DEC 2005k). Little is known about range and dispersal of the Large-eared Pied Bat.

Potential habitat for the Large-eared Pied Bat and the Common Bent-wing Bat occurs within the Study Area in both the Ridgeway Woodland and Gully Forest fauna habitats. The Common Bent-wing Bat was recorded in the Study Area in the current survey.

**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 Common Bent-wing Bat was detected during the current surveys. The Large-eared Pied Bat was not recorded during the current surveys but has been recorded within 10 km of the Study Area (DECC Atlas of NSW Wildlife).

Factors likely to disrupt the life cycle of cave-roosting bat species include the loss, disruption or modification of roost sites, particularly “maternity roosts”. Such roost sites include caves as well as human-made structures such as mines, culverts and drains (Hoye & Dwyer 1995). The Proposal is unlikely to remove or disrupt such roost sites, due to an absence of caves or similar human-made structures within the Study Area.

The Proposal will modify and/or remove approximately 238.6 ha of potential

foraging habitat for the Large-eared Pied Bat and the Common Bent-wing Bat. These habitat types are widely distributed within the Locality (6,600 ha). The amount of foraging habitat likely to be impacted by the Proposal represents 3.6 per cent of the broader distribution of this vegetation type within the Locality. Given the species' mobility, the extent of suitable habitat within the Locality and the unlikely impact on possible roosting habitat, it is unlikely that the Proposal will place a viable population of the Large-eared Pied Bat or the Common Bent-wing Bat 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.**

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

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

- i. the extent to which habitat is likely to be removed or modified as a result of the action proposed, and**
- ii. whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and**
- iii. the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the Locality.**

The Proposal is likely to modify and/or remove approximately 238.6 ha (60.5 ha directly and 178.1 ha due to indirect impacts) of potential foraging habitat for the Large-eared Pied Bat and the Common Bent-wing Bat. Within the Locality, the habitat types have an extant area of 6,600 ha. The amount to be removed therefore represents 3.6 per cent of the extant area of potential foraging habitat in the local area. Hence, in relation to the local distribution of these species, it is unlikely that a significant area of known habitat will be modified or removed.

The Proposal is unlikely to isolate or fragment areas of potential foraging habitats within Ridgetop Woodland and Gully Forest fauna habitats for the Large-eared Pied Bat or the Common Bent-wing Bat as these habitats are contiguous with similar habitat types in the Locality. Furthermore these Cave-dwelling bat species are considered to be highly mobile and capable of foraging over vast distances. However, there may be an increased mortality observed to

the Large-eared Pied Bat as a result of collision with vehicles, because it is a slow-flying bat that feeds predominantly below the canopy (Hoye & Dwyer 1995).

The habitat within the Study Area is considered to be of good quality, containing both watercourse and good canopy for foraging. These habitat features are present within the Woodland and Forest habitats within the Locality. Therefore the removal of 3.6 per cent of potential foraging habitat within the Locality is not considered significant to the long term survival of this species, given the mobility of the Large-eared Pied Bat and the Common Bent-wing Bat.

**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 or ecological communities. Under the TSC Act, the Director-General maintains a register of critical habitat. To date, no critical habitat has been for the Large-eared Pied Bat or the Common Bent-wing Bat (DECC 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-eared Pied Bat or the Common Bent-wing Bat.

**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. The proposed activities will involve the operation of the KTP 'Clearing of Native Vegetation'. Clearing of native vegetation is identified as a threat to a number of key threatened and non-threatened species, including the Large-eared Pied Bat.

The clearing of native vegetation results in a loss of foraging habitat for both bat species and also their insect prey items, which inhabit both trees and the woodland/forest floor. However, given the continuous nature of the habitat surrounding the Proposal and the high mobility of these bats, this KTP is unlikely to significantly impact the Large-eared Pied Bat or the Common Bent-wing Bat.

**Conclusion**

The Common Bent-wing Bat was detected during the current surveys. The Large-eared Pied Bat was not recorded during the current surveys but has been



recorded within 10 km of the Study Area (DECC Atlas of NSW Wildlife).

The Proposal is likely to impact approximately 238.6 ha (60.5 ha directly and 178.1 ha due to indirect impacts) of potential foraging habitat for this species. This foraging habitat is widely distributed in Woodland and Forest habitat within the Locality.

The Proposal will result in the operation of the KTP 'Clearing of Native Vegetation' which will result in a loss of potential foraging and prey species habitat. However, the Proposal is unlikely to affect important roost sites for these cave-dwelling bats and it will remove a comparatively small proportion of potential foraging habitat in the Locality (3.6 per cent). In addition, the habitat within the Locality is good quality and the Proposal is unlikely to result in fragmentation or isolation of habitat.

Given the species' mobility; extant of suitable habitat the within the Locality and the unlikely impact on possible roosting habitat, it is **unlikely** that the Proposal would have a significant impact on the Common Bent-wing Bat or the Large-eared Pied Bat.

#### Red-crowned Toadlet

#### *Pseudophryne australis*

The Red-crowned Toadlet *Pseudophryne australis* is listed as Vulnerable on Schedule 2 of the TSC Act and 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 with dense grasses, ferns and low shrubs (Thumm and Mahony 1996, Thumm and Mahoney 1997).

Potential habitat for this species occurs within the Study Area in the Ridgetop Woodland, Gully Forest and Upland Swamp habitats. These habitat types contain finer scale features such as ephemeral streams and soak areas hence possible breeding habitat for the Red-crowned Toadlet. Habitat mapping for the Red-crowned Toadlet done by NPWS also indicates potential habitat in the area (Webb and Shine 1994).

**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 was not recorded within the Study Area during the current survey however it has been recorded within the Locality and potential habitat for this species occurs on ridges, and in ephemeral drainage lines within the woodland, forest and Upland swamp habitats. It should be noted that optimal

conditions for targeted surveys of Red-crowned Toadlets (high rainfall) did not occur during the survey period. The Proposal is likely to remove or modify 241 ha of area containing potential habitat, which may result in loss of ephemeral drainage lines that provide both sheltering and breeding sites for Red-crowned Toadlets. In addition, the Proposal could potentially affect water quality via run-off into ephemeral streams and pools. This is likely to impact on the breeding habitat and possibly the development and recruitment of tadpoles.

Red-crowned Toadlets are considered to be localised and restricted to the immediate vicinity of their breeding habitat, hence recruitment and re-colonisation of areas of vacant habitat is thought to be low (DEC 2005,). Given their dependence on ephemeral feeder channels for development and their restricted mobility combined with a low rate of recruitment due to an opportunistic reproductive strategy reliant on rainfall during tadpole development, any impact to this species' life cycle is likely to have a significant affect on the population.

It is likely that the removal and/or modification of 241 ha of potential habitat would place a viable population of the Red-crowned Toadlet 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.**

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

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

- i. the extent to which habitat is likely to be removed or modified as a result of the action proposed, and**
- ii. whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and**
- iii. the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the Locality.**

Potential habitat for the Red-crowned Toadlet occurs in the Ridgetop Woodland, Gully Forest and Upland Swamp habitat types within the Study Area. The Proposal is likely to modify and/or remove approximately 241 ha of potential habitat for this species. These habitat types are continuous into the greater

region; the cleared area represents <1 per cent of the distribution of the specified habitat within the Locality (7008.8 ha). However, habitat consisting of ephemeral feeder stream and soaks draining into larger creeks is much less abundant than general forest/woodland habitat in the Locality. Therefore, the area of potential habitat removed is likely to represent a larger proportion than indicated by the figures.

The clearing in the Subject Site may fragment potential habitat for the Red-crowned Toadlet and potentially reduce the movement of these animals. While it is unlikely that the woodland habitat will be isolated or fragmented from the surrounding area, this species is thought to be localised and is not likely to travel across large areas for movement and dispersal. Thus fragmentation even on a small scale through the removal of habitat and redirection of a water course is likely to impact on the movement of this species.

The quality of Red-crowned Toadlet potential habitat within the Study Area is good and limited off-site surveys indicate that the habitat outside the directly impacted Subject Site is of similar quality. Contamination of run-off could affect the overall quality of Red-crowned Toadlet habitat within the Study Area though considering the extent of the continuous habitat in the surrounding Locality, the effect on the population in the Locality is likely to be small. In addition, it is anticipated that the plans within the Proposal for water treatment and release will minimise impacts on adjacent watercourses.

**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 or ecological communities. Under the TSC Act, the Director-General maintains a register of critical habitat. To date, no critical habitat has been declared for this species (DECC Threatened Species Unit).

**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 Red-crowned Toadlet.

**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. The Proposal would involve the operation of four KTPs: 'Bushrock Removal', 'Clearing of Native Vegetation', 'Removal of Dead Wood and Dead Trees', and

‘Alteration to the Natural Flow Regimes of Rivers, Streams, Floodplains and Wetlands’.

Bushrock Removal results in the loss of the favoured shelter microhabitat for the Red-crowned Toadlet, potentially increasing the risk of predation and desiccation. Removal of dead wood and dead trees also reduces suitable sheltering sites and clearing of native vegetation results in the removal of both breeding and sheltering habitat types. The alteration to water course and possible reduction in water quality of the water courses in the Study Area could also reduce both breeding and foraging habitat for the Red-crowned Toadlet. In addition, further effects due to contamination of run-off could have an affect on recruitment as the Red-crowned Toadlet tadpoles develop in ephemeral streams and watery areas which are susceptible to run-off.

**Conclusion:**

The Red-crowned Toadlet has not been recorded within the Study Area. However the species has been documented within the Locality and the adjacent Dharawal Nature Reserve/Dharawal State Conservation Area and good quality potential habitat exists in within the Study Area. It is highly cryptic, difficult to capture and optimal survey conditions did not occur during the survey period, limiting the likelihood of detecting this species. Given the above, using the precautionary principle, it is likely that the Study Area supports a population of the Red-crowned Toadlet.

Potential habitat for the Red-crowned Toadlet occurs in ridges and ephemeral drainage lines within Ridgetop Woodland, Gully Forest and Upland Swamp fauna habitat types in the Study Area. The Proposal is likely to remove and/or modify approximately 241 ha of potential Red-crowned Toadlet habitat, which represents 3.4 per cent of the greater distribution of suitable habitat within the Locality. However, habitat consisting of ephemeral feeder stream and soaks draining into larger creeks is much less abundant than general forest/woodland habitat in the Locality and as such the area of potential habitat impacted is likely to represent a larger proportion than indicated by these figures.

The Proposal will result in the operation of the KTPs ‘Bushrock removal’, ‘Removal of Dead Wood and Trees’, ‘Removal of Native Vegetation’ and ‘Alteration to the Natural Flow Regimes of Rivers, Streams, Floodplains and Wetlands’ which would result in loss of breeding and sheltering habitat. Furthermore, possible impacts of the Proposal on water quality in areas immediately adjacent to the Subject Site could affect recruitment. Given their dependence on ephemeral feeder channels for development and their restricted mobility it is likely that a population inhabiting the potential habitat surrounding Brennans Creek could be a discreet population. As such, the combined effects of

the above factors on this population are likely to put it at risk of extinction.

Therefore it is therefore considered **likely** the Proposal will lead to a significant impact a local population of the Red-crowned Toadlet.

### Regent Honeyeater

### *Xanthomyza phrygia*

The Regent Honeyeater *Xanthomyza phrygia* is listed as Endangered on both the TSC and the EPBC Acts. The Regent Honeyeater has a patchy distribution throughout a large geographic range. The species breeds in a small number of sites containing a variety of key *Eucalyptus* spp., particularly Mugga Ironbark *E. sideroxylon*, Yellow Box *E. melliodora* and White Box *E. robusta*, and is known to forage for nectar and/or insects or otherwise utilise a range of other species (Schedvin 1996; Webster & Menkhorst 1992; Franklin *et al.* 1989).

Potential habitat for this species occurs within the Ridgetop Woodland and Gully Forest fauna habitat types within the Study Area. However, given the lack of preferred foraging trees within the Study Area is unlikely to constitute prime or core habitat for this species. It is likely that the Regent Honeyeater would use the resources within the Study Area however it is unlikely to be dependant on them.

**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.**

It is highly unlikely that the Study Area supports a local population of the Regent Honeyeater. The particular box-ironbark woodlands usually associated with breeding are absent and there are no known breeding sites within the Locality. There is only one record of the species within a 10 km radius of the Study Area (recorded in 1934).

It is possible that the Regent Honeyeater utilises the extensive woodland and forest habitats within the Study Area. These habitat types are widely distributed throughout the Locality (6,600 ha). Given that this species is highly mobile and the extent of potential habitat within the Locality, it is unlikely that the Regent Honeyeater would be dependant on the habitat resources within the Study Area. Therefore it is unlikely the removal and/or modification of 238.6 ha of potential habitat (3.6 per cent of available habitat within the Locality) would place a viable population of this species 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.**

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

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

- i. is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or**
- ii. is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction.**

Not applicable to threatened species.

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

- i. the extent to which habitat is likely to be removed or modified as a result of the action proposed, and**
- ii. whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and**
- iii. the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the Locality.**

The Proposal would remove approximately 60.5 ha of habitat that may occasionally be used by the Regent Honeyeater during its semi-nomadic movements outside of the breeding season. This represents <1 per cent of such habitat within the Locality and a much smaller proportion of such habitat within the region.

**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 or ecological communities. Under the TSC Act, the Director-General maintains a register of critical habitat. To date, no critical habitat has been declared for the Regent Honeyeater.

**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 Regent Honeyeater.

**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 defined under Schedule 3 of the TSC Act. The Proposal will involve three KTPs and one proposed KTP. These are: 'Bushrock Removal', 'Clearing of Native Vegetation', 'Removal of Dead Wood and Dead Trees' and 'Loss of Hollow-bearing Trees' (proposed KTP).

Clearing of native vegetation would remove a small proportion of the potential foraging habitat for the Regent Honeyeater within the Locality.

**Conclusion**

Potential habitat within the Study Area is not considered to be prime or core habitat for the Regent Honeyeater given the lack of preferred winter flowering trees. It is likely that this species would utilise the resources in the Woodland and Forest habitat within the Study Area, however it is unlikely to be dependant on them. The Proposal is likely to remove approximately 3.6 per cent of the available habitat for this species within the Locality; given the mobility of this species this is unlikely to have a significant impact on the Regent Honeyeater.

It is considered highly **unlikely** that the Proposal would have a significant impact on this species.

**Rosenberg's Goanna**

*Varanus rosenbergi*

The Rosenberg's Goanna *Varanus rosenbergi* is listed as Vulnerable on Schedule 1 of the TSC Act. In NSW this species is patchily distributed in Hawkesbury/Narabeen sandstone country. Within these areas, the Rosenberg's Goanna typically inhabits heath, open forest and woodland where it is active diurnally and shelters nocturnally in hollow logs, burrows (which it digs), rock crevices and sandstone outcrops (Aitkens 1999). It is dependent upon the distribution of termite mounds in which it nests. The female Rosenberg's Goanna digs a chamber underneath a termite mound where she lays a clutch of up to 14 eggs (which take approximately eight months to hatch). This species is a generalist forager and scavenger, and as such its diet consists mainly of insects and smaller reptiles but it will scavenge on mammals killed on roads where

available (King and Green 1993). Little published data about home range and mobility of the Rosenberg's Goanna exists. Based on studies conducted on Kangaroo Island, the Rosenberg's Goanna has a relatively small home range, averaging 19.44 ha (King and Green 1993). However, radio-tracking of individuals in the Goobang Dam area, NSW has recorded individuals roaming distances in the order of 4-5 km over a couple of days (W. Smith, former employee of National Parks & Wildlife Service, Queanbeyan, pers. comm.).

Habitat for this species occurs within the Study Area in the Ridgetop Woodland and Gully Forest fauna habitats. These vegetation units contain exposed sandstone outcrops and hollow logs which the Rosenberg's Goanna utilise for sheltering sites as well as sand substrate suitable for burrowing. In addition, the Subject Site contains termite mounds, upon which the Rosenberg's Goanna is dependant for nesting. The Subject Site also contains useful foraging area for the Rosenberg's Goanna and habitat for many species of its wide range of prey. The Proposal will remove 60.5 ha of these vegetation types combined resulting in a loss of sheltering and foraging sites as well as loss of habitat for major prey items. The Proposal would directly impact on 25.4 per cent of potential habitat within the Study Area. The remaining Ridgetop Woodland and Gully Forest habitat within the Study Area may be indirectly impacted by noise and dust dispersal. In total 74.6 per cent of potential ridge and gully habitat within the Study Area may be indirectly impacted. The Proposal would directly impact on <1 per cent and indirectly impact on a further 2.7 per cent of potential habitat within the Locality.

**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 Rosenberg's Goanna has been recorded within the Study Area and also within the Locality. Burrows which were suspected to have been constructed by Rosenberg's monitors were also found within the Study Area (current survey). The Proposal will remove 60.5 ha of known habitat for this species including sandstone outcrops, hollow logs and burrows which are used for nocturnal sheltering sites as well as termite mounds which are used for nesting. Removal of sheltering sites could affect the life cycle of local population as individuals are believed to return to the same sheltering sites regularly (W. Smith, pers. comm.). Female Rosenberg's Goanna's may inspect many termite mounds before laying their eggs (W. Smith, pers. comm.), removal of any suitable termite mounds from within the Subject Site could therefore reduce recruitment. In addition, termite mounds containing egg clutches could also be destroyed by the Proposal, as clutches have been recorded to incubate in termite mounds for periods as long as three years (Ehmann *et al.* 1991).



Although the Proposal involves a gradual and staged removal of habitat, individuals are known to return to specific locations and data on the range of movement for this species is limited. It is therefore possible that individuals could have difficulty moving as the development proceeds. The proportion of potential habitat to be cleared as part of the Proposal is part of a larger and continuous area in the region, with similar vegetation types of similar habitat quality. However, it is possible that if this species has a small home range (as recorded in Kangaroo Island) and given their dependence on suitable hollow logs, rocky outcrops, burrows and termite mounds to provide shelter and nesting sites, the individuals inhabiting the Subject Site could be a discreet population. In this way, the Proposal could place a viable local population of the species at risk of extinction.

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

- i the extent to which habitat is likely to be removed or modified as a result of the action proposed, and**
- ii whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and**
- iii the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the Locality**

The Proposal will remove 60.5 ha of known habitat for this species, which is 24.9% of the distribution of this habitat within the Study Area. Habitat for this species occurs within the Study Area in both the Ridgetop Woodland and Gully Forest. These vegetation types are continuous into the greater region and as such, the cleared area represents <1 per cent of the distribution of the potential habitat within the Locality (6,600 ha). However, habitat with rocky outcrops and termite mounds is much less abundant than general foraging habitat in the Locality. Therefore, the area of potential nesting and sheltering habitat to be removed by the Proposal is likely to be smaller than that indicated by the figures.

The Proposal may temporarily fragment potential habitat for Rosenberg's Goanna and potentially reduce the movement of these animals. The habitat types of the Study Area are continuous in the greater Locality and are considered to be of similar quality. As such, the Proposal is unlikely to cause significant isolation or fragmentation of the habitat.

The Proposal is likely to significantly reduce finer scale habitat features such as termite mound and hollow logs; given these features are less abundant within the Study Area, it is likely that a viable population of Rosenberg's Goanna would be placed at risk of extinction. As previously discussed, Rosenberg's Goanna habitat

within the Study Area is considered to be of good quality and limited off site surveys indicate that potential habitat in the Locality outside the Study Area is of similar quality; therefore the overall quality of Rosenberg's Goanna habitat within the greater region is unlikely to be affected by the Proposal. In this way, the Proposal is unlikely to result in the extinction of the species within the entire Locality. However, it is possible that if this species has a small home range (as recorded in Kangaroo Island) and given their dependence on suitable hollow logs, rocky outcrops, burrows and termite mounds, individuals inhabiting the Subject Site could be a discreet population. On this basis, the Proposal could place a viable local population at risk of extinction.

**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 or ecological communities. Under the TSC Act, the Director-General maintains a register of critical habitat. To date, no critical habitat has been declared for this species (DECC Threatened Species Unit).

**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 Rosenberg's Goanna.

**Whether the action proposed 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. Key Threatening Processes that are considered relevant to the Proposal and Rosenberg's Monitor include the 'Clearing of Native Vegetation' and 'Removal of Dead Wood and Dead Trees' and 'Bushrock Removal'. In addition, the Rosenberg's Goanna is specifically listed as a threatened species which is considered to be adversely affected by the removal of dead wood and dead trees (NSW Scientific Committee 2003).

Removal of dead wood, dead trees and bushrock is likely to result in the loss of shelter for both the Rosenberg's Goanna and its prey. Work at Googong Dam, NSW indicates that hollow logs are the most commonly used sheltering sites (W. Smith, pers. comm.) although observation of the species in the Sydney region includes the use of sandstone outcrops for shelter (B. Smith, Biosis Research, pers. comm.). Clearing of native vegetation results in a loss of foraging habitat for the Rosenberg's Goanna and may result in a higher visibility of this species to

predators and therefore increased predation risk. In addition, clearing of native vegetation in the Subject Site could result in the clearing of termite mounds suitable for nesting. Reduction of suitable termite mounds for incubation of eggs could significantly affect the viability of a local population by reducing recruitment.

### **Conclusion:**

The Rosenberg's Goanna has been recorded within both the Study Area and the Locality. The Proposal will constitute removal of 60.5 ha of potential habitat for Rosenberg's Goanna and may impact on a further 178 ha of potential habitat.

The Proposal will result in the operation of KTPs 'Clearing of Native Vegetation', 'Removal of dead wood and dead trees', and 'Bushrock Removal' which will result in loss of sheltering, foraging, nesting and prey species habitat. Removal of termite mounds containing active nests or suitable for nesting could affect recruitment.

While gradual clearing may be employed, individuals may not move across large distances and thus may have difficulty moving as the development proceeds. Potential habitat for Rosenberg's Goanna within the Locality is good quality and the Proposal is unlikely to result in fragmentation or isolation of this potential habitat. However, based on a small home range (as recorded in Kangaroo Island) and this species dependence on suitable hollow logs, rocky outcrops, burrows and termite mounds to provide shelter and nesting sites, individuals inhabiting the Subject Site could be a discreet population. In this way, the Proposal could place a viable local population at risk of extinction.

For the reasons given above it is therefore considered **likely** the Proposal will lead to a significant impact on a local population of the Rosenberg's Goanna.

### **Spotted-tailed Quoll**

### *Dasyurus maculatus*

The Spotted-tailed Quoll *Dasyurus maculatus* is listed as Vulnerable on schedule 1 of the TSC Act and as Endangered on the EPBC Act.

Habitat of the Spotted-tailed Quoll includes wet and dry sclerophyll forests, rainforests, woodland, coastal heathland and riparian forest. The Spotted-tailed Quoll consumes a variety of prey, including gliders, possums, small wallabies, rats, birds, bandicoots, rabbits and insects and will also feed on carrion. Spotted-tailed Quolls are primarily solitary, nocturnal and terrestrial however, they have been seen active by day and are agile climbers. They are a highly mobile species; females occupy home ranges up to 750 ha and males significantly greater up to

3500 ha (DECC Threatened Species Unit; Claridge *et al.* 2005). Male home ranges tend to overlap considerably with those of other individuals, while females tend not to overlap with those of other females (Claridge *et al.* 2005). Home range overlap appears to be related to habitat quality with higher overlap occurring in higher quality environments (Claridge *et al.* 2005). Individuals require large areas of relatively intact vegetation through which to forage and usually traverse their ranges along densely vegetated creek lines. Den and sheltering resources utilised by the Spotted-tailed Quoll include tree hollows, hollow logs, caves, rock crevices and boulder piles, rocky-cliff faces or other animal burrows (Webb 1993). Quolls often use multiple den sites within their home range.

Potential habitat for this species occurs within the Study Area in both the Ridgetop Woodland and Gully Forest fauna habitats. The Proposal has the potential to impact on these habitat types.

**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.**

While the Spotted-tailed Quoll has not been recorded within the Study Area, it has been recorded within the Locality and also within a further 5 km of the Locality. Potential habitat for this species occurs within the Study Area in both the Ridgetop Woodland and Gully Forest fauna habitats (238.6 ha). The Proposal will remove 60.5 ha of these habitat types combined from the Subject Site resulting in a direct loss of sheltering, foraging and breeding sites as well as loss of habitat for major prey items. The Proposal would directly impact on 25.4 per cent of potential habitat within the Study Area. The remaining Ridgetop Woodland and Gully Forest habitat within the Study Area may be indirectly impacted by noise and dust dispersal. In total 74.6 per cent of potential ridge and gully habitat within the Study Area may be indirectly impacted. The Proposal would directly impact on <1 per cent and indirectly impact on a further 2.7 per cent of potential habitat within the Locality.

These vegetation units contain exposed rocky outcrops and rock crevices as well as hollow bearing trees and logs which Spotted-tailed Quolls could use during breeding. While quolls may use multiple den sites, the habitat within the Subject Site contains a higher proportion of rocky shelters than found within other areas of the Locality. It is therefore possible the habitat within Brennans Gully could act as an important den and shelter site for a local population of the Spotted-tailed Quoll, if present.

The Proposal would also result in loss of habitat for major prey items potentially increasing the risk of competition with introduced Cats *Felis catus* and Foxes *Vulpes vulpes*, and in the loss of a creek line which quolls could potentially use

for movements between sites.

The removal of this area containing high quality habitat for the Spotted-tailed Quoll and its prey, as well as a high proportion of locally less common rocky outcrops for den sites and a vegetated creek line for movement, a local population of this species would be negatively impacted, if present. However, Spotted-tailed Quolls have large home ranges (750-3,500 ha), and so a local population would extend beyond the Locality and the Proposal would remove only a small proportion of the population's potential habitat. It is therefore unlikely that a viable local 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.**

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

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

- i. the extent to which habitat is likely to be removed or modified as a result of the action proposed, and**
- ii. whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and**
- iii. the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the Locality.**

Habitat for this species occurs within the Subject Site in both the Ridgetop Woodland and Gully Forest. The Proposal would remove 60.5 ha of potential habitat for this species, which represents <1 per cent of the distribution of the potential habitat within the Locality (6,600 ha). The extent of ridgetop and gully habitat potentially impacted directly and indirectly by the Proposal is approximately 238.6 ha which represents 3.6 per cent of that habitat within the Locality. However, gully edge habitat with rocky outcrops is much less abundant than general foraging habitat in the Locality. Therefore, the area of sheltering habitat represents a larger proportion than indicated by the figures.

The vegetation types which provide habitat for the Spotted-tailed Quoll within the Subject Site are continuous in the greater Locality and habitat surrounding the Study Area is of similar quality to the habitat within the Study Area.

Although the Proposal would remove a creek line potentially used by quolls moving between neighbouring areas, there are other similar drainage lines present in the Locality. As such, the Proposal is unlikely to cause significant long-term isolation or fragmentation of the habitat.

The Spotted-tailed Quoll habitat within the Study Area is good quality. It contains foraging habitats of forest, heath and woodland including potential den sites such as rocky crevices and outcrops, fallen logs and hollow-bearing trees. The habitat outside the directly impacted Subject Site is of similar quality; therefore the overall quality of Spotted-tailed Quoll habitat within the greater region is unlikely to be affected by the Proposal. This suggests the loss of habitat within the subject area is unlikely to significantly affect the long term survival of the Spotted-tailed Quoll. However, gully edge habitat with rocky outcrops is much less abundant than general foraging habitat in the Locality. While quolls will also use alternate resources for denning (such as fallen logs), the area containing suitable den sites removed may represent a larger proportion than indicated by the figures.

**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 or ecological communities. Under the TSC Act, the Director-General maintains a register of critical habitat. To date, no critical habitat has been declared for this species (DECC Threatened Species Unit).

**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 Spotted-tailed Quoll in NSW

The DECC has identified 32 priority actions to help recover the species in NSW. Those most applicable to the current Proposal include:

- Habitat management: Ongoing EIA - Advice to consent and planning authorities;
- Survey/Mapping and Habitat assessment;
- Research: Conduct and publish ecological research on relationship between prey density, den availability and density of females in different habitat types to determine measures of habitat quality; Investigate the demographics of Spotted-tailed Quoll populations and use results to develop viability models for quoll populations; and,

- Survey/Mapping and Habitat assessment: Conduct field and community surveys for the Spotted-tailed Quoll in areas where its distribution is poorly known. Areas identified for large-scale urban development (i.e. Far north coast, Hunter) and coastal reserves should be the highest priority.

**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. The proposed activities will involve the operation of three KTPs and one proposed KTP likely to affect the Spotted-tailed Quoll. These include: 'Clearing of Native Vegetation', 'Bushrock Removal' and 'Removal of dead wood and dead trees' and 'Loss of Hollow-bearing trees' (proposed Key threatening process). The Spotted-tailed quoll is listed as a threatened species and is identified as being adversely affected by the clearing of native vegetation, bushrock removal and removal of dead wood and dead trees. In addition, competition for food and predation by Foxes and Cats is listed as a threat to the Spotted-tailed Quoll.

The DECC lists a need to retain and protect large forested areas with hollow logs and rocky outcrops, particularly areas with thick understorey or dense vegetation along drainage lines in order to assist in the recovery of this species. The clearing of native vegetation, bushrock removal, the removal of dead wood and dead trees and the loss of hollow-bearing trees results in the direct removal of potential den sites, as well as sheltering and foraging habitat for both the Spotted-tailed Quoll and its prey species. The removal of habitat may result in greater risk of competition for food and direct predation, particularly from introduced Cats and Foxes.

**Conclusion**

Although the Spotted-tailed quoll has not been recorded within the Study Area, the species has been documented within the Locality and within the 10 km search area. The Proposal would clear 60.5 ha of native vegetation. The Proposal is likely to directly and indirectly impact on approximately 238.6 ha (3.6 per cent) of the potential foraging, sheltering and breeding habitat in the Locality.

The Proposal will result in the operation of numerous KTPs and threats to the species which will result in loss of key resources such as potential den sites, sheltering and foraging habitat for a local population. In addition, loss of prey species may occur, a factor that may increase risk of competition and predation, particularly to introduced predators. However, given the habitat within the Locality is of similar high quality, it is unlikely resources are limiting to create

such competition.

Potential habitat for the Spotted-tailed Quoll within the Locality is good quality and the Proposal is unlikely to result in significant fragmentation or isolation of this potential habitat. The Proposal would see the alteration to a creek line which quolls could potentially use to move through their range. However, the presence of other similar creek lines within the area is likely to decrease the impact of barrier effects from the Proposal. Spotted-tailed Quolls have a large home range and are able to move large distances within these ranges, often utilising multiple den sites.

Based on this information, it is **unlikely** that the Proposal would have a significant impact on the Spotted-tailed Quoll.

### Squirrel Glider

### *Petaurus norfolcensis*

The Squirrel Glider *Petaurus norfolcensis* is listed as a Vulnerable species on Schedule 2 of the TSC Act.

Within the Southern Rivers Region, the Squirrel Glider is known to occur in wet or dry sclerophyll forests, forested wetlands and grassy woodlands particularly those consisting of mature and mixed age *Eucalyptus* spp., such as ironbarks, box and bloodwoods (DECC Threatened Species Unit). Squirrel Gliders require abundant hollow bearing trees and a mixed understorey of flowering banksias and acacias (Quin 1995). Nightly movements are estimated as between 300 and 500 m. Home-ranges have been estimated as between 0.65 and 8.55 ha and movements tend to be greater for males than females.

Habitat for this species occurs within the Study Area in Ridgetop Woodland and Gully Forest habitat types. These habitat types include finer scale features such as mixed-shrub understorey which provide foraging habitat for Squirrel Gliders, as well as hollow-bearing trees which the species may use for nesting.

**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**

No Squirrel Gliders have been recorded within the Study Area; however, there are records of the species within a 5 km radius of the Locality (DECC Atlas of NSW Wildlife). The species' require a diverse midstorey and understorey for foraging and hollow-bearing trees for breeding. These habitat features are present in the woodland and forest habitats within the Study Area.



The Proposal is likely to modify and/or remove approximately 238.6 ha of potential habitat for this species. Clearing of Ridgetop Woodland and Gully Forest habitat is likely to reduce the availability of breeding resources (loss of hollow-bearing trees) within the Study Area. Squirrel Gliders have a tight social organisation and inhabit small home ranges suggesting they do not move across large distances and may have difficulty relocating and maintaining their breeding group. Considering the small home range, social organisation, dependence on hollow bearing trees and dense undergrowth of nectar bearing species, the Proposal could have a detrimental effect on any local population of Squirrel Gliders in the Subject Site.

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

An Endangered Population is defined under the TSC Act as ‘a population specified in Part 2 of Schedule 1’. There are two Endangered Populations of this species listed under the Act. The endangered populations are within the Pittwater Local Government Area (LGA) and the other within the Wagga Wagga LGA. The population local to this Proposal is not within either of these listed populations.

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

- i. the extent to which habitat is likely to be removed or modified as a result of the action proposed, and**
- ii. whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and**
- iii. the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the Locality**

Potential habitat for this species occurs within Ridgetop Woodland and Gully Forest fauna habitat types within the Study Area. These habitat types are widely distributed throughout the Locality (6,600 ha). The Proposal is likely to modify and/or remove approximately 238.6 ha (60.5 directly and 178.1 ha due to indirect impacts) of potential habitat for this species; this represents 3.6 per cent of the available habitat within the Locality.

The Woodland and Forest habitat types are continuous in the greater Locality and of similar quality to the habitat within the Study Area. As such, the Proposal is unlikely to cause significant long-term isolation or fragmentation of the habitat.

The Squirrel Glider habitat within the Study Area is considered to be in good condition, containing mixed Eucalypts; midstorey and understorey banksias and acacia species and hollow-bearing trees. Habitat in the Locality is also considered to be in good condition and while the Squirrel Glider has a small home range, they are estimated to be able to move considerable distances in a night. With gradual clearing being employed the removal and/or modification of 3.6 per cent of the potential habitat is unlikely to significantly affect the long term survival of the Squirrel Glider.

**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 or ecological communities. Under the TSC Act, the Director-General maintains a register of critical habitat. To date, no critical habitat has been declared for the Squirrel Glider (DECC 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 Squirrel Glider.

The DECC has identified seven priority actions to help recover the Squirrel Glider in NSW. Those most applicable to the Proposal include:

- Habitat management: Ongoing EIA - Advice to consent and planning authorities;
- Habitat management: Other: Ensure the largest hollow bearing trees (including dead trees) are given highest priority for retention in PVP assessments and other environmental planning instruments, or other land assessment tools;
- Recovery Plan Preparation: Single species; and,
- Survey/Mapping and Habitat assessment: Delineate boundaries of population to identify the extent to which populations are interconnected (to determine propensity to move across cleared land).

**Whether the action proposed 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. The proposed activities will involve the operation of two KTPs and one

proposed KTP likely to affect the Squirrel Glider. These include: 'Clearing of Native Vegetation', 'Removal of dead wood and dead trees' and 'Loss of Hollow-bearing trees'.

The clearing of native vegetation, the removal of dead wood and dead trees and the loss of hollow-bearing trees results in the direct removal of vital food resources, and the loss of potential sheltering and foraging habitat for the Squirrel Glider.

### Conclusion

The Proposal has the ability to impact the Squirrel Glider through clearing forest and woodland habitat, in particular the loss of potential nesting and breeding habitat (loss of hollow-bearing trees).

Although the Squirrel Glider has not been recorded within the Study Area, the species has been documented within the Locality. The Proposal is likely to remove and/or modify approximately 238.6 ha of potential habitat for this species. This represents 3.6 per cent of the suitable habitat for this species within the Locality (6,600 ha).

The Proposal will result in the operation of KTPs which will result in loss of key food resources as well as sheltering, and nesting habitat for a local population. While gradual clearing may be employed, Squirrel Gliders inhabit small home ranges suggesting they may have difficulty relocating as the development proceeds. It is possible that given these gliders' small home range, social structure and dependence on hollow bearing trees, a population inhabiting the Subject Site of Brennans Creek gully could be at risk of extinction. However, given potential habitat for the Squirrel Glider is continuous within the Locality and is considered to be good quality, the Proposal is unlikely to result in fragmentation or isolation of potential habitat for the species and is **unlikely** to have a significant impact on the long-term survival of the Squirrel Glider.

|                     |                          |
|---------------------|--------------------------|
| <b>Swift Parrot</b> | <i>Lathamus discolor</i> |
|---------------------|--------------------------|

The Swift Parrot *Lathamus discolor* is listed as Endangered under both the TSC and the EPBC Acts.

The Swift Parrot is a highly nomadic species that occurs in woodlands and forest in NSW from May to August (Higgins 1999). It migrates in response to food availability and seasonal changes (Higgins 1999). This species spends the winter in NSW (dependent on winter-flowering native trees for food (Shields and

Crome 1992)) and reeds in Tasmania during the warmer seasons (Higgins 1999).

The potential habitat for this species occurs in Gully Forest and Ridgetop Woodland habitat within the Study Area.

**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.**

This species has been recorded in the Study Area and within 10 km of the Subject Site. Potential habitat for this species occurs in the Ridgetop Woodland and Gully Forest habitat types which contain winter-flowering Gums (such as Blue-leaved Stringy Bark *Eucalyptus agglomerata*, and Narrow-leaved Red Ironbark *E. crebra*).

The Proposal is likely to remove and/or modify approximately 238.6 ha of potential habitat for this species. These winter-flowering *Eucalyptus* spp. are the most important habitat feature for the Swift Parrot in NSW. The Proposal would involve the removal of a small number of these potential feed trees. However, these species are widely distributed within similar habitat types throughout the Locality (6,600 ha).

Winter-flowering eucalypts are crucial for the survival of this species, as the Swift Parrot is entirely reliant on them during its wintering time in NSW. Some winter-flowering trees are likely to be removed for the Proposal. However given the extant of suitable habitat including feed trees in the Locality and mobility of this species it is unlikely the Proposal would place a viable population of Swift Parrots at risk of extinction. Furthermore this species is known to breed in Tasmania; hence the Proposal is unlikely to significantly impact the breeding habitat of this species.

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

An Endangered Population is defined under the TSC Act as ‘a population specified in Part 2 of Schedule 1’. At the present time there are no Endangered Populations of Swift Parrot listed under the TSC Act.

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

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

- ii. **whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and**
- iii. **the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the Locality.**

The Proposal is likely to remove and/or modify approximately 238.6 ha (60.5 directly and 178.1 due to indirect impacts) of potential habitat for this species. This potential habitat contains native vegetation that may provide the species with foraging opportunities. These habitats are widely distributed throughout the Locality (6,600ha). The Proposal will remove 3.6 per cent of the suitable habitat in the Locality.

The Proposal is unlikely to fragment areas of potential habitat for this species when the mobility of the species is considered. It is also unlikely that the Proposal will create a barrier to the movement of the species in the area or isolate portions of potential habitat for the Swift Parrot for the same reason.

The removal and or modification of 238.6 ha of potential habitat for this species' is unlikely to be considered significant given the mobility of this species and extant of suitable habitat within the Locality. Therefore it is unlikely the Proposal would affect the long-term survival of this species within the Locality.

**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 or ecological communities. Under the TSC Act, the Director-General maintains a register of critical habitat. To date, no critical habitat has been declared for the Swift Parrot (DECC 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 Swift Parrot.

**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 defined under Schedule 3 of the TSC Act. The Proposal will involve three KTPs and one proposed KTP. These are: 'Clearing of Native Vegetation', 'Removal of Dead Wood and Dead Trees' and

'Loss of Hollow-bearing Trees' (proposed KTP).

Clearing of native vegetation would reduce the availability of foraging resources for the Swift Parrot in the locality.

### Conclusion

The loss or modification of 3.6 per cent of potential habitat within the locality is unlikely to be a significant impact on the Swift Parrot, given the mobility and extent of potential foraging habitat within the locality and wider region. It is **unlikely** that the Proposal would have a significant impact on the Swift Parrot.

### Woodland Birds

Six species of woodland bird, listed under the TSC Act, are considered as a group in this assessment on the basis of similar habitat preferences and potential for impact. Bird species considered as woodland birds in this assessment are: Brown Treecreeper (eastern subspecies) *Climacteris picumnus victoriae*; Painted Honeyeater *Grantiella picta*; Diamond Firetail *Stagnopleura guttata*; Turquoise Parrot *Neophema pulchella*; Hooded Robin (southern subspecies) *Melanodryas cucullata cucullata* and Speckled Warbler *Pyrrholaemus sagittata*. All these species are listed as Vulnerable under the TSC Act. They inhabit a broad range of woodland and forest types although some have specialist food sources and different migration patterns and/or breeding requirements.

Suitable habitat for these species occurs within the Study Area and Subject Site in Upland Swamps, Ridgetop Woodland and Gully Forest fauna habitat types. The Study Area contains trees with hollows and a variety of foraging habitats including areas of mistletoe and grassy understorey.

**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.**

None of the six species were detected during current surveys or within the Study Area. The Brown Treecreeper, Diamond Firetail and Turquoise Parrot have been recorded within 10 km of the Subject Site.

Factors likely to disrupt the life cycle include the destruction of limited breeding sites such as hollow trees in the case of the Brown Treecreeper and Turquoise Parrot; the loss of suitable foraging areas and isolation and removal of habitat can disrupt the life cycle of these species. The Proposal is likely to remove and/or modify approximately 241 ha of potential habitat for these species. This represents a removal of 3.4 per cent of the broader distribution of woodland habitat types within the Locality (7,008 ha). These woodland species are highly

mobile and are likely to be capable of foraging in the Upland Swamp, Ridgetop Woodlands and Gully Forests within the Study Area and surrounding region. It is therefore unlikely that a viable local population will be placed at risk of extinction by the Proposal.

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

An Endangered Population is defined under the TSC Act as ‘a population specified in Part 2 of Schedule 1’. At the present time there are no Endangered Populations of Brown Treecreeper (eastern subspecies), Painted Honeyeater, Diamond Firetail, Turquoise Parrot, Hooded Robin (southern subspecies) or Speckled Warbler listed under the Act.

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

- i. the extent to which habitat is likely to be removed or modified as a result of the action proposed, and**
- ii. whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and**
- iii. the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the Locality.**

Potential habitat for the Brown Treecreeper (eastern subspecies), Painted Honeyeater, Diamond Firetail, Turquoise Parrot, Hooded Robin (southern subspecies) and Speckled Warbler occurs within the Study Area in the Woodland and Forest habitat types. The Proposal is likely to remove and/or modify 241 ha of potential habitat (60.5 ha directly and 180.5 ha due to indirect impacts) for these species. These habitats are widely distributed within the Locality (7008 ha). The amount of potential habitat to be removed represents approximately 3.4 per cent of suitable habitat within the Locality.

The Proposal will not isolate areas of habitat for these bird species as the Study Area is continuous with greater areas of potential habitat within the immediate vicinity of the Study Area. Furthermore all of these species can be considered highly mobile and likely to move throughout the local area.

The habitat within the Study Area is good quality; it has abundant tree hollows, bark and other vegetative structures such as mistletoe and grasses for

foraging and breeding habitat. These habitat features are represented within the Locality and are also considered to be in good condition. Therefore the removal and/or modification of 3.4 per cent is unlikely to impact the long term survival of any of these species in the Locality.

**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 or ecological communities. Under the TSC Act, the Director-General maintains a register of critical habitat. To date, no critical habitat has been declared for the Brown Treecreeper (eastern subspecies), Painted Honeyeater, Diamond Firetail, Turquoise Parrot, Hooded Robin (southern subspecies) or the Speckled Warbler (DECC 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 for the Brown Treecreeper (eastern subspecies), Painted Honeyeater, Diamond Firetail, Turquoise Parrot, Hooded Robin (southern subspecies) or the Speckled Warbler. In addition, the Proposal is not inconsistent with any of the objectives or actions of any of the Priority Actions Statements (PAS) for these species or current threat abatement plans.

**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. The proposed activities will involve the operation of the KTP 'Clearing of Native Vegetation' and the proposed KTP 'Loss of Hollow-bearing Trees'. Clearing of native vegetation is identified as a threat for all these species of woodland birds. Loss of hollow-bearing trees is identified as a threat to the Turquoise Parrot and the Brown Treecreeper.

**Conclusion**

The Proposal is likely to remove approximately 241 ha of potential habitat for these Woodland bird species. This represents 3.4 per cent of the suitable habitat within the Locality. Given the abundance of suitable habitat surrounding the area and the mobility of these species it is considered **unlikely** the Proposal will have a significant impact upon the Brown Treecreeper; Painted Honeyeater; Diamond Firetail; Turquoise Parrot; Hooded Robin or the Speckled Warbler.



### 9.3 Comparison of Impact Assessment With Previous Studies

The project has been previously assessed in the *Dendrobium Coal Project Species Impact Statement* (Biosis Research 2001a). This previous assessment included the proposed developments at West Cliff, Dendrobium Areas 1-3, Nebo and Kemira Valley. The current study assesses potential impacts of the proposed West Cliff Stage 3 Coal Wash Emplacement Area only.

Since 2001, the procedures related to the assessment of threatened species in NSW, as listed in Schedules of the *Threatened Species Conservation Act 1995* (TSC Act), have changed. Prior to October 2005, Assessments of Significance were previously based on a regional and species-wide level of assessment, otherwise known as the Eight Part Test (NPWS 1996). The 2001 SIS (Biosis Research 2001a) was based on this regional and species-wide level of assessment.

Since October 2005 the Assessment of Significance has been referred to the Seven Part Test and is based on an assessment of impacts to local populations of threatened species and local occurrences of Endangered Ecological Communities (DEC 2005%). Thus, the current study (this SIS) is based on an assessment of impacts to threatened species at a local level as opposed to a regional or species-wide level.

A *local population* is defined in DEC (2005%) as a population of a threatened species that occurs in the Study Area. In this SIS, the Study Area (the areas of direct and indirect impact) is the Stage 3 Emplacement and a 500 metre buffer around the Stage 3 Emplacement. Therefore, any population of a threatened species within the 500 metre buffer is defined as a *local population* in this study. This and other definitions are included in Section 1.1.

Table 1 below outlines the differences in the the outcomes of the Eight Part Tests (regional and species-wide level of assessment) prepared for the 2001 SIS (Biosis Research 2001a) and the Seven Part Tests (local level of assessment) prepared in this study (Biosis Research 2007b). This has resulted in *Persoonia hirsuta* and Rosenberg's Goanna being assessed as *significantly impacted* where previously they were not. The difference is a reflection of the changes in the assessment system between 2001 and 2007 and is not associated with any change in scale, process or design of the Proposal.

**Table 15: Comparison of significance assessment from 2001 SIS (Biosis Research 2001a) and this study (Biosis Research 2007b)**

| Species  | 2001 Impact Assessment Outcome  | 2007 Impact Assessment Outcome                              | Agreement |
|--|---|---|-----------|
| <b>Flora species assessed to be impacted significantly by the proposal</b> |   |   |           |
| <i>Persoonia hirsuta</i>   | DETECTED – habitat and individuals removed but no significant impact on population        | DETECTED – significant impact on local population level     | No        |
| <b>Fauna species assessed to be impacted significantly by the proposal</b> |   |   |           |
| Red-crowned Toadlet  | NOT DETECTED – significant impact on species and population level                         | NOT DETECTED – Significant impact on local population level | Yes       |
| Broad-headed Snake   | DETECTED – significant impact on population level   | DETECTED – Significant impact on local population level     | Yes       |
| Eastern Pygmy Possum   | NOT DETECTED – significant impact on species and population level                         | NOT DETECTED – Significant impact on local population level | Yes       |
| Rosenberg's Goanna   | NOT DETECTED – habitat present, but no impact based on large home range and high mobility | DETECTED – Significant impact on local population level     | No        |

## 10.0 ADDITIONAL INFORMATION

### 10.1 Qualifications and experience

Detailed curriculum vitae's for all staff members involved in the study are provided in Appendix 8.

### 10.2 Other approvals required for the development or activity

There are no other approvals relating to terrestrial flora and fauna required for the Proposal.

#### 10.2.1 *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act)

On 20 December 2001, the proposed Dendrobium underground coal mine was approved by the Commonwealth of Australia as a controlled action in respect to Sections 18 and 18A (Listed threatened species and ecological communities) of the *Environment Protection and Biodiversity Conservation Act 1999* (Commonwealth of Australia 2001). The West Cliff Colliery Stage 3 Coal Wash Emplacement Area is a component of the controlled action. Approval of the project was subject to five conditions which are summarised below:

1. Before clearing any native vegetation, BHPBIC must conduct a survey to identify any *Cryptostylis hunteriana* or *Caladenia tessellata* present in the area to be cleared.
2. BHPBIC must establish a monitoring program to establish whether Kembla Creek is used by Macquarie Perch *Macquaria australasica* for spawning.
3. If BHPBIC clear any vegetation which includes *Persoonia hirsuta*, the area must be revegetated to resemble the original vegetation community.
4. BHPBIC must take all reasonable measures to minimise the effect of the proposed action on the Giant Burrowing Frog *Heleioporus australasicus* in the vicinity of Sandy Creek.
5. BHPBIC must submit for the Ministers approval a plan for managing the impacts of the action on the Broad-headed Snake *Hoplocephalus bungaroides*. The plan must be implemented. No vegetation may be cleared as part of West Cliff Stage 3 Coal Wash Emplacement until the

plan has been approved by the Minister.

Conditions 1,3 and 5 have been addressed in this SIS. Conditions 2 and 4 do not apply to the West Cliff Stage 3 Coal Wash Emplacement.

### 10.3 Licensing Matters Relating to the Survey

Relevant licences and approvals for flora and fauna survey held by Biosis Research are:

- NSW *National Parks and Wildlife Act* 1974 - License Number S10318 to harm/trap/pick/hold/study protected fauna and native flora,
- NSW *Animal Research Act* 1985 – Certificate of Approval by the Animal Care and Ethics Committee of the Director-General of NSW Agriculture to conduct fauna survey work carried out as part of Environmental Impact Statements, Species Impact Statements and general wildlife research.

### 10.4 Section 110 (5) reports

Section 110(5) of the TSC Act states that

*“The requirements of subsections (2) and (3) in relation to information concerning the State-wide conservation status of any species or population, or any ecological community, are taken to be satisfied by the information in that regard supplied to the principal author of the species impact statement by the National Parks and Wildlife Service, which information that Service is by this subsection authorised and required to provide”.*

The information provided by the DECC in fulfilment of this requirement is available at <http://www.threatenedspecies.environment.nsw.gov.au/index.aspx>. This website provides profiles for threatened species, populations and ecological communities, and links to more detailed information.

Information provided by the DECC has been utilised in the preparation of this report and is cited where appropriate.

## 11.0 CONCLUSION

In accordance with the requirements of the Director General of DECC, a SIS has been prepared for the proposed West Cliff Stage 3 coal wash emplacement. The project has been previously assessed in the *Dendrobium Coal Project Species Impact Statement* (Biosis Research 2001a), although this report assessed the impacts of West Cliff in combination with other projects associated with the Dendrobium coal mine, including Dendrobium Areas 1-3, Nebo and Kemira Valley. Due to a change in the assessment process between these two documents (i.e. Eight Part Tests at a species level in 2001 compared with Seven Part Tests at a local population level currently), one species (Rosenberg's Goanna) previously assessed to not be significantly impacted has been determined to be significantly impacted in this document. The table below provides a comparison of the significance assessments for the five threatened species assessed to be significantly impacted by the proposal during this study with the outcomes of the 2001 SIS (Biosis Research 2001a).

| Species                  | 2001 impact assessment outcome  | Current impact assessment outcome                           | Agreement |
|--------------------------|---|---|-----------|
| <b>Flora</b>             |   |   |           |
| <i>Persoonia hirsuta</i> | DETECTED - significant impact on species and population level                             | DETECTED – Significant impact on local population level     | Yes       |
| <b>Fauna</b>             |   |   |           |
| Red-crowned Toadlet      | NOT DETECTED – significant impact on species and population level                         | NOT DETECTED – Significant impact on local population level | Yes       |
| Broad-headed Snake       | DETECTED – significant impact on population level   | DETECTED – Significant impact on local population level     | Yes       |
| Eastern Pygmy Possum     | NOT DETECTED – significant impact on species and population level                         | NOT DETECTED – Significant impact on local population level | Yes       |
| Rosenberg's Goanna       | NOT DETECTED – habitat present, but no impact based on large home range and high mobility | DETECTED – Significant impact on local population level     | No        |

### Flora Species

Three threatened plant species, *Acacia bynoeana*, *Persoonia hirsuta* and *Pultenaea aristate*, were recorded in Exposed Sandstone Scribbly Gum Woodland and Sandstone Gully Peppermint Forest within the Study Area. Seven

Part Tests concluded that the Proposal would have a significant impact on a local population of *Persoonia hirsuta* only.

Potential habitat for a further 11 threatened species also occurs within the Study Area, these are; *Acacia baueri* ssp. *aspera*, *Astrotricha crassifolia*, *Boronia deanei*, *Cryptostylis hunteriana*, *Darwinia peduncularis*, *Eucalyptus camfieldii*, *Epacris purpurascens* var. *purpurascens*, *Grevillea parviflora* ssp. *parviflora*, *Gyrostemon thesioides*, *Leucopogon exolasius* and *Pommaderris adnata*. Seven Part Tests for these species concluded that the Proposal was unlikely to cause significant impacts on these species.

### **Fauna Species**

Of the 39 threatened animal subject species eight species were recorded in the Study Area, either during this study or during previous studies conducted by Biosis Research. These are the Powerful Owl, Gang Gang Cockatoo, Common Bent-wing Bat, Large-footed Myotis, Grey-headed Flying-fox, Koala, Broad-headed Snake and Rosenberg's Goanna. Seven Part Tests concluded that the Proposal would have a significant impact on a local population of the Broad-headed Snake, Eastern Pygmy Possum, Red-crowned Toadlet and Rosenberg's Goanna.

It is possible to minimise the disturbance caused by the construction phase of the project, and safeguards to reduce the impacts on threatened species habitats and from weed invasion from this process are described and summarised in Section 8.1 (Ameliorative Measures).

### **Endangered Ecological Communities**

No currently listed Endangered Ecological Communities occur within the Study Area.