Olsen Consulting Group Pty Ltd

**Appendices I - II**

# ENVIRONMENTAL ASSESSMENT

## Illawarra Coal Seam Gas Exploration Drilling
## &
## Gas Monitoring Program

## APEX Energy NL

**March 2009**

# APPENDIX I

(No. of pages excluding this page = 20)

**Assessment and Management of Water-related Impacts: Illawarra Coal Seam Gas Exploration Program, September 2008**

**Ecoengineers Pty Limited**

---

# ASSESSMENT AND MANAGEMENT

# OF WATER-RELATED IMPACTS

# ILLAWARRA COAL SEAM GAS

# EXPLORATION PROGRAM

**for**

**APEX ENERGY NL**

**SEPTEMBER 2008**

ECOENGINEERS Pty Ltd
9 Sunninghill Circuit
Mount Ousley NSW
Australia 2519
Tel: 61 2 4227 4174 Fax: 61 2 4227 5154
www.ecoengineers.com
ABN 74 078 666 510

| |
|---|
| **PROJECT: Apex Energy NL Methane Exploration Program** |
| **TITLE: Assessment and Management of Water-Related Environmental Impacts Illawarra Coal Seam Gas Exploration Program.** |
| **DOCUMENT REFERENCE NO: 2008/09B** |

| | |
|---|---|
| **PROJECT MANAGER:** S. Short | **FILE: Water Impacts Assessment Apex Energy Methane Drilling Program Rev2.doc** |
| **SPELL CHECK BY:** S. Short | **SUBJECT: Apex Energy** |

| **Document Details** | | **Preparation & Self Check** | **Independent Review By:** | **Corrective Action** | **Approved By:** |
|---|---|---|---|---|---|
| **REVISION** | **Name:** | Joseph Cairns | D. Olsen, Chris Rogers | S. Short | S. Short |
| **FINAL** | **Date:** | 01/10/08 | 24/10/08 | 15/01/09 | 15/01/09 |
| | **Signature:** | | D. Olsen 15/01/09 | | |
| Reviewers Comments: | | | | | |

# TABLE OF CONTENTS

## LIST OF FIGURES

## LIST OF TABLES

# 1. INTRODUCTION

Ecoengineers Pty Ltd ('Ecoengineers') was engaged by Apex Energy NL ('Apex') to provide an assessment of potential water related impacts associated with the proposed drilling of 20 exploration boreholes in the Woronora Plateau region of the Southern Sydney Basin Coalfield.

In this region, Apex holds Petroleum Exploration Licences (PEL) 442 and 444, for which the defined areas are outlined in **Figure 1.1**. **Figure 1.1** also shows the location of Consolidated Coal Lease Number 703 (CCL 703), the area for which Apex has a joint venture with Metropolitan Collieries Pty Limited ('Metropolitan') to extract and utilise waste coal mine and coal seam gas.

Within the areas outlined by **Figure 1.1**, preliminary borehole locations were selected to give a representative coverage of the area under exploration. These locations are identified in **Figure 1.2** below, though it is noted that some of those locations have changed slightly following on site inspections and preliminary assessment of each site in terms of underlying coal workings. The original tentative locations of boreholes were partly flexible in order to allow for relocation to avoid unacceptable environmental impacts without jeopardising the success of the exploration program.

The proposed drill holes are proposed to be one of four types:

- Open – a "rotary drill hole", drilled with an air drilling rig. Drilled using a large rig, generally using compressed air for drilling production sized holes. Open holes are to be used for goafed areas.
- Cored (unmined) – a "diamond drill hole", drilled with a diamond impregnated drill bit. Uses a smaller drilling rig for drilling exploratory core holes in unmined areas to assess the gas content of deeper seams.
- Cored (pillar) – as above but with the hole targeted on a pillar in a mined area. These holes will be drilled to below the workings level with the large open hole drilling rig, then cored with the smaller rig. This is in order to avoid possible problems regarding the precise position of the pillar and whether it is still solid or collapsed.
- Precollar cored – a cored hole with the top of the hole drilled with an air rig. To be used for drilling beyond goafed areas.

Coring rigs are smaller, truck-mounted rigs with a gross vehicle weight under 20 t. Either excavated sumps or above ground tanks are required in order to enable the recirculation of drilling fluid.

The larger air rigs are also truck mounted, but with a gross weight of around 35 tonne, and require a larger operations area.


**Figure 1.1: Exploration License Areas for Apex Energy NL Illawarra Coal Seam Gas Project.**

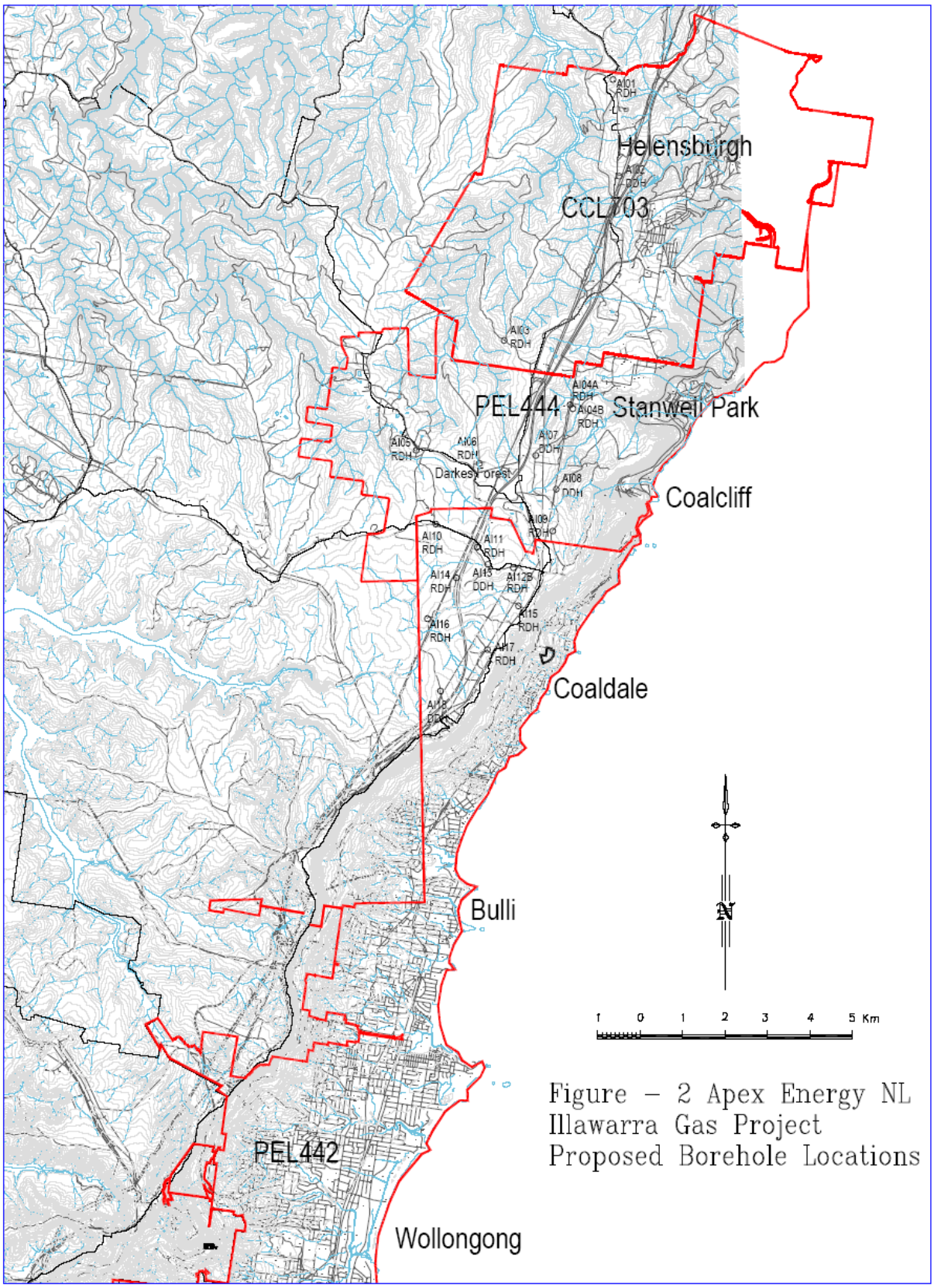



**Figure 1.2: Apex Energy NL Illawarra Gas Project Proposed Borehole Locations.**

It is proposed that each borehole will be drilled to 50 m below the base of the Woonona Seam so that the gas potential in this seam and each of the overlying seams (all of which are shown in **Figure 1.3 below**) can be determined. In addition, the commercial potential of gases accumulated in goafed workings (predominantly of the Bulli Seam) will also be determined.

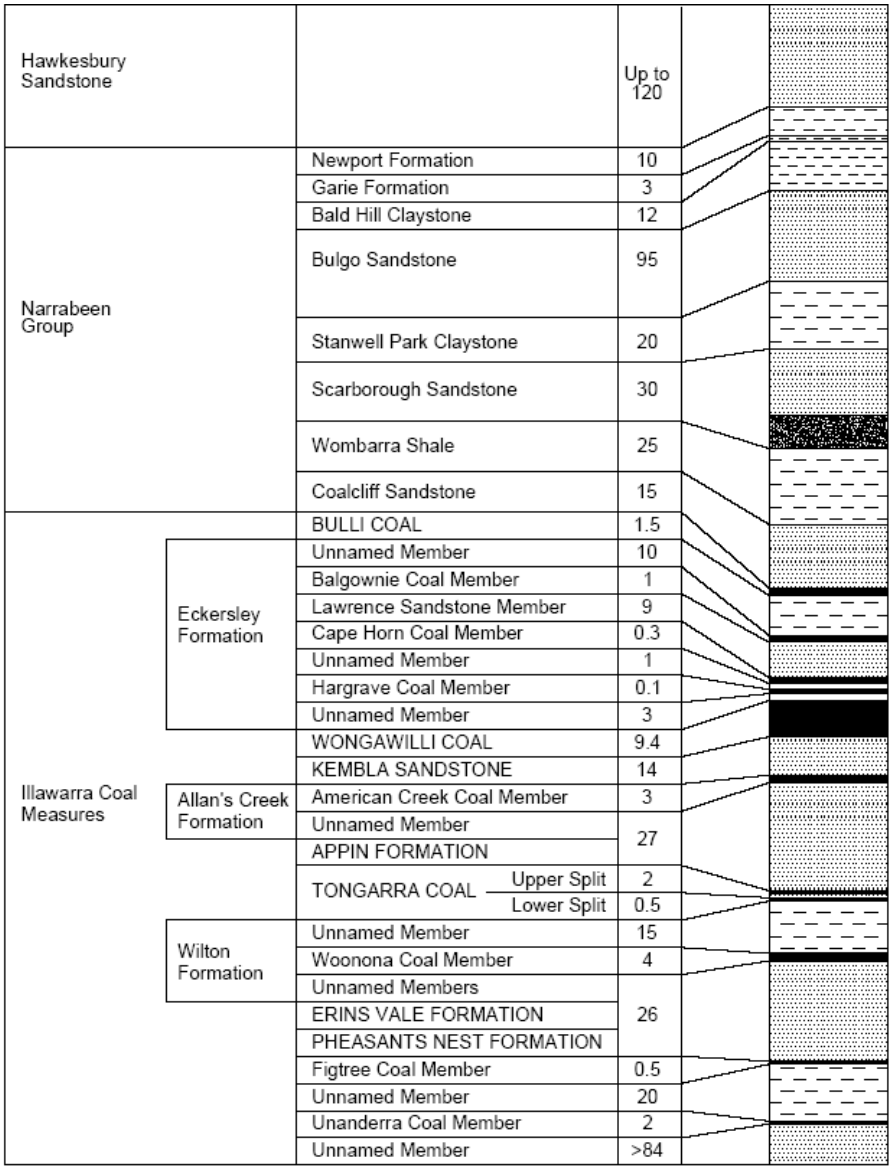



**Figure 1.3: Generalised Lithology of the Southern Coalfield.**

Core drilling requires the use and circulation of drilling fluid. Apex does not intend to use additives in drilling fluids, but it is possible that a potassium chloride (KCl) may be needed, typically at about a 5% w/v loading, to provide clay stability.

Naturally, in addition to management of drill fluid and any produced groundwaters, site stormwater management is also carefully considered for each site.

# 2. THE STUDY AREA

Over 2 – 4 September 2008, each of the 18 proposed drill sites shown in **Figure 1.2** above were visited, and detailed water-related environmental assessments of the topography each site were made. In cases where the original proposed site coordinates were unsuitable due to a potential water-related environmental impact Apex Energy management were advised and the site was relocated to a nearby suitable area and the original site name was kept. In some cases, possible alternative site locations were also inspected e.g. site AI04, for which there are currently two potential alternative locations (AI04 A and B).

On site assessment of potential water related impacts involved:

1. examination of the local topography, noting all proximate drainage lines and main drainage direction;
2. investigation of any proximate hydrological features e.g. upland swamps or creeks;
3. assessment of any prior site disturbance i.e. excavations or soil scraping and baring to the area, inspection of soil type for erodibility; and
4. identification of any significant water-related features further down gradient of the proposed drill site.

For each site, geographic coordinates were recorded, and a photographic record made, with photographs showing the view looking in each compass direction from the proposed location of the borehole. Additional photographs were also taken of significant nearby features. In the individual sections below which discuss each site, locations are given in Map Grid of Australia (MGA) coordinates (zone 56), along with a brief description of the site and an aerial photograph taken using Google Earth (2008) satellite imagery software.

## 2.1 DRILL SITE AI01

Date of Inspection: 02/09/08

MGA coordinates:

Easting: 312790

Northing: 6218272

Hole Type: Cored

Workings: No workings in area

AI01 is situated within a partially rehabilitated quarry and within 100 m of a model airplane field, and there is thus a high level of prior disturbance. The proposed drill site is relatively clear of vegetation and slopes slightly to the east.

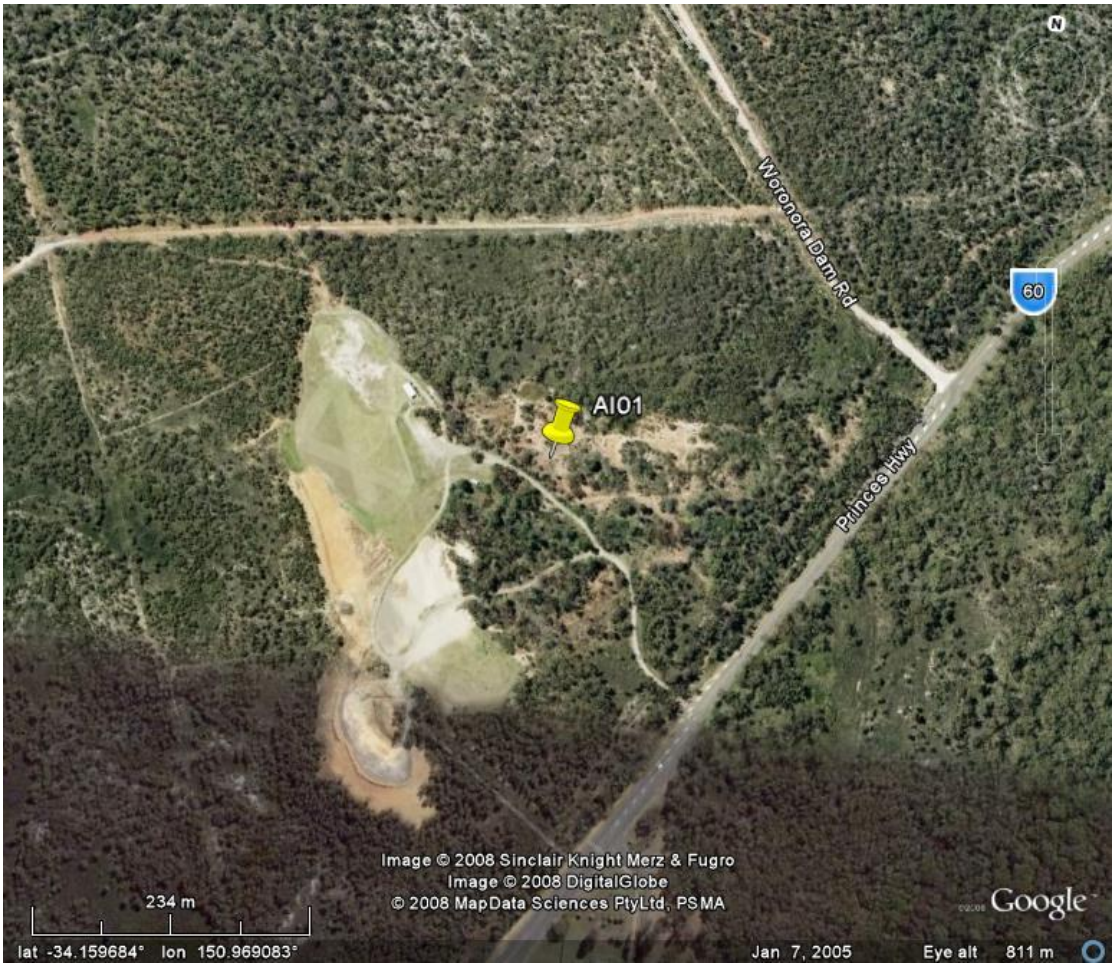



**Figure 2.3: Satellite Photograph of Site AI01.**

## 2.2 DRILL SITE AI02

Date of Inspection: 02/09/08

MGA coordinates:

Easting: 312936

Northing: 6215997

Hole Type: Cored

Workings: No workings in area

AI02 is located on crown land between the Princes Highway and the Southern Freeway and is approximately 50 m from high tension power lines. The proposed site is directly adjacent to the four wheel drive path where the vegetation is dense and dominated by banksias and small casuarinas. The site is relatively flat, although it drops off quickly to the south-east beyond the reach of the proposed site perimeter.

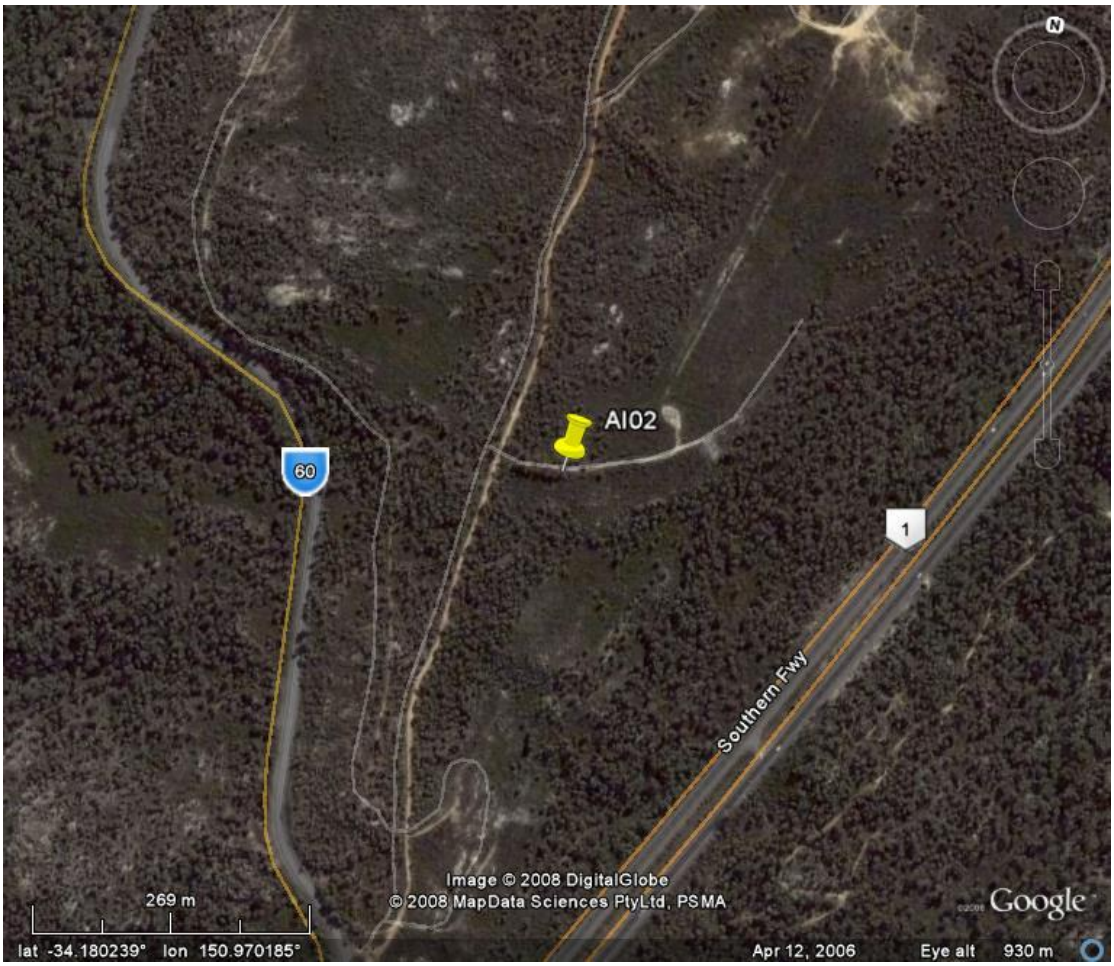



**Figure 2.4: Satellite Photograph of Site AI02.**

## 2.3 DRILL SITE AI03

Date of Inspection: 03/09/08

MGA coordinates:

Easting: 310223

Northing: 6212129

Hole Type: Cored

Workings: Adjacent to Metropolitan longwall area, unmined.

Site AI03 is within the SCA Woronora Special Area. It is a flat site adjacent to Fire Road 9H.

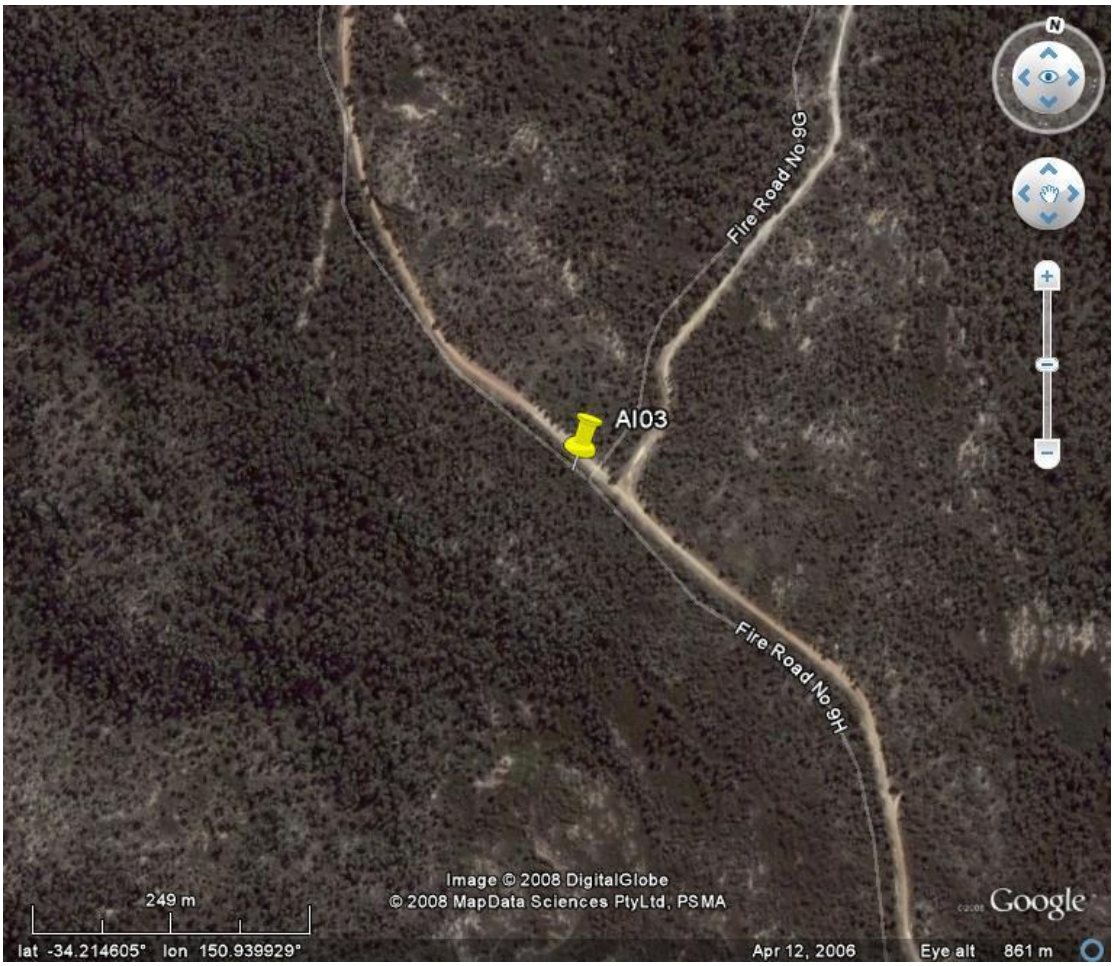



**Figure 2.5: Satellite Photograph of Site AI03.**

## 2.4 DRILL SITE AI04A

Date of Inspection: 03/09/08

MGA coordinates:

Easting: 311778

Northing: 6210611

Hole Type: Cored - pillar

Workings: Coalcliff

Site AI04A is within 50 m of an old vent shaft which has been backfilled. The proposed drill hole itself is situated over a pillar in the underlying workings, although the seam is expected to be at least partially collapsed. The drainage direction is to the north-northeast of the site, which would therefore drain to the roadway to the immediate east. Further to the north-east by some 225 – 275 m lies Stanwell Creek.

## 2.5 DRILL SITE AI04B

Date of Inspection: 03/09/08

MGA coordinates:

Easting: 311840

Northing: 6210520

Hole Type: Cored - pillar

Workings: Coalcliff

AI04B is located approximately 110 m south-south-east of AI04A. It is a steeper site (with a slope of approximately 10%, with more vegetation cover, and drains north-east.


**Figure 2.6: Satellite Photograph of Sites AI04A and AI04B.**

## 2.6 DRILL SITE AI05

Date of Inspection: 03/09/08

MGA coordinates:

Easting: 308151

Northing: 6209539

Hole Type: Open hole

Workings: Darkes Forest

AI05 is located approximately 200 m north of the boundary of Dharawal Nature Reserve. The site appears to have been previously cleared for a small quarry and natural revegetation is partially complete. Vehicular access is currently blocked-off by large sandstone boulders which will require temporary relocation. Drainage is to the

south. Maddens Creek lies approximately 250 metres due south of the site. A small pool which appears to have been excavated lies on the western side of the site.

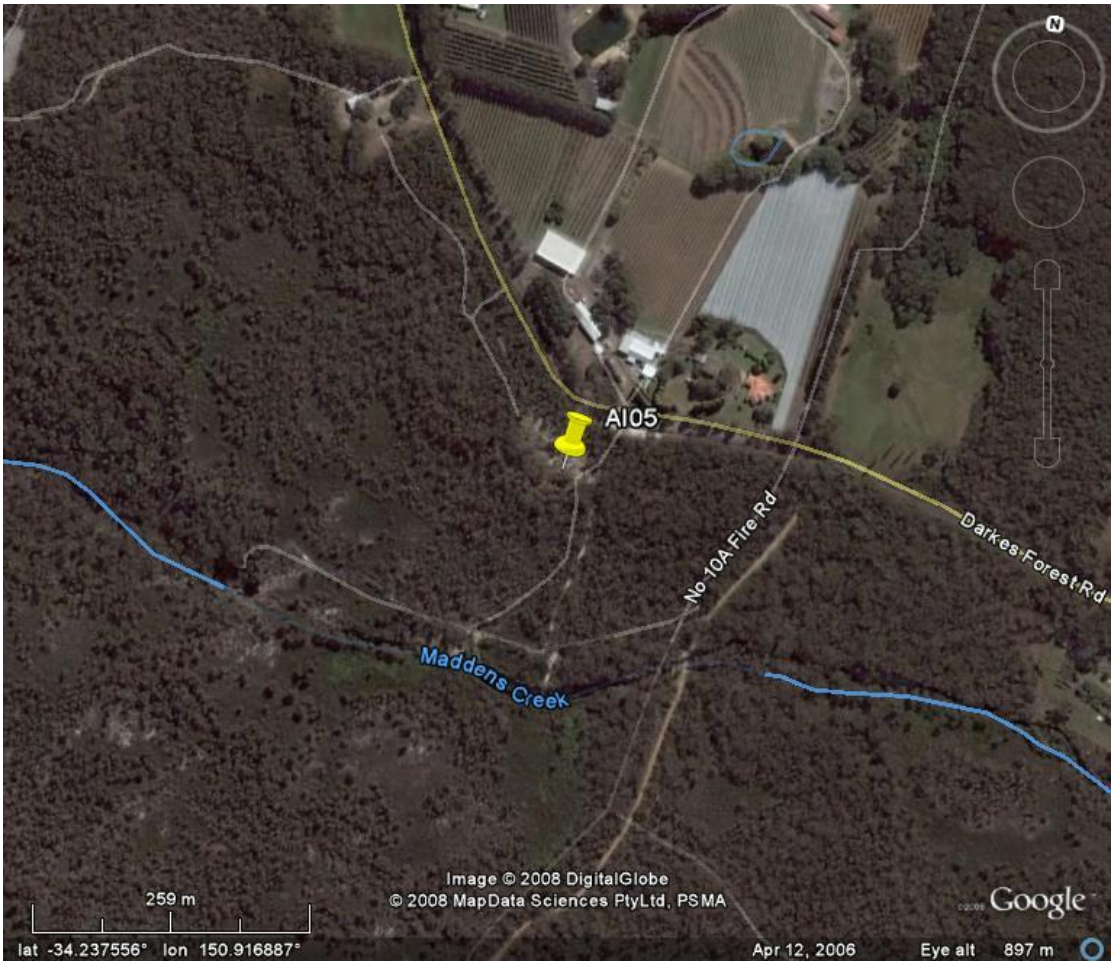



**Figure 2.7: Satellite Photograph of Site AI05.**

## 2.7 DRILL SITE AI06

Date of Inspection: 02/09/08

MGA coordinates:

Easting: 309639

Northing: 6209234

Hole Type: Cored - pillar

Workings: In area of Darkes Forest Mine first workings. Borehole should overlie a pillar.

Site AI06 is located approximately 50 m east of the former Darkes Forest Mine site offices. The site has already been cleared, and drains to the west, where a drainage line has been excavated to run north past the old offices. Upslope of the site, to the east and north-east are two large filled dams which could be used to supply drilling fluid makeup.

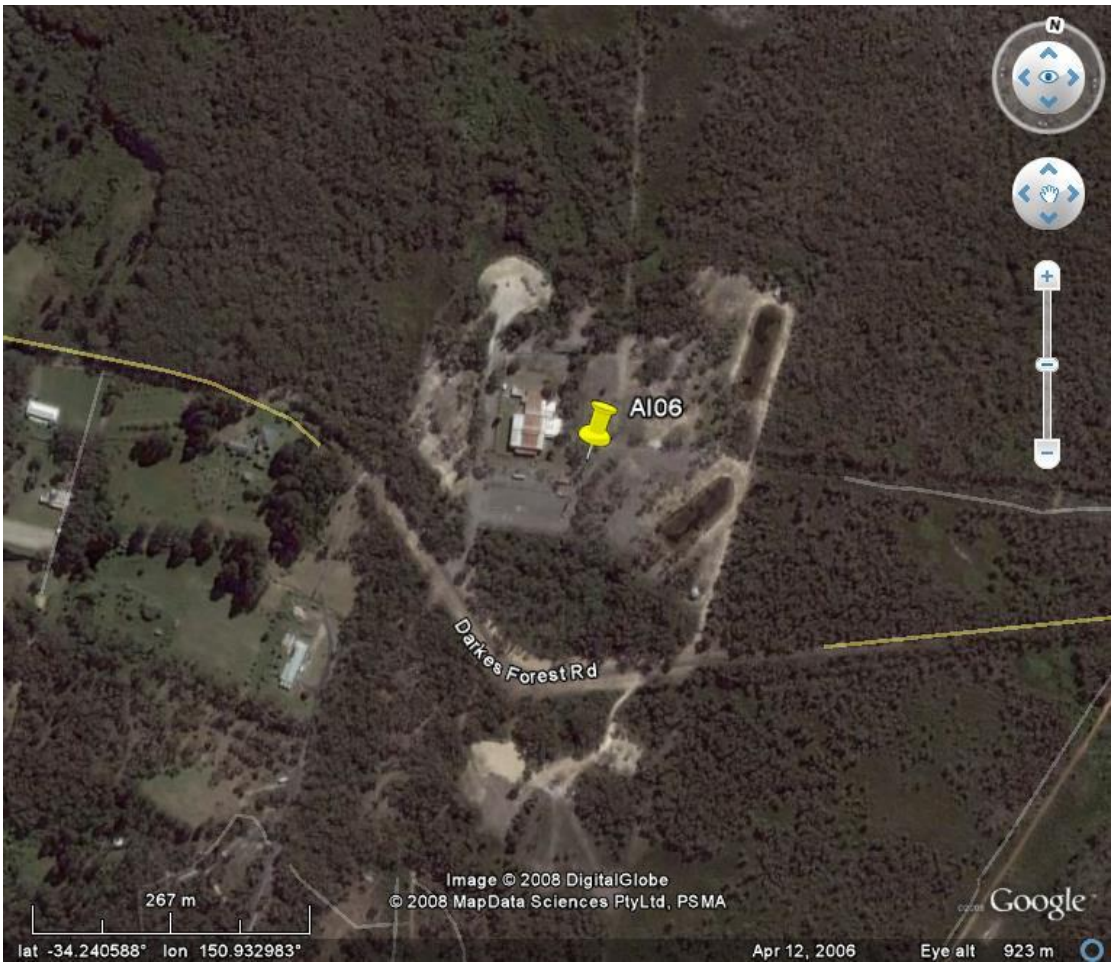



**Figure 2.8: Satellite Photograph of Site AI06.**

## 2.8 DRILL SITE AI07

Date of Inspection: 03/09/08

MGA coordinates:

Easting: 310966

Northing: 6209419

Hole Type: Open hole

Workings: Darkes Forest/Coalcliff - In extensive goaf area.

AI07 is adjacent to a road built up with Coal Wash Discard (CWD). Drainage direction from the site is north-northeast. An excavated drain runs along the western side of the road.

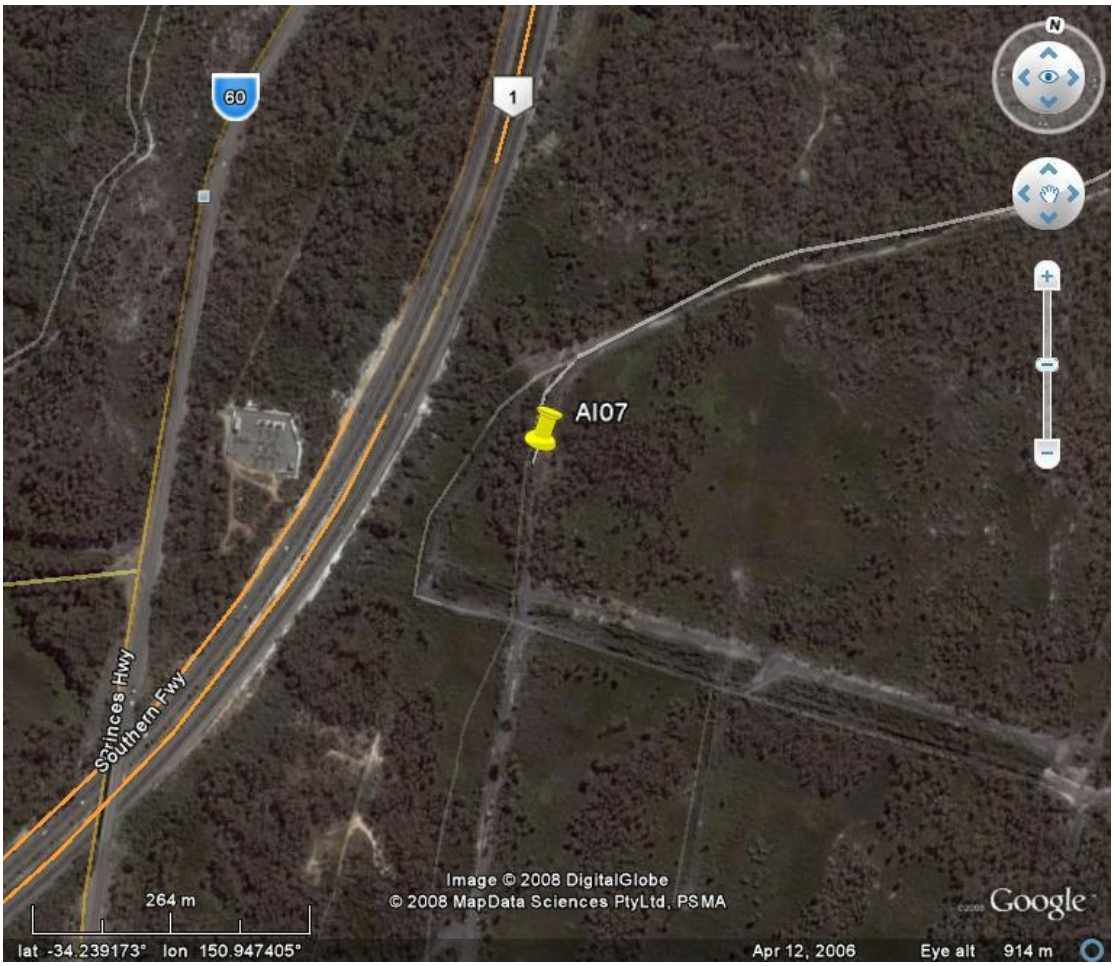



**Figure 2.9: Satellite Photograph of Site AI07.**

## 2.9 DRILL SITE AI08

Date of Inspection: 03/09/08

MGA coordinates:

Easting: 311449

Northing: 6208627

Hole Type: Open hole

Workings: Within Coalcliff goaf.

The area surrounding the proposed drill hole location for AI08 has already been partially cleared. The road adjacent to the site has also been built up with CWD. The area is very close to level, but site inspection indicates any drainage would be to the north.

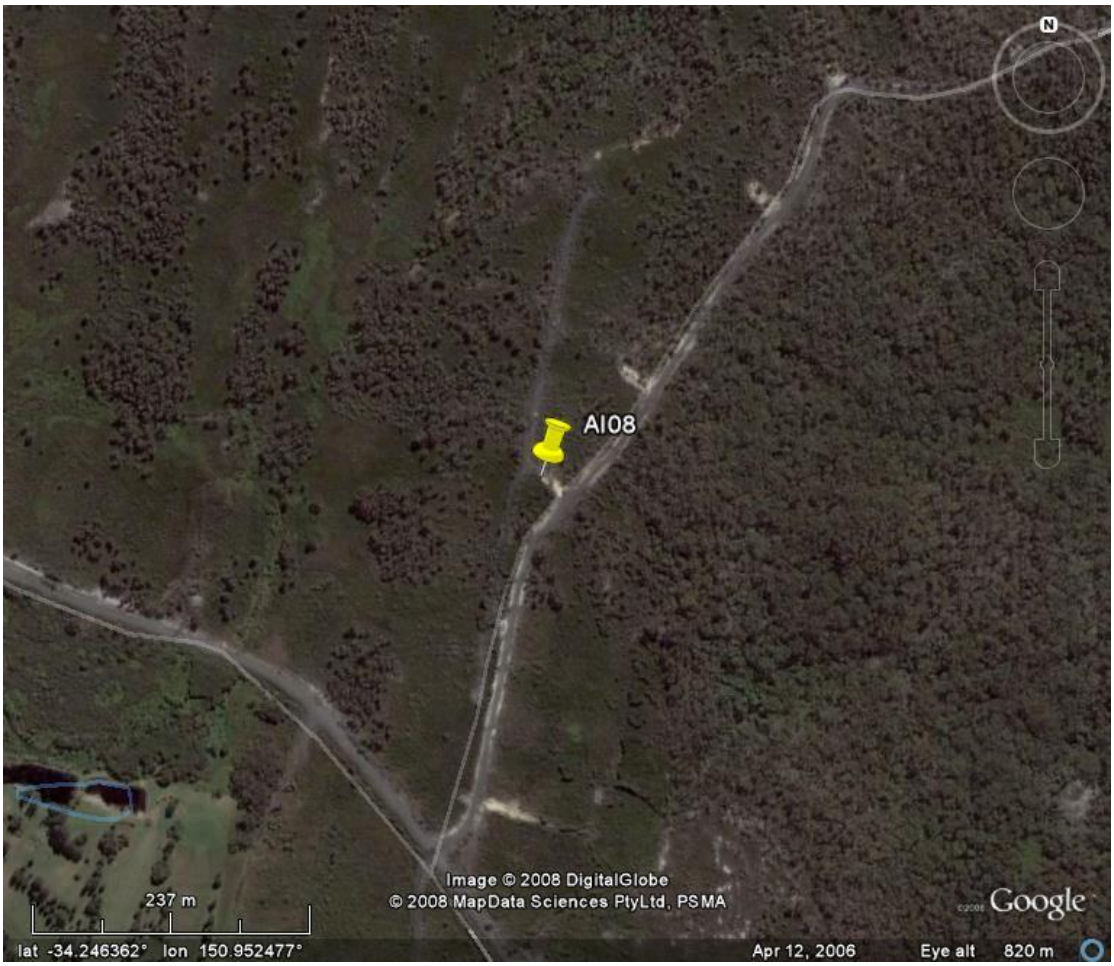



**Figure 2.10: Satellite Photograph of Site AI08.**

## 2.10 DRILL SITE AI09

Date of Inspection: 03/09/08

MGA coordinates:

Easting: 311366

Northing: 6207639

Hole Type: Open hole

Workings: Coalcliff goaf

AI09 is situated on flat ground, on the western side of a road built up with CWD. On the eastern side of this road an incised drainage channel drains northeast beside dense *Banksia* coverage.

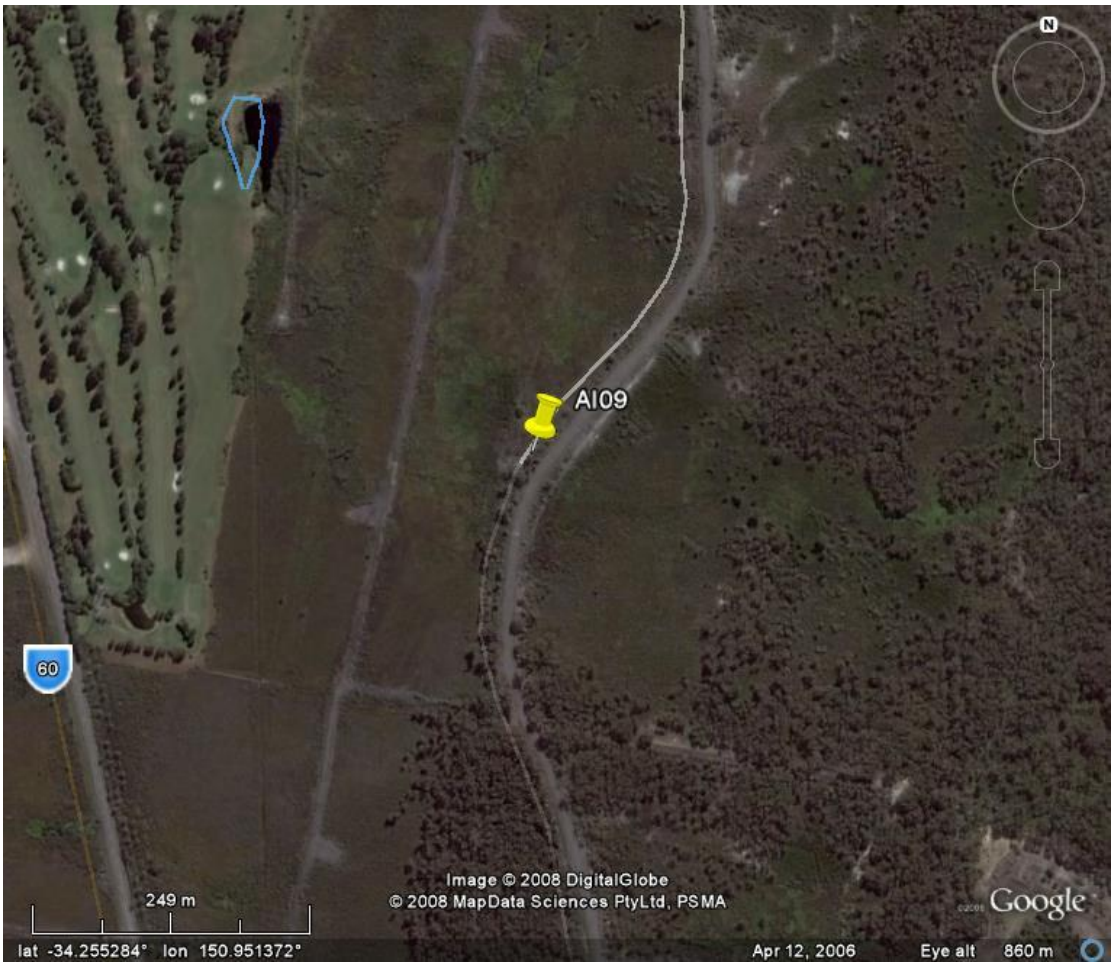



**Figure 2.11: Satellite Photograph of Site AI09.**

## 2.11 DRILL SITE AI10

Date of Inspection: 04/09/08

MGA coordinates:

Easting: 308612

Northing: 6207805

Hole Type: Open hole

Workings: South Clifton Colliery goaf.

AI10 is situated within the SCA Metropolitan special area, just south of O'Hares Creek area. The drainage direction is ESE.


**Figure 2.12: Satellite Photograph of Site AI10.**

## 2.12 DRILL SITE AI11

Date of Inspection: 02/09/08

MGA coordinates:

Easting: 309586

Northing: 6207257

Hole Type: Open hole

Workings: South Clifton goaf

Site AI11 is within the SCA Metropolitan Special Area, in an area that has been previously cleared. There is an excavated pool approximately 50 m southeast of the proposed site. The site drains to the north.

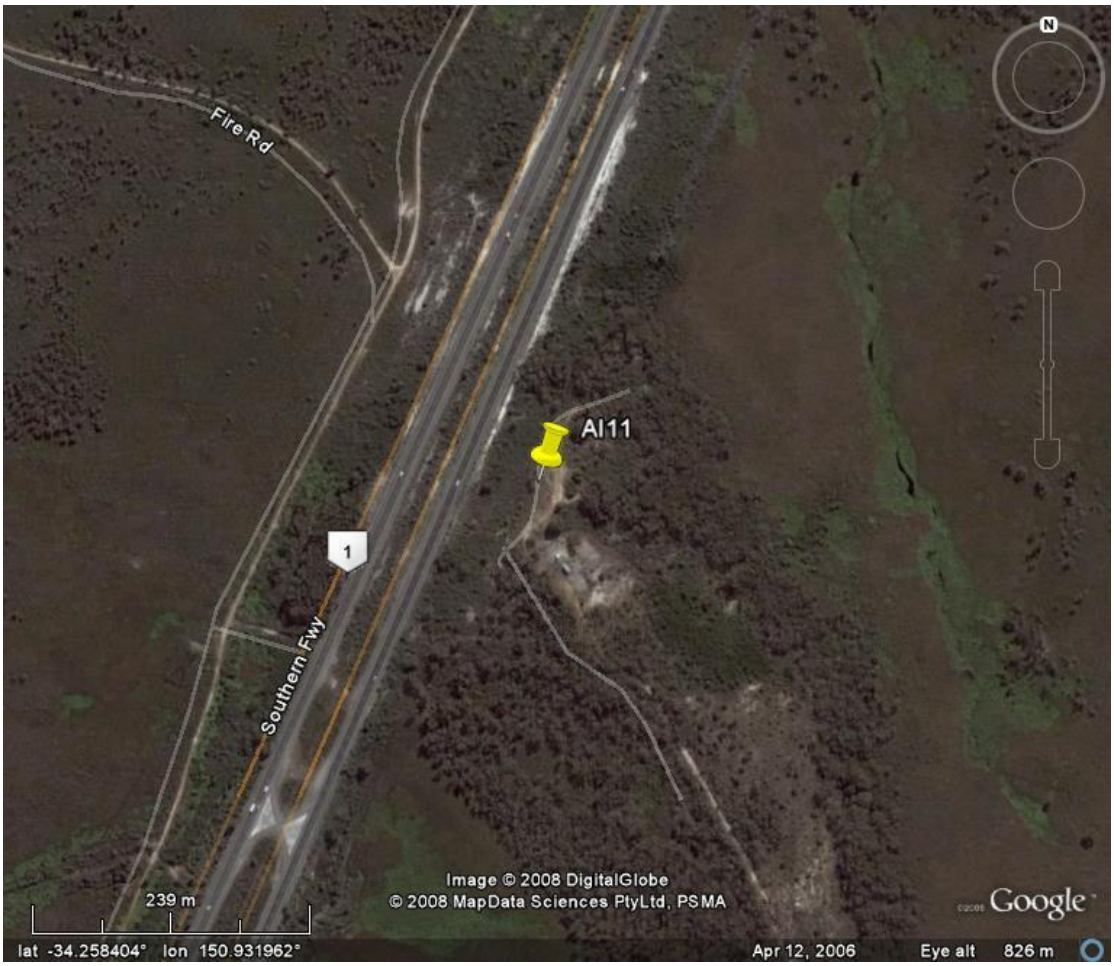



**Figure 2.13: Satellite Photograph of Site AI11.**

## 2.13 DRILL SITE AI12B

Date of Inspection: 02/09/08

MGA coordinates:

Easting: 310438

Northing: 6206778

Hole Type: Open hole

Workings: South Clifton goaf

AI12B is within the SCA O'Hares Creek Special Area. The proposed drill hole is on the southern side of the main access road, and just east of a path built up with CWD. The site is only slightly sloping, draining to the east.


**Figure 2.14: Satellite Photograph of Site AI12B.**

## 2.14 DRILL SITE AI13

Date of Inspection: 02/09/08

MGA coordinates:

Easting: 309839

Northing: 6206858

Hole Type: Open hole

Workings: South Clifton Goaf

AI13 is on the boundary of Metropolitan and O'Hares Creek SCA Special Areas. The site has been disturbed by prior clearing, and is approximately 50 m north of an electrical tower. Drainage direction is northwest, towards an excavated drain.

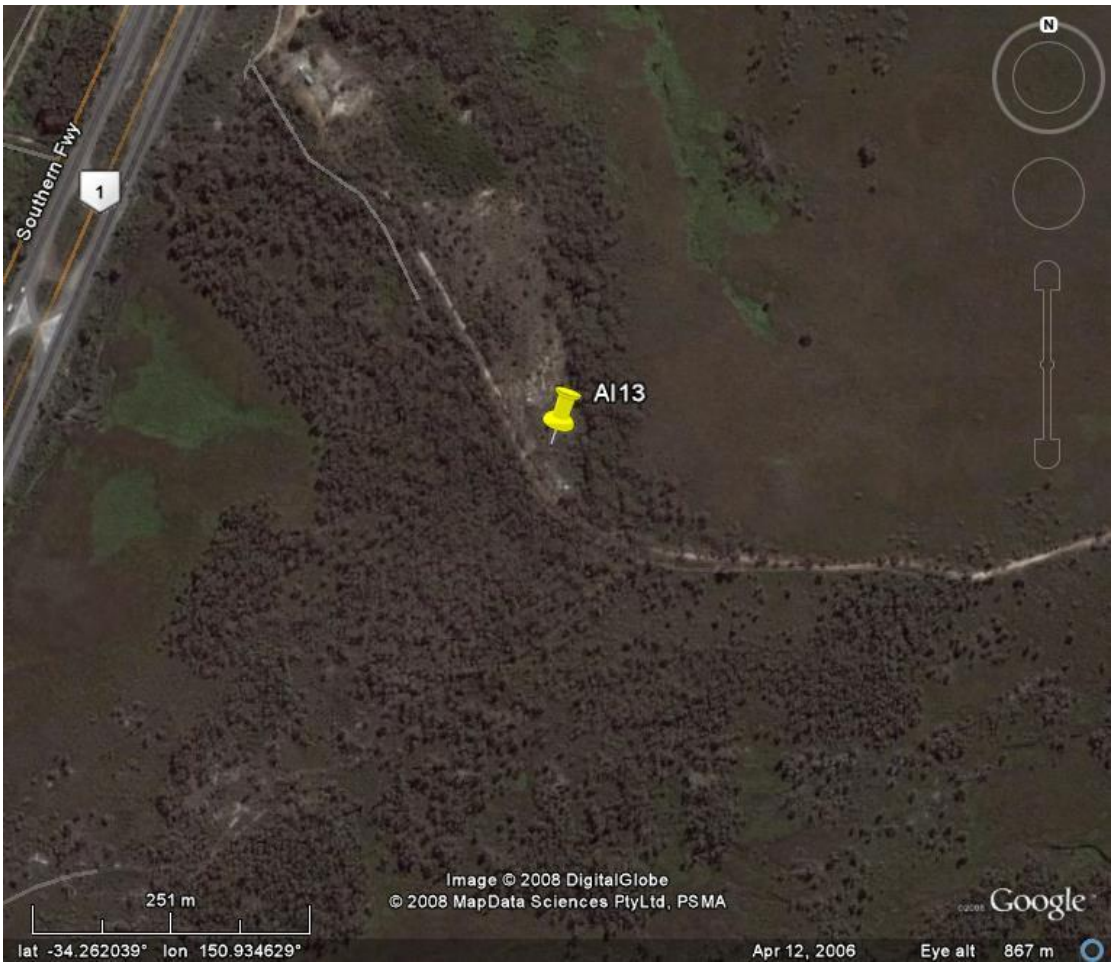



**Figure 2.15: Satellite Photograph of Site AI13.**

## 2.15 DRILL SITE AI14

Date of Inspection: 04/09/08

MGA coordinates:

Easting: 309099

Northing: 6206539

Hole Type: Open hole

Workings: South Clifton Goaf

AI14 is on the western side of the Southern Freeway, within the SCA Metropolitan Special Area. The site is bordered to the north and east by a single dirt road. Drainage is to the west.


**Figure 2.16: Satellite Photograph of Site AI14.**

## 2.16 DRILL SITE AI15

Date of Inspection: 04/09/08

MGA coordinates:

Easting: 310559

Northing: 6205879

Hole Type: Cored - pillar

Workings: Unmined area.

AI15 is within the SCA Metropolitan Special Area and south of an area of upland swamp. The proposed drill hole site is located on the southern side of the access road; which is built up with coal washery discard and has a concreted drain lying directly to the west of the site keeping downslope runoff off the road. Drainage direction is northeast, i.e. towards the nearby upland swamp.


**Figure 2.17: Satellite Photograph of Site AI15.**

## 2.17 DRILL SITE AI16

Date of Inspection: 04/09/08

MGA coordinates:

Easting: 308416

Northing: 6205579

Hole Type: Open hole

Workings: Unmined area

AI16 is a disturbed site on a small plateau. The plateau slopes to the northeast. Following the drainage line downslope leads to a small creek and upland swamp.

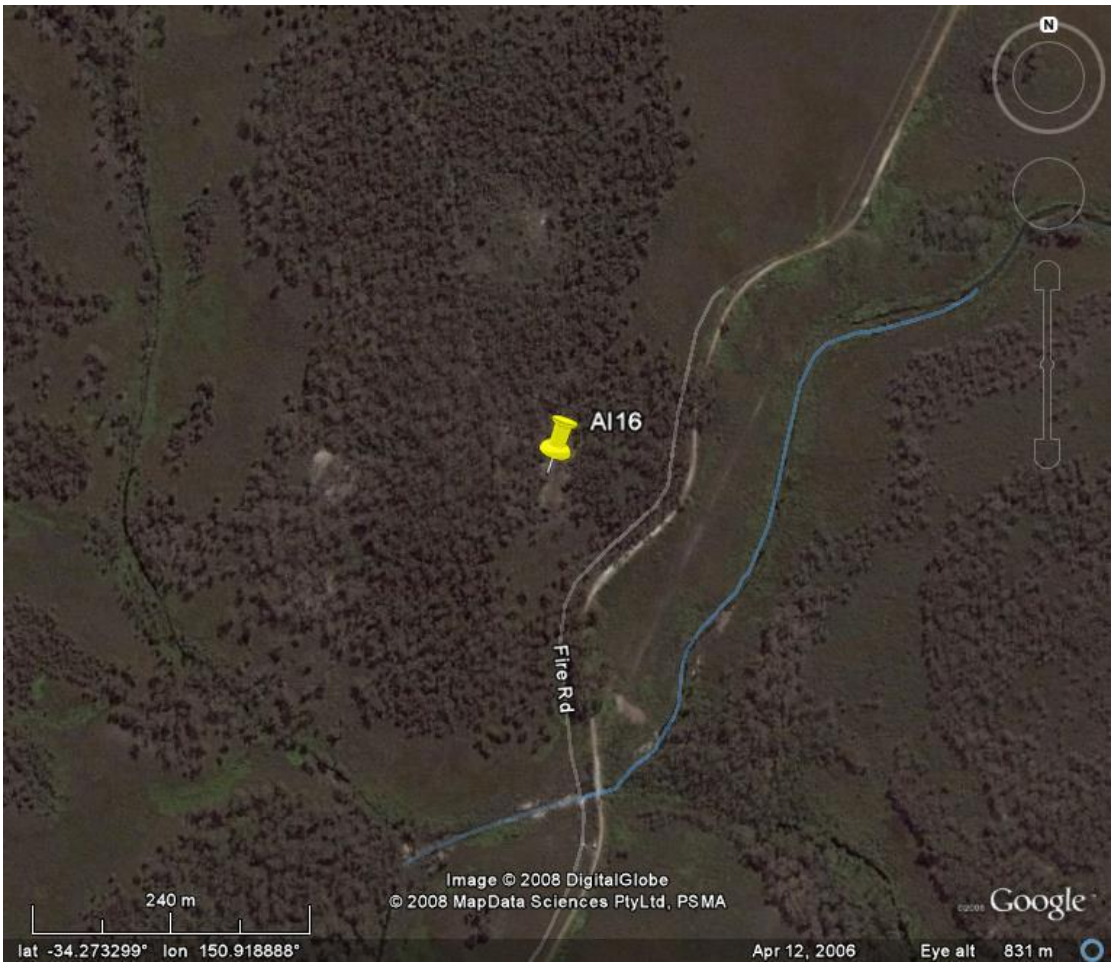



**Figure 2.18: Satellite Photograph of Site AI16.**

## 2.18 DRILL SITE AI17

Date of Inspection: 04/09/08

MGA coordinates:

Easting: 309829

Northing: 6204849

Hole Type: Open hole

Workings: North Bulli goaf.

AI17 is located within the SCA Metropolitan Special Area. There is a concrete lined drainage line approximately 50 m southeast of the site which directs water towards the proposed drill hole location. Drainage from the site would be northwest, towards an area of upland swamp.


**Figure 2.19: Satellite Photograph of Site AI17.**

## 2.19 DRILL SITE AI18

Date of Inspection: 04/09/08

MGA coordinates:

Easting: 308723

Northing: 6203877

Hole Type: Open hole

Workings: North Bulli goaf

AI18 is within the SCA Metropolitan Special Area. This site is located just east of the access road, and appears relatively undisturbed. Drainage is northwest toward the access road.


**Figure 2.20: Satellite Photograph of Site AI18.**

# 3. POTENTIAL WATER-RELATED IMPACTS

By reference to the National Water Quality guidelines (ANZECC&ARMCANZ, 2000), receiving waters in the study area are classed as 'upland rivers and streams'.

Expected groundwater qualities, and associated potential impacts for such produced water are assessed with reference to the National Water Quality guidelines in **Section 3.3** below.

## 3.1 STORMWATER RUNOFF

During and immediately following the clearing of each site, and prior to the commencement of drilling, there is a potential for significant topsoil erosion due to the site run-off and, in a few cases run-on from upslope.

Given the small size of the drilling sites, loss of significant sediment off-site, however, would be unlikely if there were adequate stormwater detention volume provided and, in the case of two sites with slope exceeding approximately 5%, adequate diversion of run-on from upslope.

## 3.2 DRILLING FLUID

In terms of water used for drilling, the only additive that may possibly be used is KCl, which may be needed to provide clay stability, in which case standard practice in the Southern Coalfield is to use a 5% weight: volume fluid.

Any impact related to the loss of KCl solutions into the surrounding environment would relate primarily to the high salinity of the water, which would have an electrical conductivity of approximately 68 mS/cm.

All drilling sites are located on the Woronora Plateau, an area characterized by extremely low soil salinities.

If such solutions were to be lost offsite, negative effects would likely be seen on any native vegetation receiving these waters, and potentially also in any nearby non-ephemeral receiving water, as this salinity greatly exceeds the default trigger value for the protection of 95% of all freshwater species in upland rivers, as set out in the national water quality guidelines (ANZECC&ARMCANZ, 2000).

## 3.3 PRODUCED GROUNDWATER

It is likely that, should any groundwater produced during drilling by the associated air-lifting be lost off-site there would be a potential for significant off site phyto- and ecotoxic effects.

Due to the possibility of there being significant concentrations of dissolved methane ($CH_4$) in some produced groundwater, any release off site, even if it this does not reach a receiving water, will likely cause a temporary growth of methanotrophic bacteria (which are ubiquitous) in the down slope drainage line.

It is known that there are metabolic products of such growth, 4-methyphenol (para-cresol) and possibly hydrogen sulfide which are both phyto- and ecotoxic (Ecoengineers, 1998). Should such water reach a nearby receiving water such compounds are also ecotoxic to aquatic species.

Some produced groundwaters would also have:

- elevated salinity; and
- concentrations of heavy metals,

which may also be phyto- and/or ecotoxic.

Expected groundwater qualities associated with the major strata proposed to be drilled through are presented below in **Table 3.1**. The values for the Hawkesbury and Bulgo Sandstones have been drawn from a recent University of Wollongong Honours research study over Dendrobium Mine Area 2 by Hammond (2007), whereas all other data have been drawn from Ecoengineers' substantial resources of past studies for local coal mining companies.

The values shown for the water quality parameters pH, Electrical Conductivity (EC; a measure of salinity), sodium (Na), aluminium (Al), iron (Fe), manganese (Mn), nickel (Ni), zinc (Zn) and arsenic (As) are based on past experience and are presented as means with probable error limits at the ± one standard deviation level.

All values are for filtered samples. All metal values are in mg/L. The default trigger values for the protection of 95% of all freshwater species in upland rivers, as set out in the National Water Quality guidelines (ANZECC&ARMCANZ, 2000), are shown in the final row.

**Table 3.1: Typical Groundwater Qualities Associated With Major Strata**

| Strata | pH | EC (µS/cm) | Na (mg/L) | Al (mg/L) | Fe (mg/L) | Mn (mg/L) | Ni (mg/L) | Zn (mg/L) | As (mg/L) |
|---|---|---|---|---|---|---|---|---|---|
| **Hawkesbury Sandstone** | 5.19 ±0.48 | 92.3 ±40.2 | 9.2 ±2.8 | 0.071 ±0.065 | 0.457 ±0.748 | 0.132 ±0.180 | 0.073 ±0.046 | 0.374 ±0.537 | |
| **Bulgo Sandstone** | 5.88 ±0.71 | 281 ±272 | 14.3 ±3.4 | 0.02 ±0.01 | 1.012 ±0.819 | 0.307 ±0.167 | 0.497 ±0.298 | 4.477 ±3.450 | |
| **Scarborough Sandstone** | 8.07 ±0.28 | 844 ±89 | 176 ±32 | 0.009 ±0.01 | 0.561 ±0.632 | 0.028 ±0.030 | | | 0.002 ±0.001 |
| **Wombarra Shale** | 7.60 ±0.23 | 1741 ±61 | 405 ±19 | 0.007 ±0.005 | 0.029 ±0.012 | 0.017 ±0.002 | | | 0.038 ±0.009 |
| **Wongawilli Seam** | 7.98 ±0.20 | 6605 ±7 | 2030 ±269 | 0.015 ±0.014 | 1.56 ±2.17 | 0.023 ±0.003 | | | |
| **Default Trigger Value for protection of 95% of all freshwater species in NWQG** | 6.5-7.5 | 30 - 350 | n/a | 0.055 (pH>6.5) | n/a | 1.9 | 0.011 | 0.008 | 0.013 |

As can be seen in **Table 3.1 above**, for each of the parameters where National Water Quality guidelines default trigger values are available, at least one of the groundwaters tabulated has an exceeding mean value.

In addition to ecotoxic effects arising from possible exceedance of National Water Quality guidelines default trigger values, there are potentially deleterious effects on Dissolved Oxygen (DO) in receiving waters resulting from the physical addition and mixing of anoxic groundwater with them.

High concentrations of dissolved iron (Fe), despite having no trigger value and manganese (Mn), sometimes present in these groundwaters, particularly those

associated with Bulgo Sandstone which can have substantial water storativity in some areas, can also reduce DO concentrations, as both metals consume DO when being oxidized to form insoluble oxyhydroxides. This effect also lowers the pH of the water (i.e. makes it more acidic).

# 4. SURFACE WATER AND SEDIMENT CONTROL.

## 4.1 SITE MANAGEMENT

Conceptual site layouts showing the general site requirements for Air (open) and Core drilling using both inground mud pits and above ground tanks are shown below by **Figures 4.1**, **4.2** and **4.3** respectively, being minor modifications of those previously presented in the preliminary Environmental Assessment by OEC (2007).

The modifications include the widening of the arc made by the earth spoil bund so that the angle drawn from the drill hole is a minimum of 90 degrees, i.e. 45 degrees on either side of the site's drainage line. Additionally, run-on diversion drains have been added to the layouts, as these are required for some sites to divert clean surface water into existing drainage lines and away from the drill site.

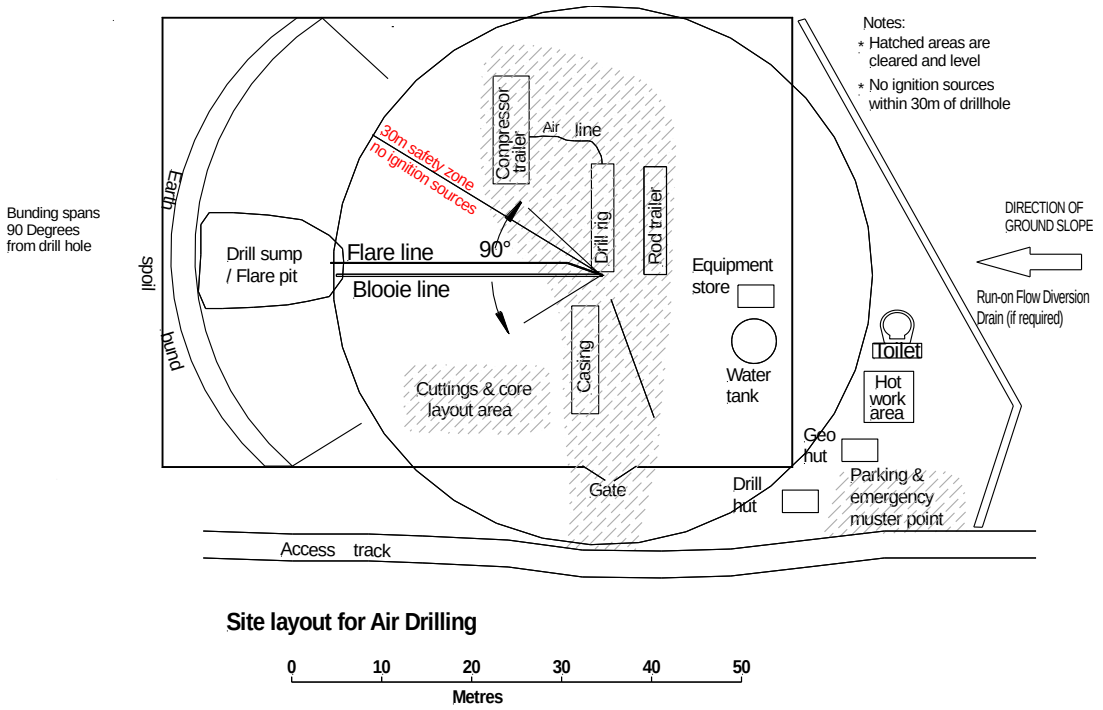



**Figure 4.1: Site Layout for Air Drilling.**

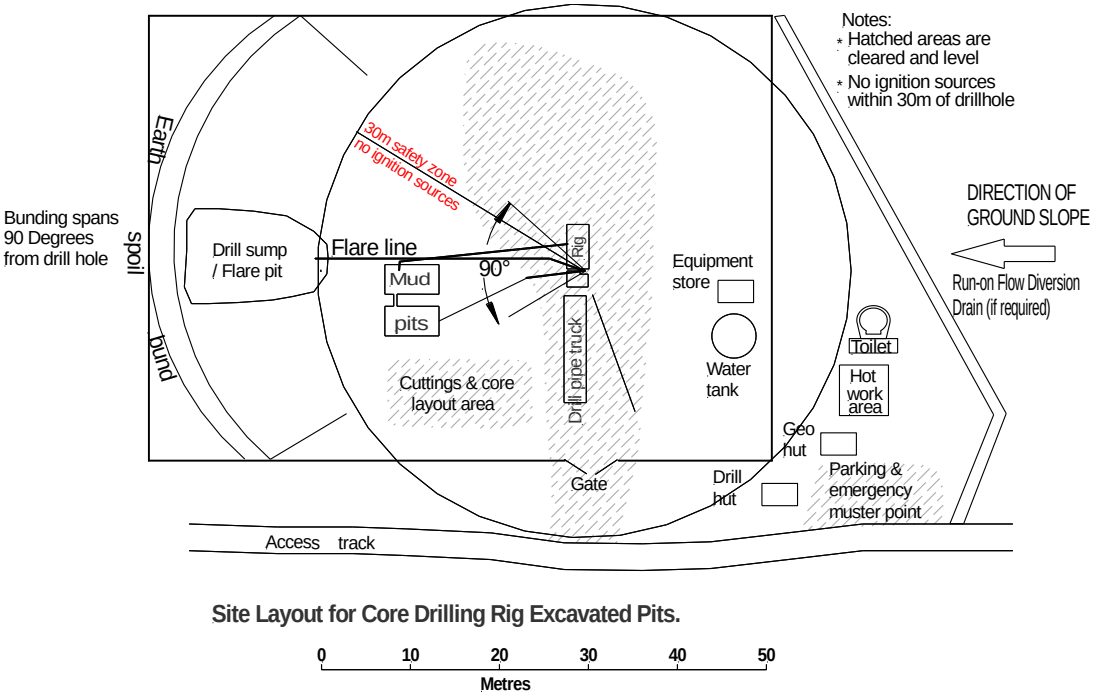



**Figure 4.2: Site Layout for Core Drilling Using In-Ground Fluid Pits.**

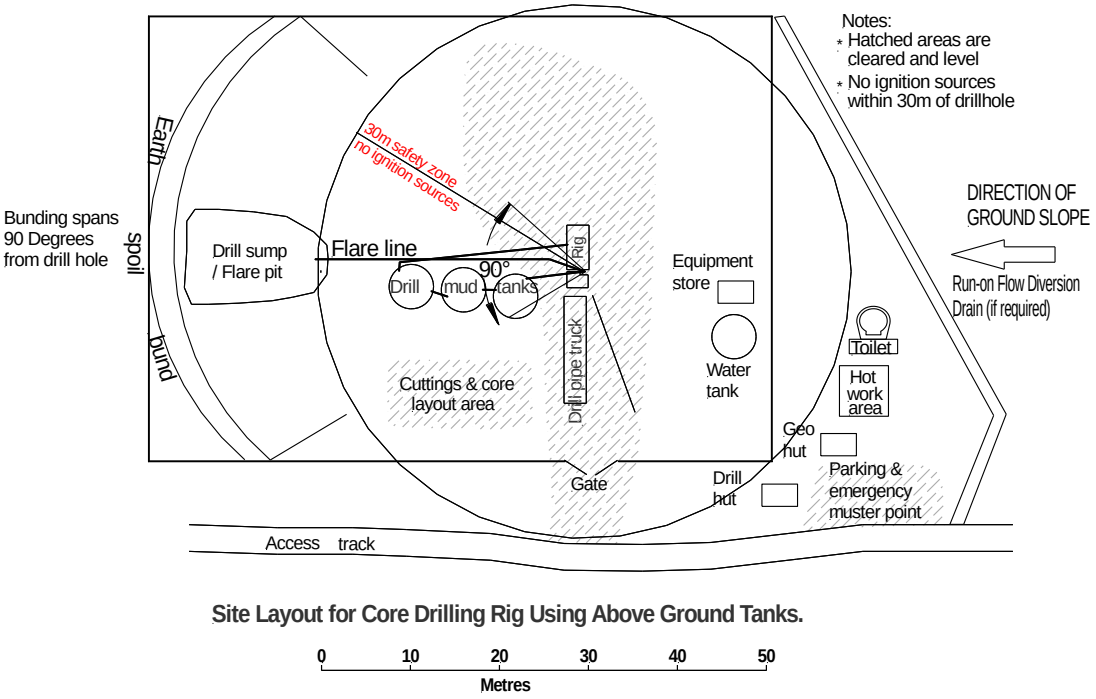



**Figure 4.3: Site Layout for Core Drilling Using Above Ground Tanks.**

As can be seen, the main components of the dirty water containment system are:

1. the excavated drill sump(s); and
2. the earth spoil bund.

For air drilling, excavated sumps would be approximately 10 by 7 m, and 2 m deep, i.e. having a total capacity of approximately 140 $m^3$.

For core drilling, should excavated pits be used for the recirculation of drilling fluids, two sumps would be required, each approximately 3 by 4 m and 2 m deep, i.e. a volume of approximately 25 $m^3$.

Henceforth, both excavated sump(s) and the volume of effective water storage behind the bund wall will be referred to collectively as the "bund", as in the DECC (2008) guideline document "Bunding and Spill Management".

Silt-stop fencing will be required on the down slope extremes of the sites area to control sediment prior to, and during the clearing of the site.

Following the clearing of the site, immediate construction of the bund is mandatory, as from this point on the risk of erosion under conditions of high rainfall events is high.

The downslope bund wall is required for:

1. the safe containment to site of any bore cuttings;
2. the safe containment to site of any excess drilling fluid confined to the drill sump or onsite tanks; and
3. disturbed site stormwater runoff and sediment settlement prior to off site release.

On-site storage of fuel, lubricants, potassium chloride and any other chemicals must be kept to a minimum and safely stored in bunded pallets, as the earthen bund will only be deemed required to be suitable for water and drilling fluid containment.

## 4.2 SITE-SPECIFIC WATER DETENTION REQUIREMENTS

As DECC (2008) specifies, the net capacity of a bund must be *at least* 100% of the net capacity of the largest tank, and it is recommended that an additional allowance be made so that the bund has sufficient capacity to cope with a significant storm.

Water onsite is most likely to be brought in by tanker. Generally such water tanks will have a net capacity of approximately 20 $m^3$, a volume which would be easily captured by the site's bunding system. The ability of the recommended bunding system to capture run-off following significant rainfall events is discussed below, where the calculations have been based on the volume contained by the bund wall, not including that of excavated drill sump(s).

Assuming an average slope of 5% (i.e. a fall of 0.5 m per 10 m horizontal run) for the majority of near-level sites, the required minimum bund wall height is 660 mm, and this is recommended as a minimum height for all but two sites.

This bund wall height means that the detention volume is approximately 190 $m^3$, allowing for capture of a 20-year, 6 hour rainfall event of total rainfall approximately 42 mm.

The steeper site AI04B, with an estimated slope of about 10%, will require bund walls of a minimum height of 1320 mm, giving a detention volume of approximately 380 $m^3$. This allows for the capture of a 20 year, 10 hour storm event of total rainfall approximately 84 mm.

Following the completion of operations at each site, water contained in site sumps and behind the bund wall will be allowed to settle.

The ultimate disposal of water collected in the sump will depend on its final quantity and quality, and will comply with DECC requirements. It has been assumed that waste drilling fluid will be removed off site by tanker in all cases.

**Table 4.1** below identifies the direction or location of the required downslope bund, the arc through which the bund should extend, the recommended minimum bund wall height and in two cases identifies where an upslope run-on diversion drain is also required.

**Table 4.1: Surface Water and Sediment Control Requirements for Each Site.**

| Site | Centre Point of Downslope Bund | Bund Arc Recommended | Minimum Bund Wall Height Required (mm) | Additional Surface Water Control Measures |
|---|---|---|---|---|
| AI01 | E | NE to SE | 660 | |
| AI02 | SE | E to S | 660 | |
| AI03 | Flat site. Bunding 5-10 m south of hole. | SE to SW | 660 | |
| AI04A | NNE | NNW to ENE | 660 | |
| AI04B | NE | N to E | 1320 | |
| AI05 | S | SE to SW | 660 | |
| AI06 | W | SW to NW | 660 | |
| AI07 | NNE | NNW to ENE | 660 | |
| AI08 | N | NW to NE | 660 | |
| AI09 | Bunding is required on the eastern side of the access road (hole is on western side) | N to E, with the northern edge of bund wall meeting the pre-existing drainage channel. | 660 | |
| AI10 | ESE | NNE to ESE | 660 | |
| AI11 | N | NW to NE | 660 | |
| AI12B | E | NE to SE | 660 | |
| AI13 | NW | W to N | 660 | |
| AI14 | W | SE to NW. Northern end of bund to meet the access road. | 660 | |
| AI15 | NE. On southern side of the road. | N to E | 660 | |
| AI16 | NE | N to E | 660 | |
| AI17 | NW of the hole. | W to N | 660 | Run-on diversion drain required to divert water from existing concreted drainage line away from site. |
| AI18 | NW | N to W, with the edge of the bund meeting the access road. | 660 | |

# 5. CONCLUSIONS AND RECOMMENDATIONS

## 5.1 CONCLUSIONS

The potential environmental effects of drilling fluid and produced groundwaters were considered in **Section 3** above.

Noting the default upper limit for salinity (EC) in local receiving waters is 350 µS/cm (ANZECC/ARMCANZ, 2000), immediate or eventual exceedances in local receiving waters would be likely if any significant volume of drilling fluid if containing 5% potassium chloride or most produced natural groundwaters greater than say 10 $m^3$ were to be discharged off-site.

Additionally, some groundwaters encountered during air-lift testing would likely also show potentially ecotoxic levels of trace metals, such as Aluminium (Al), Arsenic (As), Manganese (Mn), Nickel (Ni) and Zinc (Zn).

Considering the likely detrimental environmental effects of drilling fluid and produced groundwaters should they not be successfully contained on-site, the bunding requirements described in **Section 4** above are considered to be of critical importance and must be implemented at all sites.

In the event of a spill of produced groundwater onsite which is not contained within site sumps or above ground tanks, a water quality sampling and testing service should be employed to ensure that any 'normal' stormwater runoff retained by the bund wall has not been contaminated and, if it has, that prompt removal by tanker will apply.

Appropriate procedures for eroded sediment and surface water control have been set out in **Section 4** above.

With the sediment and surface water controls implemented as specified, no off-site impacts of site stormwater runoff, drilling fluid, chemical or produced groundwaters are expected.

## 5.2 RECOMMENDATIONS

For core drilling sites, where excavated sumps are used for the circulation of drilling fluid rather than above ground tanks, it is strongly recommended that in the event of an actual commenced or predicted very high rainfall event, if possible drilling fluid should be confined within the mud pits and temporarily covered with say a tarpaulin so that mixing with stormwater is prevented.

Significant amounts of produced groundwaters which can be confined within on site tanks or pits should have pH and EC monitored prior to tankering away off site.

To assess requirements for management of excessive volumes of produced groundwaters i.e. volumes which have not been successfully confined within on site tanks or pits and are contained behind the site bund wall, water samples should be collected to determine water quality in the event of possible loss of containment. This should be done by measuring pH and EC onsite, and collection by an appropriately trained person of samples to be sent to a NATA-accredited laboratory for determination of key chemical analytes as identified in **Table 3.1**.

On demand, water quality sampling and analysis should be conducted in the unlikely event that there is any uncontrolled release from the site water containment system.

# 6. REFERENCES

ANZECC&ARMCANZ (2000). National Water Quality Management Strategy, Australian and New Zealand Guidelines for Fresh and Marine Water Quality. Australia and New Zealand Environment and Conservation Council and Agriculture and Resource Management Council of Australia and New Zealand.

DECC (2008). Bunding and Spill Management. New South Wales Department of Environment and Climate Change.

Available at: http://www.environment.nsw.gov.au/mao/bundingspill.htm

DEC (2004) Approved Methods for the Sampling and Analysis of Water Pollutants in New South Wales. March 2004. NSW Dept. of Environment and Conservation.

Ecoengineers Pty Ltd (1998) Ecoengineers (1998) Assessment of Environmental Effects of Produced water Borehole DP6, Douglas Park. August 1998. (for BHP Collieries Technical Services).

Ecoengineers (2008) End of Panel Assessment of Water Flow and Quality Effects Appin Colliery Longwall 701. June 2008 (for Comur Consulting Pty Ltd).

Hammond, M. (2007) Baseline Study of Hydrogeology Above a Longwall Mine in Cordeaux Dam Catchment Area. B. Env. Sci. Honours thesis, Faculty of Science, University of Wollongong.

Herbert, C and Helby, R. (1980) A Guide to the Sydney Basin. Bulletin 26. Geological Survey of New South Wales. Department of Mineral Resources.

Kefford, B.J., Dunlop, J.E., Horrigan, N., Zalizniak, L., Hassell, K.L., Prasad, R., Choy, S., and Nugegoda, D. (2006b) Predicting salinity-induced loss of biodiversity. Project No: RMI 12 Final Report to CSIRO Land and Water Australia, RMIT University.

NAP Water Quality Program (2006) Project WQ06. Water Quality Impacts on Aquatic Ecosystem Health, Assessing the impacts of salinity and turbidity. Project Fact Sheet.

Available from: http://www.wqonline.info/products/infoanddata/factsheets.html

Olsen Environmental Consulting (OEC) Pty Limited (2007). Illawarra Coal Seam Gas Exploration Drilling Programme, Preliminary Environmental Assessment Under Part 3A of the Environmental Planning and Assessment Act 1979. March 2005. (for Apex Energy NL).

Rutherford, J.C. and Kefford, B.J. (2005) Effects of salinity on stream ecosystems: improving models for macroinvertebrates. CSIRO Land and Water Technical Report 22/05. October 2005.

SCA (1997) Track Stabilisation and Erosion Control Manual. Sydney Catchment Authority.

# APPENDIX II

(No. of pages excluding this page = 97)

**Flora and Fauna Impact Assessment: Illawarra Coal Seam Gas Exploration Program, October 2008**

**Biosis Research Pty Limited**

---

BIOSIS
RESEARCH

# Flora and Fauna Impact Assessment: Illawarra Coal Seam Gas Exploration Drilling Program

January 2009

*Natural & Cultural Heritage Consultants 8 Tate St Wollongong NSW 2500*

**BIOSIS**
RESEARCH

Report for

Apex Energy NL

# Flora and Fauna Impact Assessment: Illawarra Coal Seam Gas Exploration Drilling Program

## Final Report

January 2009

Sian Wilkins
Jessica Herring
Matthew Swan

*Project no: s4806*

*Ballarat:*
*449 Doveton Street North, Ballarat VIC 3354*
*Ph: (03) 5331 7000 Fax: (03) 5331 7033*
*email: 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*

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

*Sydney:*
*18-20 Mandible Street, Alexandria NSW 2015*
*Ph: (02) 9690 2777 Fax: (02) 9690 2577*
*email: sydney@biosisresearch.com.au*

*Wollongong:*
*8 Tate Street, Wollongong NSW 2500*
*Ph: (02) 4229 5222 Fax: (02) 4229 5500*
*email: wollongong@biosisresearch.com.au*

***BIOSIS** RESEARCH Pty. Ltd. A.C.N. 006 075 197*
*Natural & Cultural Heritage Consultants*

# ACKNOWLEDGMENTS

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

- Robert Suansri (GIS Operator, Biosis Research)
- David Olsen (Olsen Environmental Consulting)
- Matthew Richardson (Resource Manager/ Senior Botanist, Biosis Research)
- Kirsten Crosby (Senior Zoologist, Biosis Research)

# ABBREVIATIONS

| | |
|---|---|
| Apex | Apex Energy NL |
| DECC | NSW Department of Environment and Climate Change, (formerly NSW Department of Environment and Conservation, DEC) |
| DEWHA | Commonwealth Department of the Environment, Water, Heritage and the Arts |
| EP&A Act | NSW *Environmental Planning and Assessment Act* 1979 |
| EPBC Act | Commonwealth *Environment Protection and Biodiversity Conservation Act* 1999 |
| LGA | Local Government Area |
| NPWS | NSW National Parks and Wildlife Service (now part of DECC) |
| ROTAP | Rare or Threatened Australian Plant as listed by Briggs and Leigh (1995) |
| SEPP | NSW State Environmental Planning Policy |
| TSC Act | NSW *Threatened Species Conservation Act* 1995 |
| sp. | Species (singular) |
| spp. | Species (plural) |
| ssp. | Subspecies |
| var. | Variety |

# CONTENTS

## *TABLES*



## *FIGURES*

# 1.0 SUMMARY

Biosis Research was commissioned by Apex Energy NL (Apex) to conduct a terrestrial flora and fauna assessment for the proposed gas exploration drilling program in the Illawarra. This assessment has been carried out for approval under Part 3A of the NSW *Environmental Planning and Assessment Act* 1979 (EP&A Act) with reference to threatened biota listed on the NSW *Threatened Species Conservation Act* 1995 (TSC Act) and the Commonwealth *Environment Protection and Biodiversity Conservation Act* 1999 (EPBC Act).

The Study Area supports Coastal Sandstone Ridgetop Woodland, Coastal Sandstone Gully Forest, Coastal Upland Swamp and Cleared areas.

The proposal would involve clearing or modifying approximately:

- 3.6 ha of Coastal Sandstone Ridgetop Woodland;
- 0.6 ha of Coastal Sandstone Gully Forest;
- 1.2 ha of Coastal Upland Swamp; and,
- 6 ha of disturbed areas supporting regenerating common native and exotic species.

No Endangered Ecological Communities (EEC) listed on the TSC Act or EPBC Act were recorded in the Study Area. No threatened plant species were recorded within the Study Area. However, potential habitat for eight threatened species (*Acacia bynoeana*, *Callistemon linearifolius*, *Cryptostylis hunteriana*, *Epacris purpurascens* var. *purpurascens*, *Persoonia acerosa*, *Persoonia hirsuta*, *Pomaderris adnata* and *Pultenaea aristata*) occurs within the Study Area.

The proposal is likely to remove or modify potential habitat for fifteen threatened animal species listed on the TSC Act (Koala, Greater Broad-nosed Bat, Eastern False Pipistrelle, Eastern Bent-wing Bat, Eastern Freetail-bat, Large-footed Myotis, Red-crowned Toadlet, Square-tailed Kite, Gang-gang Cockatoo, Glossy Black- cockatoo, Powerful Owl, Sooty Owl, Barking Owl, Masked Owl and Eastern Pygmy-possum) and eight threatened species listed on the EPBC Act (Grey-headed Flying Fox, Satin Fly catcher, Black-faced Monarch, Rainbow Bee-eater, Regent Honeyeater Swift Parrot, Southern Brown Bandicoot and Large-eared Pied Bat).

Impact Assessments following the Part 3A Guidelines under the EP&A Act were carried out for the threatened biota listed on the TSC Act occurring or with potential habitat in the Study Area. These assessments concluded that the proposal would have a minor impact, given that a relatively small area of potential habitat would be impacted and none of the threatened species were

recorded during surveys of the Study Area. Further, impact assessments following the EPBC Act Significant Impact Guidelines have been prepared for threatened biota listed under the EPBC Act with potential habitat in the Study Area. It was found that the proposal would not have a significant impact on threatened biota.

A Referral for Matters of National Significance (EPBC Act) is not considered necessary for any threatened biota within the Study Area.

The following mitigation measures are proposed to minimise any disturbances of the proposal on the ecological values of the Study Area:

- adjustment of the location of boreholes and access tracks to avoid native trees and significant habitat features such as sandstone outcropping, where required;
- trees with hollows should be retained and protected, with no drilling within the critical root zone (extending to 2 m beyond the drip line) of the trees;
- access to boreholes AI10, AI16, and AI18 may require trimming of branches along existing fire trails. Such branch trimming should be limited and restricted to smaller branches that do not support hollows. Should large branches with hollows be required to be removed, a suitably qualified ecologist should be on site during clearing to ensure no resident fauna are harmed. Cleared branches should be placed in adjoining vegetation, as they will provide habitat for fauna;
- access to boreholes AI10, AI16 and AI18 will involve two creek crossings. These crossings will use established crossings along the established Fire Road 10Q and will not divert into other areas of the creeklines. Caution should be taken to prevent sedimentation runoff and minimise disturbance along the creek;
- where possible, proposed boreholes and access tracks should be located within existing cleared areas;
- sediment and erosion control measures should be implemented on all sites to prevent erosion during and after construction;
- disturbance to native vegetation should be minimised, or, where disturbance is unavoidable, borehole sites should be rehabilitated using locally sourced tubestock and brush-matting. Rehabiliation should be undertaken by suitably qualified bush regenerators;

- where clearing of native vegetation is unavoidable, native shrubs, logs and bush-rock should be stockpiled on the side of the proposed boreholes and access routes and replaced following completion of the works;
- if required, bush regeneration and weed control should be undertaken to ensure the flora and fauna of the locality are protected throughout the construction and operation phases of the proposal. This is particualry important for boreholes where intact native vegetation will be disturbed. Any bush regeneration and weed control should be undertaken by suitably qualified bush regenerators;
- any chemicals used on site will be taken off site after use and disposed of appropriately;
- machinery and vehicles should be washed down prior to use on site to avoid the transmission of weed seed or disease into intact areas of native vegetation; and,
- a suitably qualified ecologist should be on site during the initial site setup for each borehole, to ensure significant habitat features and species are not impacted by the proposal.

# 2.0 INTRODUCTION

Biosis Research was commissioned by Apex Energy NL (Apex) to conduct a terrestrial flora and fauna assessment for the proposed gas exploration drilling program in the Illawarra. The installation involves the construction of surface infrastructure at 18 sites (referred to as the boreholes in this document), which are located north of Wollongong, in the vicinity of Helensburgh and Darkes Forest (Figure 1).

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

## 2.1 Aims

The specific aims of this assessment are to:

- conduct a literature review and database search for the locality;
- undertake targeted field surveys for habitat of threatened terrestrial flora and fauna species, populations or ecological communities that are listed on the TSC Act and the EPBC Act and have been identified as potentially occurring in the locality;
- provide an assessment of the habitat values of the site;
- undertake impact assessments for threatened biota listed on the TSC and/or EPBC Acts following the guidelines for threatened species assessment under Part 3A of the EP&A Act (DEC & DPI 2005) and the EPBC Act Significant Impact Guidelines (DEH 2006); and,
- provide recommendations to minimise the environmental impacts of the proposal.

## 2.2 Definitions

The following terms are used frequently throughout the report:

- ***The proposal*** is the development, activity or action proposed. In this case the proposal is the installation of 18 gas extraction boreholes in a sector of the Illawarra Coal Measures.
- ***Subject site*** is defined in *Threatened Biodiversity Survey and Assessment: Guidelines for Developments and Activities - Working Draft* (DEC 2004b)

and means the area directly affected by the proposal. In this case, the subject site is the combination of all 18oreholes.

- ***Study Area*** is defined in DECC (2004b) as the subject site and any additional areas that are likely to be affected by the proposal, either directly or indirectly.

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

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

- ***Local population*** is defined in DECC (2004b) as the population of a species within the Study Area.

- ***Local occurrence*** is used in reference to endangered ecological communities and is defined in (DEWHA 2004) as the community that occurs within the Study Area.

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

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

## 2.3 The Proposal

Apex is proposing to undertake an18 hole exploration drilling program to define coal seam gas and goaf gas reserves in a sector of the Illawarra Coal measures. The project will determine the potential for future commercial production of goaf gas and unmined coal seam exploration wells. The proposed drill holes are designed to collect data necessary for the establishment of the potential for gas production in the project area.

The proposed boreholes can be divided into four categories, each of which will require different testing equipment and duration on site:

- Cored holes drilled over areas with no underlying abandoned goafs (old mine workings) for stratigraphic data, desorption testing of gas content and seam permeability testing. Cored hole diameter is 100mm.

- Cored holes drilled over areas underlain by abandoned goafs. Drilling through and sealing off abandoned goafs requires additional equipment and procedures. This includes a larger diameter hole from the surface to allow placement of additional bore casing. This would require a larger rig and additional time on site.

- Goaf gas exploration wells (i.e. gas held in abandoned coal mine workings) for exploring gas quality and quantity from such goafs. It should be noted that the goaf areas which form the target for the goaf gas exploration wells have been sealed for many years and are not open to the fresh air environment. With a lack of ventilation, methane buildup in these areas would be such that the atmosphere at target deapth would not support life.

- Unmined coal seam exploration wells for extended testing of flow rates.

The location of the holes was selected to give a representative coverage of the area under exploration (Figure 2). Other factors taken into consideration in selecting the proposed locations included the level of pre-existing disturbance, ease of access, land ownership and topography.

### 2.3.1 Borehole Installation

Three significantly different types of drilling rigs will be used in the exploration program:

- Coring rig;

- Open-hole drilling rig; and,

- Workover rig.

Coring rigs are small truck-mounted or jack-up rigs with a gross vehicle weight under 20t. In-ground pits or above ground tanks are required to enable recirculation of drilling fluid. Exploration rigs for coal seam methane drilling are usually truck-mounted, but are larger and heavier than coring rigs and are around 35t gross weight. Drilling of an exploration hole requires a larger operations area than a coring rig site and better access for delivery of casing, which is 12m long. A workover rig is smaller than a coring rig and will be used to undertake zero radius lateral drilling.

Other equipment on site will include a drillpipe truck (or racked pipe), air compressor (may be an on-board rig or on a separate truck/trailer), pumps, equipment storage container, water tank, drillers hut and geologists hut/testing hut.

Temporary access will be required for delivery of drillpipe, casing and other drilling supplies. This could be by semi-trailer. Other vehicle access would be required for a water supply tanker, cement trucks, pumpout tanker and a 4WD geophysical logging vehicle.

Personnel on site will usually comprise a driller and one or two assistants and a geologist and assistant. Other personnel visiting the site will include drilling and company supervisors, specialist technicians and delivery drivers. Daily access for on-site personnel will be by 4WD or conventional vehicle as appropriate.

### 2.3.2 Potential Impacts of the Proposal

The disturbance footprint of each borehole site comprises a 50 x 60 metre compound with additional light vehicle parking for up to six vehicles. Additional construction of access tracks may be required. It is therefore assumed that a total area of 80 m x 80 m for each disturbed area is adequate to consider all direct and indirect impacts associated with the proposal.

Direct impacts that may apply to this proposal and will therefore be considered in this assessment include:

- vegetation clearance;
- the removal of potential habitat; and,
- the fragmentation of potential habitat.

Indirect impacts that may apply to this proposal include:

- the potential for erosion;
- the provision of a suitable seed bed for exotic weed invasion; and,
- increased human activity within or adjacent to sensitive habitat areas.

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

It should be noted that threatened bat species have recently been identified with the disused workings, adits and portals of various mines in the Illawarra. In each of these cases the disused mine infrastructure has been well ventilated. One component of the current project is to drill into sealed goaf areas targeting goaf gas for extraction. Such environments provide environments which are contrary to life and provide no possible habitat for threatened bat species.

## 2.4 The Study Area

The Study Area is located in the Wollongong Local Government Authority (LGA) boundary. It extends from Helensburgh south to Darkes Forest and further

south to Coaldale (Figure 1). The land within the Study Area is currently owned by a number of private land holders, Sydney Catchment Authority (Water Catchment land) and the Department of Environment and Climate Change (Dharawal State Conservation Area).

The Study Area generally supports intact native vegetation in good condition with a high native species diversity. Some borehole locations had been previously disturbed by coal mining and quarry activities. These disturbed areas generally support reduced species diversity with a limited capacity to regenerate given topsoil disturbance.

### 2.4.1 Geology, Soils and Topography

The topography surrounding the borehole locations includes discrete areas of rugged sandstone escarpment and ridges, with moderate to steep slopes and narrow, deeply incised valleys. Those sections of the Study Area which are located away from major water courses comprise gently undulating crests, ridges and plateau surfaces.

The Study Area consists of a number of waterbodies including rivers, lake, creek and drainage lines. The main waterbodies include Warratah Rivulet, O'Hares Creek, Iluka Creek and Maddens Creek in the northwest and Lodden Creek in the south with a number of smaller tributaries and drainage lines.

Hazelton and Tille (1990) have defined two soil landscapes within the Study Area, with minor occurrences of a third soil landscape. Each soil landscape has distinct morphological and topological characteristics. The Study Area is located on Hawkesbury Sandstone, with occasional occurrences of the Mittagong Formation when the Lucas Heights Soil landscape is encountered.

The Hawkesbury Soil landscape is characterised by rugged sandstone escarpment and ridges, with moderate to steep slopes and narrow, deeply incised valleys of the Woronora Plateau (Hazelton & Tille 1990). Sandstone rock outcrops are very common, and occur as boulders, benches and large blocks, often forming scarps up to 10 m high. It is confined to the margins of the major rivers including the Nepean and Avon, and larger tributaries. The soils in this landscape are shallow, discontinuous and generally sandy.

The Bundeena Soil landscape comprises exposed plateaux and coastal headlands within the Woronora Plateau (Hazelton & Tille 1990:31). The soils consist mostly of siliceous and earthy sands, along with yellow earths and gleyed podzolic soils on the mid to lower slopes. Swamps are a commonly noted feature of this landscape.

The Lucas Heights Soil landscape consists of soils which are generally yellowed to lateritic podsolic; however, this landscape is known for outcrops and limited deep soil bases (Hazelton & Tille 1990:23). Within the Study Area this soil type is confined to the ridge tops and gentle slopes.

### 2.4.2 Climate

Climatic conditions within the Study Area vary slightly, on average the maximum temperature is 25.6 degrees Celsius with a low of 18.6 degrees Celsius in February. The average minimum winter temperature is 8.4 degrees Celsius with a maximum of 16.9 degrees Celsius in July (BOM Website http://www.bom.gov.au/). The Study Area normally receives a high summer/ spring rainfall with mean precipitation of 176 mm in March, and a low of 58 mm in July.

## 2.5 Planning Approvals

The proposal has been included as a Major Project under Part 3A of the NSW *Environmental Planning and Assessment Act* 1979 (EP&A Act) and State Environmental Planning Policy (Major Projects) 2005.

The EP&A Act was amended in June 2005 to reform the land-use planning and development assessment and approval system, particularly as it relates to major infrastructure and other significant development. In the new Part 3A, the Act provides a single assessment and approval regime for all major infrastructure and other projects previously undertaken under Part 4 and/or Division 4 of Part 5 of the EP&A Act. The new Part applies to major State government infrastructure projects, development that was previously classified as State significant development and other projects, plans or programs declared by the Minister for Planning.

Provisions have been made in the amended Act for:

- Independent Hearings and Panel Assessments to strengthen the assessment process;
- Concept plans for complex projects, plans or programs so that the overall provisions can be evaluated prior to consideration of the details of the project(s). This provides for matters such as the suitability of the site/route and environmental issues to be resolved up-front and provides for the simplification of subsequent approvals where environmental impacts can be avoided or minimised; and,

- The Minister to declare projects to be ‘critical infrastructure projects’. Prior to making such a declaration, a preliminary risk assessment will be required to consider the financial, economic, social and environmental risks of declaring the project a critical infrastructure project. These projects only require a concept approval and there are no appeal rights except if initiated by the Minister.

# 3.0 METHODS

## 3.1 Taxonomy

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

Names of vertebrates follow the Census of Australian Vertebrates maintained by Department of Environment and Heritage (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 the Appendices.

## 3.2 Legislation

Federal and State Acts and Policies that haven been considered in this report with regard to terrestrial flora and fauna are listed below:

- Commonwealth *Environmental Protection and Biodiversity Conservation Act* 1999 (EPBC Act);
- NSW *Threatened Species Conservation Act* 1995 (TSC Act);
- NSW *Environmental Planning and Assessment Act* 1979 (EP&A Act); and,
- State Environmental Planning Policy (SEPP) 44 – Koala Habitat.

## 3.3 Literature and Database Review

A list of documents used to prepare this report is located in *References*. Records of threatened species, populations and communities were obtained from the Department of Environment and Climate Change (DECC) *Atlas of NSW Wildlife* within a 10 km radius of the Study Area.

Potential occurrences of threatened species, populations and communities listed on the EPBC Act were obtained from the Department of the Environment, Water, Heritage and the Arts (DEWHA) *EPBC Online Database* within a 10 km radius of the Study Area. Database searches were conducted in September 2008.

## 3.4 Field Survey

The Study Area was inspected on the 2 to 4 September 2008. The general condition of the site was assessed and observations of flora and fauna species and plant communities were made (as detailed below). During the site visit the weather was cool and cloudy with intermittent light to medium showers.

### 3.4.1 Flora

Information recorded during the flora survey at each of the 18 boreholes included: location (GPS), photograph, community structure and composition, the presence of threatened plants and ecological communities (or their potential habitat), fire history, condition (Section 3.4.2), flora species list and habitat description.

A compiled plant species list for the Study Area was entered into the NSW Flora Information System (Viridans 2003) and is included in Appendix 1.

### 3.4.2 Vegetation Condition Assessment

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

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

The categories of vegetation conditions are as follows:

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

**Moderate**: containing a moderate number of indigenous species; moderate level of weed invasion; weeds occurring in isolated patches or scattered throughout; one or more of original layers of vegetation are modified; vegetation layers (ground, shrub, canopy etc.) are largely intact, or if modified, natural soil profile

remains intact; able to be regenerated to Good condition with minimal level of management;

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

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

### 3.4.3 Fauna

The fauna survey was undertaken as a habitat based assessment. Fauna species using the site were surveyed by undertaking active searching and listening, as well as recording incidental observations.

### 3.4.4 Fauna Habitat Assessment

The site assessment was primarily a habitat assessment, active searching or trapping for animal species was not undertaken during this assessment. The habitat assessment was based on the presence of one or more of the following features:

- vegetation cover;
- size range and abundance of tree hollows;
- rock outcrops, overhangs or crevices;
- freestanding water bodies, ephemeral drainage or seepage areas;
- disturbances including weed invasion, clearing, rubbish dumping or fire;
- connectivity to off site habitats; and,
- surrounding habitat.

The following three categories were used to evaluate habitat value:

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

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

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

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

## 3.5 Limitations

This study was by design a habitat assessment, therefore does not include trapping, spotlighting, active searching, call playback techniques and vegetation quadrat sampling.

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

# 4.0 RESULTS

## 4.1 Boreholes

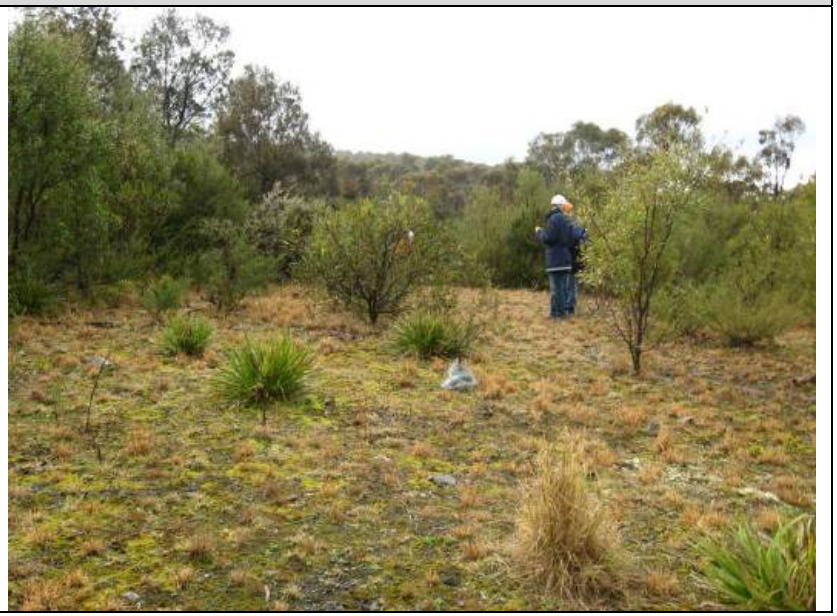
Details of boreholes surveyed, their location and flora and fauna values are detailed below in Table 1. Table 1 also lists recommendations to reduce impacts to native flora and fauna values of the impact area.

**Table 1: Boreholes locations, flora and fauna values and recommendations to reduce impacts**

| Description | Flora | Fauna | Impacts | Recommendations | Plate |
|---|---|---|---|---|---|
| **Borehole AI01** | | | | | |
| Former gravel pit, with extensive disturbance to topsoil. | Mostly cleared of native vegetation. Low native species diversity, with some regeneration of common native species. Disturbed condition, due to disturbance to topsoil. No threatened species or EECs recorded. No potential habitat for threatened flora. | Highly disturbed area. No large trees, tree hollows, logs, rocks/crevices or water bodies were present within the impact area, however a small waterhole and ephemeral drainage feature are located within close proximity to the site. No threatened species were recorded however threatened species that have previously been recorded within the vicinity of this site include the Grey-headed Flying fox, Eastern Pygmy Possum and Koala. | Minimal vegetation clearing required for borehole and access. | Retain trees and shrubs where possible. Sediment and erosion controls required upslope of ephemeral drainage feature and waterhole to the west of borehole location. Access to the borehole site will be via existing roads and tracks only. |  |

| Description | Flora | Fauna | Impacts | Recommendations | Plate |
|---|---|---|---|---|---|
| **Borehole AI02** | | | | | |
| Area of dense regrowth next to slashed powerline easement. | Transitional area between Coastal Sandstone Ridgetop Woodland and Coastal Sandstone Gully Forest. Modified structure due to slashing for powerline easement, with tree layer absent and dense shrub layer. Moderate condition, with relatively high species diversity despite altered structure. No threatened species or EECs recorded. Potential habitat for *Acacia bynoeana*, *Callistemon linearifolius*, *Cryptostylis hunteriana*, *Epacris purpurascens* var. *purpurascens*, *Persoonia acerosa*, *Persoonia hirsuta*, *Pomaderris adnata*. | Dense regrowth area with moderate to high ground cover. Variety of potential feeding resources. No large trees, tree hollows, logs, rocks/crevices or water bodies were present within the impact area. Directly linked to adjacent woodland and Gully forest. No threatened species were recorded however threatened species that have previously been recorded within the vicinity of this site include the Grey-headed Flying fox, Eastern Pygmy Possum, Red-Crowned Toadlet and Koala. | Clearing of modified native vegetation required for borehole location only. Access to the borehole site will be via existing roads and tracks only. | Sediment and erosion controls required to reduce impacts to adjoining native vegetation. No large trees to be removed. |  |

| Description | Flora | Fauna | Impacts | Recommendations | Plate |
|---|---|---|---|---|---|
| **Borehole AI03** | | | | | |
| Adjoining slashed road easement of Fire Road 9H. | Supports Coastal Sandstone Ridgetop Woodland in good condition, with high diversity. No trees occur within impact area. No threatened species or EECs recorded. Potential habitat for *Acacia bynoeana*, *Cryptostylis hunteriana*, *Persoonia acerosa*, *Persoonia hirsuta*, *Pomaderris adnata*. | Dense ground cover with scattered shrubs and trees surrounding the boundary. Directly linked to adjacent woodland. Variety of feeding resources. No large trees, tree hollows, logs, rocks/crevices or water bodies were present within impact area. No threatened species were recorded however threatened species that have previously been recorded within the vicinity of this site include the Eastern Pygmy Possum, Red-crowned Toadlet, Koala and Eastern Bent-wing Bat. | Clearing of native vegetation required for borehole only. | Majority of borehole clearing to be restricted to slashed road easement. Minimise clearing in adjoining intact vegetation. No trees to be removed. Sediment and erosion controls required along southern edge of borehole to protect adjoining vegetation from impacts. |  |

| Description | Flora | Fauna | Impacts | Recommendations | Plate |
|---|---|---|---|---|---|
| **Borehole AI04A** | | | | | |
| Coalcliff Shaft site. Former gravel pit, with extensive disturbance to topsoil. | Mostly cleared of native vegetation. Low native species diversity, with some regeneration of common native species. Disturbed condition, due to disturbance to topsoil. No threatened species or EECs recorded. No potential habitat for threatened flora. | Previously cleared and modified area with no potential habitat features observed. No large trees, tree hollows, logs, rocks/crevices or water bodies were present, however a creek is located within 250m along the adjacent fire road. No threatened species were recorded onsite however threatened species that have previously been recorded within the vicinity of this site include the Sooty Owl, Rosenburg's Goanna, Eastern Bent-wing Bat, Large-footed Myotis and Koala. | Minimal vegetation clearing required for borehole and access. | Sediment fencing required along northern boundary of borehole site to minimise impacts to adjoining native vegetation and creek along fire road. No large trees to be removed. This is the preferred location of this borehole given the minimal impact to intact habitats. |  |

| Description | Flora | Fauna | Impacts | Recommendations | Plate |
|---|---|---|---|---|---|
| **Borehole AI04B** | | | | | |
| Intact native vegetation. Clearing required for access (approx. 80 m) off existing fire road | Coastal Sandstone Gully Forest in good condition, with intact structure and high species diversity. No threatened species or EECs recorded. Potential habitat for *Callistemon linearifolius*, *Epacris purpurascens* var. *purpurascens*. | Undisturbed area with a variety of potential habitat features and feeding resources. Large *E. racemosa* with small to medium sized tree hollows. Dense ground cover with scattered logs and small rocks. Large rocky outcrop in centre. No water bodies present. No threatened species were recorded onsite however threatened species that have previously been recorded within the vicinity of this site include the Sooty Owl, Rosenburg's Goanna, Eastern Bent-wing Bat, Large-footed Myotis and Koala. | Vegetation clearing required for borehole location and access. | Large trees with hollows occur in vicinity of site, which will be retained. No drilling activities should occur within 2 m of the outer drip line of trees to protect the root zone and prevent dieback. Rocky outcrops should be retained and protected. If required to be moved during construction, these habitat features should be replaced on completion of works. Sediment fencing required to protect downslope areas of native vegetation from indirect impacts. Borehole AI04A would be the preferred location for this borehole, given the impact of Borehole AI104B on intact habitats. |  |

| Description | Flora | Fauna | Impacts | Recommendations | Plate |
|---|---|---|---|---|---|
| **Borehole AI05** | | | | | |
| Former gravel pit within Dharawal State Conservation Area, with extensive disturbance to topsoil. | Mostly cleared of native vegetation. Low native species diversity, with some regeneration of common native species. Disturbed condition, due to disturbance to topsoil. No threatened species or EECs recorded. No potential habitat for threatened flora. | Area previously cleared with no large trees, tree hollows, rock outcrops or crevices present. There is a small dam to the west of the site which is potential breeding habitat for a number of amphibian species. Logs and woody debris are scattered throughout the site. No threatened species were recorded however there have been a number of threatened species previously recorded within the vicinity of this site which include the Grey-headed Flying-fox, Sooty Owl, Powerful Owl, Rosenburg's Goanna, Eastern Bent-wing Bat, Large-footed Myotis, Greater Broad-nosed Bat, Gang-gang Cockatoo, Koala, Eastern Pygmy Possum, Red-crowned Toadlet and Giant Burrowing Frog. | Minimal vegetation clearing required for borehole and access.<br>A few trees may need to be lopped along access track. | Sediment fencing required along southern boundary of borehole site to prevent impacts to downslope native vegetation and Maddens Creek. Sediment fencing also required on western edge to protect the small dam. |  |

| Description | Flora | Fauna | Impacts | Recommendations | Plate |
|---|---|---|---|---|---|
| **Borehole AI06** | | | | | |
| Darkes Forest Shaft site, with vacant buildings and bitumen carpark. Coal wash established over topsoil. | Mostly cleared of native vegetation. Low native species diversity, with some regeneration of common native species. Disturbed condition, due to previous clearing and introduction of coal wash over topsoil. No threatened species or EECs recorded. No potential habitat for threatened flora. | Disturbed area with scattered *Acacia* shrubs and *E. robusta* which is an important feeding resource for Swift Parrots, Regent Honeyeaters and Koalas. No tree hollows, logs, rocks outcrops/crevices or water bodies were present on site, however there are two large dams covered with spike rushes within close vicinity of the impact area. No threatened species were recorded onsite however threatened species that have previously been recorded within the vicinity of this site include the Square-tailed Kite, Grey-headed Flying-fox, Sooty Owl, Powerful Owl, Rosenburg's Goanna, Eastern Bent-wing Bat, Large-footed Myotis, Greater Broad-nosed Bat, Gang-gang Cockatoo, Koala, Eastern Pygmy Possum, Red-crowned Toadlet and Giant Burrowing Frog. | Minimal clearing required. | Retain existing trees. No drilling activities should occur within 2 m of the outer drip line of trees to protect the root zone and prevent dieback. |  |

| Description | Flora | Fauna | Impacts | Recommendations | Plate |
|---|---|---|---|---|---|
| **Borehole AI07** | | | | | |
| Cleared area, with coal wash established over topsoil. | Mostly cleared of native vegetation. Low native species diversity, with regeneration of common native species. Disturbed condition, due to previous clearing and introduction of coal wash over topsoil. No threatened species or EECs recorded. Upland swamp occurs downslope of proposed borehole location. No potential habitat for threatened flora. | Highly disturbed area with low species diversity. No large trees, tree hollows, rocks/crevices or water bodies were present within impact area. A few scattered logs and woody debri observed. No threatened species were recorded onsite however threatened species that have previously been recorded within the vicinity of this site include the Eastern Bent-wing Bat, Large-footed Myotis and Koala. | Minimal clearing required. No large trees to be cleared. | Sediment and erosion controls required on northern side of borehole site to minimise impacts to downslope upland swamp. |  |

| Description | Flora | Fauna | Impacts | Recommendations | Plate |
|---|---|---|---|---|---|
| **Borehole AI08** | | | | | |
| Cleared area, with coal wash established over topsoil. | Supports upland swamp in disturbed condition. Mostly cleared of native vegetation. Low native species diversity, with some regeneration of common native swamp species. Disturbed condition, due to previous clearing and introduction of coal wash over topsoil. No threatened species or EECs recorded. Upland swamp occurring downslope to the north-west of borehole site. No potential habitat for threatened flora. | Modified area with low species diversity. No large trees, tree hollows, logs, rocks/crevices or water bodies were present on site. Directly linked to upland swamp. No threatened species were recorded onsite however threatened species that have previously been recorded within the vicinity of this site include the Grey-headed Flying-fox, Sooty Owl, Barking Owl, Littlejohns Tree Frog, Red-crowned Toadlet and Koala. | Minimal clearing required. | Sediment fencing required along north-western side of borehole site to minimise impacts to downslope swamp. |  |

| Description | Flora | Fauna | Impacts | Recommendations | Plate |
|---|---|---|---|---|---|
| **Borehole AI09** | | | | | |
| Cleared area, with coal wash established over topsoil. Borehole location within road, extending into adjoining vegetation. | Mostly cleared of native vegetation. Low native species diversity, with some regeneration of common native species. Disturbed condition, due to previous clearing and introduction of coal wash over topsoil. No threatened species or EECs recorded. Upland swamp occurring to the west and east of borehole site. | Previously cleared and modified area with no potential habitat features observed. No large trees, tree hollows, logs, rocks/crevices or water bodies were present. No threatened species were recorded onsite however threatened species that have previously been recorded within the vicinity of this site include the Grey-headed Flying-fox, Sooty Owl, Barking Owl, Eaastern Bent wing Bat, Littlejohns Tree Frog, Red-crowned Toadlet Giant Burrowing Frog and Koala. | Minimal clearing required. No impacts to threatened flora or potential habitats. | Sediment fencing required along west and east side of borehole site to minimise impacts to adjoining swamp. |  |

| Description | Flora | Fauna | Impacts | Recommendations | Plate |
|---|---|---|---|---|---|
| **Borehole AI10** | | | | | |
| Intact native vegetation adjoining fire road. Access via Fire Road 10Q, including two creek crossings. | Supports Coastal Upland Swamp in good condition, with high species diversity. No threatened species or EECs recorded. One ROTAP species recorded (*Darwinia grandiflora*). Potential habitat for *Darwinia biflora*, *Epacris purpurascens* var. *purpurascens*, *Pultenaea aristata*. | Diverse upland swamp with no large trees, tree hollows, rock outcrops/crevices or water bodies present within impact area. A few logs and woody debris are scattered throughout the site. There are a number of large hollow bearing trees surrounding the impact area and along the access track to the site which could be potential habitat for several bird, bat and small mammal species. No threatened species were recorded however there have been a number of threatened species previously recorded within the vicinity of this site which include the Grey-headed Flying-fox, Rosenburg's Goanna, Eastern Bent-wing Bat, Large-footed Myotis, Greater Broad-nosed Bat, Gang-gang Cockatoo, Koala, Eastern Pygmy Possum, Red-crowned Toadlet and Giant Burrowing Frog. | Vegetation clearing required for borehole location. Creek crossings should remain on existing crossings only. | Retain existing trees. No drilling activities should occur within 2 m of the outer drip line of trees to protect the root zone and prevent dieback. Minimise clearing area required, restrict development to existing cleared fire road as far as practicable. Sediment and erosion control measures fencing required along north, east and south of boundary of borehole site to minimise impacts to upland swamp. Caution should be taken to prevent sedimentation run off and minimise disturbance to the 2 creek crossings along Fire Road 10Q. |  |

| Description | Flora | Fauna | Impacts | Recommendations | Plate |
|---|---|---|---|---|---|
| **Borehole AI11** | | | | | |
| Disturbed area, previously cleared. Former gravel pit, with extensive disturbance to topsoil. | Mostly cleared of native vegetation. Low native species diversity, with some regeneration of common native species. Altered structure, with no tree layer present. Disturbed condition, due to previous clearing and topsoil removal. No threatened species or EECs recorded. No potential habitat for threatened flora. | Area previously cleared with a track through the middle. No large trees, tree hollows, rock outcrops or crevices present. There is a ephemeral drainage line on the boundary south west of the site and an excavated water hole north east of the site providing habitat for amphibian species. No leaf litter or ground cover present. No threatened species were recorded however there is a previous record of an Eastern Bent-wing Bat nearby. | Clearing of common native shrub and groundcover species required. No trees required to be cleared. | Sediment fencing required along south-western and north-eastern boundary of borehole site to prevent impacts to drainage areas and waterbodies. |  |

| Description | Flora | Fauna | Impacts | Recommendations | Plate |
|---|---|---|---|---|---|
| **Borehole AI12B** | | | | | |
| Intact native vegetation. | Transitional area between Coastal Upland Swamp and Coastal Sandstone Ridgetop Woodland. Vegetation in good condition, with high native species diversity and few weed species, mainly on the edges of the access track, made of coal wash. No threatened plants or EECs recorded. Potential habitat for *Acacia bynoeana*, *Cryptostylis hunteriana*, *Darwinia biflora*, *Epacris purpurascens* var. *purpurascens*, *Persoonia acerosa*, *Persoonia hirsuta*, *Pomaderris adnata*, *Pultenaea aristata*. | Undisturbed area directly linked to adjacent woodland. Variety of feeding resources. Dense ground cover with scattered woody debris and small rocks. No water bodies present. No threatened species were recorded onsite however threatened species that have previously been recorded within the vicinity of this site include the Eastern Bent-wing Bat and Giant Burrowing Frog. | Vegetation clearing required for borehole location. | Miminise clearing area required. No trees to be removed. Sediment and erosion control measures fencing required along south, east and west boundary of borehole site to minimise impacts to upland swamp and woodland. |  |

| Description | Flora | Fauna | Impacts | Recommendations | Plate |
|---|---|---|---|---|---|
| **Borehole AI13** | | | | | |
| Disturbed native vegetation. | Regenerating native vegetation, with dense shrubs and few trees present. Area considered to be in moderate condition, due to altered structure and reduced species diversity due to previous clearing. No threatened plants or EECs recorded. No potential habitat for threatened flora. | Area previously cleared with no large trees, tree hollows, rock outcrops, logs or crevices present in impact area. Variety of feeding resources. The site is directly linked to adjacent woodland with large Scribbly gums. Glider incisions observed on a *C. gummifera* adjacent to site near firetrail. Sparse ground cover. No threatened species were recorded however threatened species that have previously been recorded within the vicinity of this site include the Eastern Bent-wing Bat and Giant Burrowing Frog. | No trees will need to be removed. Clearing of regrowth shrubs and small trees required. | Restrict clearing to area previously cleared, avoiding adjoining intact bushland. Sediment fencing required along south east boundary to minimise impacts to adjoining intact vegetation. |  |

| Description | Flora | Fauna | Impacts | Recommendations | Plate |
|---|---|---|---|---|---|
| **Borehole AI14** | | | | | |
| Intact native vegetation. | Coastal Sandstone Ridgetop Woodland in good condition. Dense shrubs and groundcover, with no trees within impact area. High species diversity. No threatened plants or EECs recorded. Potential habitat for *Acacia bynoeana*, *Cryptostylis hunteriana*, *Persoonia acerosa*, *Persoonia hirsuta*, *Pomaderris adnata*. | Dense vegetation with a variety of potential feeding resources. No large trees, tree hollows, logs, rocks/crevices or water bodies were present within the impact area. Directly linked to adjacent woodland. No threatened species were recorded however threatened species that have previously been recorded within the vicinity of this site include the Grey-headed Flying-fox, Eastern Bent-wing Bat. | No trees will need to be removed. Clearing of dense shrubs and groundcover species required. | Miminise clearing area required. Sediment and erosion control measures fencing required along southern boundary of borehole site to minimise impacts to upland swamp and woodland. |  |

| Description | Flora | Fauna | Impacts | Recommendations | Plate |
|---|---|---|---|---|---|
| **Borehole AI15** | | | | | |
| Intact native vegetation. | Transitional between Coastal Upland Swamp and Coastal Sandstone Ridgetop Woodland. Upland swamp occurs to the north. No threatened plants or EECs recorded. Potential habitat for *Acacia bynoeana, Cryptostylis hunteriana, Darwinia biflora, Epacris purpurascens* var. *purpurascens, Persoonia acerosa, Persoonia hirsuta, Pomaderris adnata, Pultenaea aristata*. | No large trees, tree hollows, logs, rocks/crevices or water bodies were present within the impact area. Directly linked to adjacent woodland. No threatened species were recorded however threatened species that have previously been recorded within the vicinity of this site include the Powerful Owl and Eastern Bent-wing Bat. | No mature trees will need to be removed. Clearing of small trees, dense shrubs and groundcover species required. | Miminise clearing area required. Sediment and erosion control measures fencing required along south, east and northern boundaries of borehole site to minimise impacts to adjoining upland swamp and woodland. |  |

| Description | Flora | Fauna | Impacts | Recommendations | Plate |
|---|---|---|---|---|---|
| **Borehole AI16** | | | | | |
| Former gravel pit, cleared of native vegetation with disturbance to topsoil. Access along existing access track off Fire Road, including two creek crossings along Fire Road 10Q. | Previously cleared area, likely to have supported Coastal Sandstone Ridgetop Woodland prior to clearing. Some regeneration of common native species. Reduced species diversity due to removal of topsoil. No threatened plants or EECs recorded. No potential habitat for threatened flora. | Modified area with no large trees, tree hollows, logs, rocks/crevices or water bodies present within the impact area. However small water bodies present south west of site providing habitat for amphibian species. Glider incisions observed on nearby *C. gummifera*. Directly linked to adjacent woodland. No threatened species were recorded however threatened species that have previously been recorded within the vicinity of this site include the Grey-headed Flying-fox, Eastern Bent-wing Bat. | Clearing of common native shrub and groundcover species required. No trees required to be cleared. Some tree branches will be lopped along the Fire Road to facilitate access. Creek crossings should remain on existing crossings only. | Sediment fencing required along the south eastern boundary of the borehole site. Avoid impacts to adjoining intact native vegetation. Caution should be taken to prevent sedimentation run off and minimise disturbance to the 2 creek crossings along Fire Road 10Q. |  |

| Description | Flora | Fauna | Impacts | Recommendations | Plate |
|---|---|---|---|---|---|
| **Borehole AI17** | | | | | |
| Cleared area, with coal wash established over topsoil. | Cleared area, likely to have previously supported Coastal Upland Swamp. Disturbed condition, with reduced species diversity due to placement of coal wash over topsoil. No threatened plants or EECs recorded. Intact upland swamp occurring to the north. No potential habitat for threatened flora. | Scattered shrubs with no large trees, tree hollows, logs, rocks/crevices or water bodies present within the impact area. Directly linked to adjacent woodland and upland swamp. No threatened species were recorded however threatened species that have previously been recorded within the vicinity of this site include the Grey-headed Flying-fox, Sooty Owl and Eastern Bent-wing Bat. | Minimal clearing required. No trees to be removed. Access to the borehole site will be via existing roads and tracks only. | Sediment fencing required along the north-western boundary of borehole site, to minimise impacts to upland swamp. |  |

| Description | Flora | Fauna | Impacts | Recommendations | Plate |
|---|---|---|---|---|---|
| **Borehole AI18** | | | | | |
| Intact native vegetation. Access along existing Fire Road. Two creek crossings along Fire Road 10Q. | Coastal Sandstone Ridgetop Woodland in good condition, with high species diversity and intact structure. No threatened plants or EECs recorded. Potential habitat for *Acacia bynoeana, Cryptostylis hunteriana, Persoonia acerosa, Persoonia hirsuta, Pomaderris adnata*. | Undisturbed area with potential habitat features and feeding resources. An old stag with numerous small sized hollows likely to provide habitat for birds, small mammals and micro-bats is centered within the impact area. Dense shrubs and ground cover with scattered logs and small rocks. No water bodies present. No threatened species were recorded onsite however threatened species that have previously been recorded within the vicinity of this site include the Sooty Owl, Masked Owl, Grey-headed Flying-fox, Eastern Bent-wing Bat, Red-crowned toadlet and Giant Burrowing Frog. | Vegetation clearing required for borehole location. Some tree branch lopping may be required along Fire Road to facilitate access. Creek crossings should remain on existing crossings only. | Retain existing trees and Stag containing numerous small hollows. No drilling activities should occur within 2 m of the outer drip line of trees to protect the root zone and prevent dieback. No hollow bearing branches along access track to be lopped. Miminise clearing area required, restrict development to existing cleared fire road as far as practicable. Sediment and erosion control measures fencing required along north, east and south boundary of borehole site to minimise impacts to upland swamp. |  |

## 4.2 Plant Communities

The vegetation of the region has been mapped by Tindall et al. (2004). Five native plant communities have been mapped as occurring in the Study Area for the 18 boreholes (Figure 3). These are listed and described below.

**Coastal Sandstone Ridgetop Woodland**

Coastal Sandstone Ridgetop Woodland is a low eucalypt forest with a diverse shrub layer and open groundcover of sedges (Tindall *et al.* 2004). It is distributed extensively on ridgetops and upper valley slopes of the Hornsby and Woronora Plateau and the lower Blue Mountains (Tindall *et al.* 2004). About one quarter of its range has been cleared for urban development, but large areas are represented in conservation reserves (Tindall *et al.* 2004).

Within the Study Area, areas supporting Coastal Sandstone Ridgetop Woodland were dominated by canopy species *Eucalyptus sieberi, E. racemosa* and *Corymbia gummifera*, over a layer shrub of *Hakea teretifolia, Banksia paludosa, Leptospermum polygalifolium, L. trinervium, Lambertia formosa* and *Petrophile pulchella*. The understorey supported a high diversity of grasses, sedges and small shrubs such as *Entolasia stricta, Ptilothrix deusta, Xyris complanata, Epacris microphylla, Lomandra* spp., *Patersonia sericea, Leptocarpus tenax* and *Lepyrodia scariosa.* Plant species identified during the field survey were relatively consistent with the diagnostic plant species described for this community (Tindall *et al.* 2004).

Boreholes AI02, AI03, AI07, AI12B, AI14, AI15 and AI18 supported Coastal Sandstone Ridgetop Woodland. Borehole AI10 was mapped by Tindall et al. (2004) as supporting this plant community, but a survey of this location found the vegetation to be more consistent with Coastal Upland Swamp. Borehole AI16 was also mapped by Tindall et al. (2004) as supporting Coastal Sandstone Ridgetop Woodland, but this area was found to be mostly cleared.

**Coastal Sandstone Gully Forest**

Coastal Sandstone Gully Forest is an open eucalypt forest with a diverse sclerophyll shrub stratum and an open groundcover dominated by sedges (Tindall *et al.* 2004). It occurs on the lowerslopes of sandstone gullies along the eastern portion of the Hornsby and Woronora plateaux (Tindall *et al.* 2004). About one third of the distribution of this plant community has been cleared for urban development, but there are several examples represented in conservation reserves (Tindall *et al.* 2004).

Within the Study Area, areas supporting Coastal Sandstone Gully Forest supported canopy trees of *Eucalyptus racemosa, E. sieberi* and *Angophora*

*costata*, over a small tree layer of *Allocasuarina littoralis*, *Banksia serrata* and *Leptospermum* spp. The shrub layer supported species such as *Banksia ericifolia, Petrophile pulchella, Dillwynia floribunda, Platysace linearifolia* and *Kunzea ambigua*. Dominant understorey species included *Doryanthes excelsa, Empodisma minus, Lepyrodia scariosa* and *Actinotus minor*. Plant species identified during the field survey were relatively consistent with the diagnostic plant species described for this community (Tindall *et al.* 2004).

Boreholes AI02 and AI04B supported Coastal Sandstone Gully Forest.

**Coastal Upland Swamp**

Coastal Upland Swamp is described as having an open to dense shrub canopy with dense groundcover of sedges and forbs (Tindall *et al.* 2004). This plant community is restricted to swampy areas on humic sandy loams in headwater valleys and seepage zones on coastal sandstone plateaux (Tindall *et al.* 2004).

Dominant plant species recorded in Coastal Upland Swamps in the Study Area included a shrub canopy of *Banksia paludosa, B. ericifolia, Epacris microphylla* and *Hakea teretifolia* over a groundlayer supporting *Actinotus minor, Leptocarpus tenax, Ptilothrix deusta, Schoenus brevifolius* and *Bauera microphylla*. Plant species identified during the field survey were consistent with the diagnostic plant species described for this community (Tindall *et al.* 2004).

Boreholes AI08, AI10, AI12A, AI12B and AI15 supported Coastal Upland Swamp. Borehole AI17 was also mapped by Tindall et al. (2004) as supporting Coastal Upland Swamp, but this area was found to be mostly cleared.

**Sydney Shale Ironstone Cap Forest**

Sydney Shale Ironstone Cap Forest is described as a low eucalypt forest, with a very diverse, mixed understorey of shrubs, forbs and grasses (Tindall *et al.* 2004). This plant community is restricted to shale lenses and ironstone mantles on ridges (Tindall *et al.* 2004). Much of this plant community has been cleared for orchards and small farms (Tindall *et al.* 2004).

Dominant plant species in this community include *Corymbia gummifera, Angophora costata, Ceratopetalum gummiferum, Eucalyptus sieberi, E. capitellata* and *E. globoidea* in the canopy; *Lomatia silaifolia, Banksia spinulosa, Persoonia levis, Acacia myrtifolia* and *Hakea sericea* in the shrub layer; and *Entolasia stricta, Dianella caerula, Pteridium esculentum, Patersonia glabrata* and *Lomandra multiflora* in the groundlayer (Tindall *et al.* 2004).

This plant community was not recorded in the Study Area. Tindall et al. (2004) mapped Boreholes AI05, AI06, AI13, as supporting Sydney Shale Ironstone Cap Forest. However, these boreholes were found to be mostly cleared of native

vegetation, with some regeneration of common native shrubs and groundcovers, but supporting reduced species diversity due to disturbance to the topsoil. These boreholes were considered not likely to regenerate to support this plant community. Further, borehole AI14 was also mapped as supporting Sydney Shale Ironstone Cap Forest, but the survey of this location found the vegetation to be more consistent with Coastal Sandstone Ridgetop Woodland.

**Cleared**

Many of the boreholes have been placed within previously cleared and disturbed areas, in an effort to reduce impacts on local flora and fauna. These include old shaft sites, quarries and areas where coal wash has been introduced over the topsoil. The borehole locations in these disturbed areas did not support a native plant community and generally suffered a highly modified structure and reduced species diversity. These disturbed areas have a limited capacity to regenerate given the extensive topsoil disturbance.

Some regeneration of native shrub and groundcover species was evident at many of these sites, including species such as *Banksia ericifolia, Hakea teretifolia, H. sericea, Kunzea ambigua, Leptospermum polygalifolium, Petrophile pulchella, Lomandra longifolia, Acacia longifolia* and *Pteridium esculentum.* Exotic species such as *Andropogon virginicus, Cynodon dactylon* and *Ageratina adenophora* were also common at these disturbed sites.

Boreholes AI01, AI04A, AI05, AI06, AI07, AI09, AI11, AI16 and AI17 were located within cleared or disturbed areas.

### 4.2.1 Endangered Ecological Communities

Sydney Shale Ironstone Cap Forest includes O'Hares Creek Shale Forest, which listed as an EEC on the TSC Act (Tindall *et al.* 2004). This plant community was mapped as occurring in the Study Area by Tindall et al. (Tindall *et al.* 2004), though it was not recorded in the Study Area during the field surveys, as described above. This EEC is therefore not considered to occur in the Study Area.

## 4.3 Flora

A total of 119 plant species were recorded in the Study Area, including 109 (92%) native species and 10 (8%) exotic species.

A list of plant species recorded in the Study Area is provided in Appendix 1.

### 4.3.1 Threatened Flora

A total of 25 threatened flora species listed on the TSC Act and/or the EPBC Act have been either previously recorded or have potential habitat within the locality (Table 2). Records from the Biosis Research Threatened Flora Database have also been included from previous work in the locality. The distribution of threatened plants derived from DECC Atlas of NSW Wildlife and the Biosis Research Threatened Flora Database are illustrated in Figure 4.

No threatened flora species were recorded within the Study Area. However, potential habitat exists within the Study Area for *Acacia bynoeana, Cryptostylis hunteriana, Callistemon linearifolius, Epacris purpurascens* var. *purpurascens, Persoonia acerosa, Persoonia hirsuta, Pomaderris adnata* and *Pultenaea aristata.*

**Table 2: Threatened flora within 10km of the Study Area**

Key: 1) Listed on the TSC Act as Endangered (E1), Extinct (E4) or Vulnerable (V); 2) Listed on the EPBC Act as Endangered (E) or Vulnerable (V); 3) for ROTAP conservation ratings see Appendix 2.

| Scientific Name | Status | | | Habitat | Potential habitat |
|---|---|---|---|---|---|
| | EPBC Act[1] | TSC Act[2] | ROTAP | | |
| *Acacia baueri* ssp. *aspera* | - | V | 2R | Restricted to the Sydney region, occurring on the Kings Tableland in the central Blue Mountains and with sporadic occurrences on the Woronora Plateau in the Royal National Park, Mt. Keira district and at Wedderburn. Occurs in low, damp heathlands, often on exposed rocky outcrops. Appears to prefer open conditions; rarely observed where there is any shrub or tree canopy development; and many of the observations of this species have been made following fire, suggesting the species prefers early successional habitats. Peak flowering occurs December to March (DEC 2005m). | No |
| *Acacia bynoeana* | V | E1 | 3V | *Acacia bynoeana* is found in central eastern NSW, from the Hunter District (Morisset) south to the Southern Highlands and west to the Blue Mountains. It has recently been found in the Colymea and Parma Creek areas west of Nowra. Occurs in heath or dry sclerophyll forest on sandy soils. Seems to prefer open, sometimes slightly disturbed sites such as trail margins, edges of roadside spoil mounds and in recently burnt patches (DEC 2005a). | Yes. Coastal Sandstone Ridgetop Woodland. |
| *Astrotricha crassifolia* | V | V | 2V | 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. | No. South of species known range. |
| *Caladenia tessellata* | V | E1 | 3V | Low open forest with heath or sometimes grass understorey this species only grows in very dense shrubbery in coastal areas (Bishop 1996). Generally found in grassy sclerophyll woodland on clay loam or sandy soils, though the population near Braidwood is in low woodland with stony soil (DEC 2005b). Currently known from three disjunct areas: Braidwood on southern tablelands, Ulladulla on the south coast and three populations in Wyong area on the Central Coast (DEC 2005b). ROTAP; 3V. | Unlikely. Not known to occur in the area. |
| *Callistemon linearifolius* | - | V | 2Ri | Occurs chiefly from Georges River to the Hawkesbury River, and north to the Nelson Bay area of NSW (DEC 2005c)where it grows in dry sclerophyll forest (Harden 2002), open forest, scrubland (Fairley and Moore 2000) or woodland on sandstone. Found in damp places, usually in gullies (Robinson 1994). Flowers in Spring. | Yes. Coastal Sandstone Gully Forest. |

| Scientific Name | Status | | | Habitat | Potential habitat |
|---|---|---|---|---|---|
| | EPBC Act[1] | TSC Act[2] | ROTAP | | |
| *Chorizema parviflorum* | - | EP | - | Heath and sclerophyll woodland and forest on heavy soils (Harden 2002). All known sites (excluding the site at Austinmer) occupy woodland or forest dominated by Forest Red Gum (*Eucalyptus tereticornis*) and/or Woollybutt (*E. longifolia*) (DEC 2005d). | No |
| *Cryptostylis hunteriana* | V | V | 3V | This species typically grows in swamp-heath on sandy soils chiefly in coastal districts (Harden 1993) but has also been recorded on steep bare hillsides (Bishop 1996). This species does not appear to have well defined habitat preferences and is known from a range of communities, including swamp-heath and woodland. The larger populations typically occur in woodland dominated by Scribbly Gum (*Eucalyptus sclerophylla*), Silvertop Ash (*E. sieberi*), Red Bloodwood (*Corymbia gummifera*) and Black Sheoak (*Allocasuarina littoralis*); appears to prefer open areas in the understorey of this community and is often found in association with the Large Tongue Orchid (*C. subulata*) (DEC 2005e). | Yes. Coastal Sandstone Ridgetop Woodland |
| *Cynanchum elegans* | E | E1 | 3Ei | Rainforest gullies scrub and scree slopes in Gloucester and Wollongong districts (Harden 1992). Occurs mainly at the ecotone between dry subtropical rainforest and sclerophyll forest/woodland communities (DEC 2005~). Has been recorded in dry subtropical rainforest, littoral rainforest, *Leptospermum laevigatum-Banksia integrifolia* Coastal scrub, *Eucalyptus tereticornis* forest and woodland, *Corymbia maculata* forest and woodland and *Melaleuca armillaris* scrub to open scrub (DEC 2005~). | No |
| *Daphnandra sp. 'Illawarra'* | E | E1 | 2Vi | 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 2005f). | No |
| *Darwinia biflora* | V | V | 2Va | Grows in heath or sedgeland on sandstone or in the understorey of woodland on shale-capped ridges (Fairley and Moore 2000; Harden 1991; Robinson 1994) particularly where they intergrade with Hawkesbury sandstone. Associated overstorey species include *Eucalyptus haemastoma*, *Corymbia gummifera* and/or *E. squamosa*. The vegetation structure is usually woodland, open forest or scrub-heath (DEC 2004). Prefers moist shallow depressions (Robinson 1994). | Unlikely. *Eucalyptus haemastoma* and *E. squamosa* not recorded. |
| *Epacris purpurascens* var. *purpurascens* | - | V | 2K | 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 ridgetop drainage depressions supporting wet heath within or adjoining shale cap communities (including Shale Sandstone Transition Forest). Also occurs in riparian zones draining into Sydney Sandstone Gully Forest, shale lenses within sandstone habitats and colluvial areas overlying or adjoining sandstone or tertiary alluvium. Has been recorded from Gosford, Narrabeen, Silverdale and Avon Dam vicinity (DEC 2005h) | Yes. Coastal Upland Swamp and Coastal Sandstone Gully Forest. |
| *Eucalyptus camfieldii* | V | V | 2Vi | 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 2005i). | No. |
| *Genoplesium baueri* | - | V | 3R | This terrestrial orchid species grows in open sclerophyll forest or moss gardens on sandstone. Typically the habitat is a drier heathy forest (Harden 1993; Bishop 1996). The species has been recorded from locations between Nowra and Pittwater and may occur as far north as Port Stephens. About half the records were made before 1960 with most of the older records being from Sydney suburbs including Asquith, Cowan, Gladesville, Longueville and Wahroonga. No collections have been made from those sites in recent years. Flowers December to March (DEC 2005j). | No |

| Scientific Name | Status | | | Habitat | Potential habitat |
|---|---|---|---|---|---|
| | EPBC Act[1] | TSC Act[2] | ROTAP | | |
| *Grevillea parviflora* subsp. *parviflora* | 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 2005k). | No |
| *Leucopogon exolasius* | V | V | 2V | Woodland on sandstone, restricted to the Woronora and Grose Rivers (Harden 1991). The plant occurs in woodland on sandstone and prefers rocky hillsides along creek banks (NPWS 1997). Flowering occurs in August and September. | No |
| *Melaleuca deanei* | V | V | 3R | The species grows in heath on sandstone (DEC 2005n). 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 2005n). Flowers appear in summer but seed production appears to be small and consequently the species exhibits a limited capacity to regenerate. | No. |
| *Persoonia acerosa* | V | V | 2V | The Needle Geebung has been recorded only on the central coast and in the Blue Mountains, from Mt Tomah in the north to as far south as Hill Top where it is now believed to be extinct. Mainly in the Katoomba, Wentworth Falls, Springwood area. The Needle Geebung occurs in dry sclerophyll forest, scrubby low-woodland and heath on low fertility soils (DEC 2005o). | Yes. Coastal Sandstone Ridgetop Woodland. |
| *Persoonia bargoensis* | V | E1 | 2V | Restricted to a small area south-west of Sydney on the western edge of the Woronora Plateau. Its entire range falls between Picton, Douglas Park, Yanderra, Cataract River and Thirlmere. Occurs in woodland or dry sclerophyll forest on sandstone and on heavier, well drained, loamy, gravely soils typical of Shale Sandstone Transition Forest. Like most Geebungs this species seems to benefit from the reduced competition and increased light available on disturbance margins including roadsides (DEC 2005p). | No |
| *Persoonia hirsuta* | E | E1 | 3Ki | Occurs from Gosford to Royal NP and in the Putty district from Hill Top to Glen Davis (Harden 2002). Two subspecies are recognised, *P. hirsuta* ssp. *hirsuta* (Gosford to Berowra and Manly to Royal NP) and *P. hirsuta* ssp. *evoluta* (Blue Mountains, Woronora Plateau and Southern Highlands). Found in sandy soils in dry sclerophyll open forest, woodland and heath on sandstone and shale-sandstone transition areas (DEC 2005q). | Yes. Coastal Sandstone Ridgetop Woodland. |
| *Pomaderris adnata* | - | E1 | - | Ridgetop vegetation often with *Eucalyptus sieberi* and *Corymbia gummifera* (NSW Scientific Committee 2001). Occurs near the edge of the plateau behind the Illawarra escarpment. Known only from one site at Sublime Point, north of Wollongong (DEC 2005s). | Yes. Coastal Sandstone Ridgetop Woodland. |
| *Pomaderris brunnea* | V | V | 2V | 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 2005t). | No |
| *Prostanthera densa* | V | V | 3V | Occurs on coastal headlands and near-coastal ranges where it grows in sclerophyll forest and shrubland usually on sandstone (Harden 1992). This species has been recorded from the Currarong area in Jervis Bay, Royal National Park, Cronulla and Port Stephens (Gan Gan Hill, Nelson Bay). The Sydney and Royal NP populations have not been seen in recent times. Plants flower throughout the year (DEC 2005u). | No |
| *Pultenaea aristata* | V | V | 2V | Restricted to the Woronora Plateau, a small area between Helensburgh, south of Sydney, and Mt Keira above Wollongong. The species occurs in either dry sclerophyll woodland or wet heath on sandstone. Flowering has been recorded in winter and spring (DEC 2005v). | Yes. Coastal Upland Swamp. |

| Scientific Name | Status | | | Habitat | Potential habitat |
|---|---|---|---|---|---|
| | EPBC Act[1] | TSC Act[2] | ROTAP | | |
| *Solanum celatum* | - | E1 | - | Restricted to an area from Wollongong to just south of Nowra, and west to Bungonia. Majority of records are prior to 1960 and the majority of populations are likely to have been lost to clearing. Grows in rainforest clearings, or in wet sclerophyll forests. Flowers August to October and produces fruit December to January (DEC 2005y). | No |
| *Thesium australe* | V | V | 3Vi | Clay soils in grassy woodlands or coastal headlands (James *et al.* 1999). Found in very small populations scattered across eastern NSW, along the coast, and from the Northern to Southern Tablelands. Often found in damp sites in association with Kangaroo Grass (Themeda australis). A root parasite that takes water and some nutrient from other plants, especially Kangaroo Grass (DEC 2005}). | No |

### 4.3.2 ROTAP

Rare or Threatened Australian Plants (ROTAP) lists species that are Presumed Extinct, Endangered, Vulnerable, Rare or Poorly Known at the national level (Briggs and Leigh 1995). The ROTAP list has no legal status but is an important reference for the national status of threatened species, particularly for Rare or Poorly Known species which are not recognised by national and state threatened species legislations (Briggs and Leigh 1995) (EPBC and TSC Acts).

*Darwinia grandiflora* is listed as a ROTAP, with a conservation rating of 2RCi, indicating:

- 2 - the species has a geographic range of less than 100 km in Australia;
- R - the species is rare, but not currently considered to be endangered;
- C - the species is known to be represented within a conserved area,
- i – less than 1,000 plants are known to occur within a conservation reserve(s).

This species was recorded at borehole AI10 within Coastal Upland Swamp. It is recommended that the exact location of this species is flagged, so it can be adequately protected and avoided by the proposal during and after construction of the borehole. A suitably qualified ecologist should be on site during the initial borehole site setup, to ensure this species is not impacted by the proposal.

## 4.4 Fauna Habitats

The fauna habitat within the Study Area consists largely of Woodland and Upland Swamp habitat and broadly corresponds to the plant communities outlined in Section 4.2. Finer scale habitat features include rock outcrops, overhangs, tree hollows, leaf litter, and permanent and ephermeral waterbodies. Animal species may utilise some of these features wholly or partly, in conjunction with one another, or may depend entirely on one specific habitat

type. These habitat features and species associations are discussed in further detail below.

***Woodland***

Woodlands provide a wide range of foraging and sheltering habitat for vertebrate fauna. Myrtaceaeous trees dominate the upper canopy in these areas and supply direct (foliage, nectar, exudates) and indirect food (arthropods) for a range of vertebrates. In particular, native trees such as *Eucalyptus punctata* and *Allocasuarina littoralis* are considered feed trees for threatened species including Koala *Phascolarctos cinereus,* and Glossy Black-cockatoo *Calyptorhynchus lathami*.

A number of small tree hollows (formed in stags, mature and/or senescent trees) were recorded in the Study Area, providing nesting and roosting habitat for a range of common birds and arboreal mammal species. Locally recorded threatened species requiring tree-hollows for mating and nesting include the Gang-gang Cockatoo *Callocephalon fimbriatum*, Glossy Black-cockatoo and hollow-dwelling microchiropteran bats (micro bats).

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

Woodland habitat is considered to be in Moderate to Good condition, with the ground flora containing a high number of indigenous species; ground, log and litter layer intact; and a variety of habitat and resources for a range of native fauna available. Examples of threatened fauna that may utilise these habitats include Gang-gang Cockatoo, Glossy Black-cockatoo, Swift Parrot *Lathamus discolor* and Regent Honeyeater *Xanthomyza phrygia*.

***Rock Outcrops, Caves and Overhangs***

Rock outcrops, overhangs and small crevices occur along Cataract River and the tributaries throughout the Study Area. These habitats provide refuge for a range of reptile species including, Southern Leaf-tailed Gecko *Phyllurus platurus,* Lesueur's Velvet Gecko *Oedura lesueuri*i, and possibly the threatened Broad-headed Snake *Hoplocephalus bungaroides*.

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

Rocky outcrops, overhangs and small crevices were considered to be in Good condition, providing a high number of foraging and breeding habitat resources for native fauna.

***Cleared Areas***

The majority of the impact sites within the Study Area are located in sections that have been previously cleared or disturbed for a range of uses including fire roads, shaft sites, quarries, coal wash placement, and powerline easements. Despite these activities some native species still occur within disturbed vegetation and microhabitat components of these areas. Generally these areas would provide few habitat opportunities for native fauna. Species more likely to inhabit these areas include introduced and domestic animals and natives tolerant of disturbance or favouring edge/ecotone habitat.

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

***Waterbodies (Rivers, Creeks and Drainage lines)***

The Cataract River and tributaries (Cascade, Wallandoola, Lizard and an unnamed creek) provide habitat for a range of vertebrates (amphibian, reptile, bird and mammal) and invertebrate species.

## 4.5 Fauna

A detailed fauna survey was not undertaken for this assessment. Incidental observations of fauna species utilising the study site are listed in Appendix 3 and include two amphibian species, 30 bird species, five mammal species and four reptile species.

### 4.5.1 Significant Fauna

A total of 54 threatened and migratory animal species or their habitat have been previously recorded within the locality (DECC Atlas of NSW Wildlife (Figure 5)

and DEWHA EPBC Online Database). Of these, 44 animal species are listed under the TSC Act and 25 animal species listed under the EPBC Act.

No threatened fauna were recorded during the current survey. However, the Study Area contains potential habitat for 23 threatened or migratory animal species listed on the TSC Act and/or the EPBC Act (Koala, Greater Broad-nosed Bat *Scoteanax ruepellii*, Eastern False Pipistrelle *Falsistrellus tasmaniensis*, Eastern Bentwing Bat *Miniopterus schreibersii oceanensis*, Eastern Freetail-bat *Mormopterus norfolkensis*, Grey-headed Flying Fox *Pteropus poliocephalus*, Large-footed Myotis *Myotis macropus*, Red-crowned Toadlet *Pseudophryne australis*, Square-tailed Kite *Lophoictinia isura*, Gang-gang Cockatoo, Glossy Black- cockatoo, Powerful Owl *Ninox strenua*, Sooty Owl *Tyto tenebricosa*, Barking Owl *Ninox connivens*, Masked Owl *Tyto novaehollandiae*, Eastern Pygmy Possum *Cercartetus nanus*, Satin Flycatcher *Myiagra cyanoleuca*, Black-faced Monarch *Monarcha melanopsis*, Rainbow Bee-eater *Merops ornatus*, Regent Honeyeater, Swift Parrot, Southern Brown Bandicoot *Isoodon obesulus* and Large-eared Pied Bat *Chalinolobus dwyeri*) (see Table 3 below).

A number of threatened marine or pelagic species or their habitats have been recorded within a 10 km radius of the Study Area. As the proposal will not impact upon marine species they have not been considered further in this report.

**Table 3: Terrestrial fauna listed on the TSC Act or EPBC Act that may occur in the locality**

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

| Scientific Name | Common Name | EPBC Act [1] | TSC Act [2] | Habitat | Potential habitat |
|---|---|---|---|---|---|
| **Amphibians** | | | | | |
| *Heleioporus australiacus* | Giant Burrowing Frog | V | V | Prefers hanging swamps on sandstone shelves adjacent to perennial non-flooding creeks (Daly 1996; Recsei 1996). Can also occur within shale outcrops within sandstone formations. In the southern part of its range can occur in wet and dry forests, montane sclerophyll woodland and montane riparian woodland (Daly 1996). Individuals can be found around sandy creek banks or foraging along ridge-tops during or directly after heavy rain. Males often call from burrows located in sandy banks next to water (Barker *et al.* 1995). | No |
| *Litoria aurea* | Green and Golden Bell Frog | V | E1 | Found in marshes, dams and stream sides, particularly those containing bullrushes or spikerushes (NPWS 1999d). Preferred habitat contains water bodies that are unshaded, are free of predatory fish, have a grassy area nearby and have diurnal sheltering sites nearby such as vegetation or rocks (NPWS 1999d; White and Pyke 1996). | No |

| Scientific Name | Common Name | EPBC Act [1] | TSC Act [2] | Habitat | Potential habitat |
|---|---|---|---|---|---|
| *Litoria littlejohni* | Littlejohn's Tree Frog | V | V | Occurs in wet and dry sclerophyll forests associated with sandstone outcrops between 280 and 1000 m on the eastern slopes of the Great Dividing Range (Barker *et al.* 1995). Prefers flowing streams with a rocky base, but individuals have also been collected from semi-permanent dams with some emergent vegetation (Barker *et al.* 1995). Forages both in the tree canopy and on the ground, and has been observed sheltering under rocks on high exposed ridges during summer. It is not known from coastal habitats. | No |
| *Mixophyes balbus* | Stuttering Frog | V | E1 | This species is usually associated with mountain streams, wet mountain forests and rainforests (Barker *et al.* 1995). It rarely moves very far from the banks of permanent forest streams, although it will forage on nearby forest floors. Eggs are deposited in leaf litter on the banks of streams and are washed into the water during heavy rains (Barker *et al.* 1995). | No |
| *Pseudophryne australis* | Red-crowned Toadlet | | V | Occurs on wetter ridge tops and upper slopes of sandstone formations on which the predominant vegetation is dry open forests and heaths. This species typically breeds within small ephemeral creeks that feed into larger semi-perennial streams. After rain these creeks are characterised by a series of shallow pools lined by dense grasses, ferns and low shrubs (Thumm and Mahony 1997). | Yes |
| **Birds** | | | | | |
| *Apus pacificus* | Fork-tailed Swift | M | | Almost exclusively aerial (foraging and roosting). Breed in Asia (Higgins 1999). | No, overfly only |
| *Ardea alba* | Great Egret | M | | Terrestrial wetlands, estuarine and littoral habitats and moist grasslands. Inland, prefer permanent waterbodies on floodplains; shallows of deep permanent lakes (either open or vegetated), semi-permanent swamps with tall emergent vegetation and herb dominated seasonal swamps with abundant aquatic flora. Also regularly use saline habitats including mangrove forests, estuarine mudflats, saltmarshes, bare saltpans, shallows of salt lakes, salt fields and offshore reefs. Breeding requires wetlands with fringing trees in which to build nests including mangrove forest, freshwater lakes or swamps and rivers (Marchant and Higgins 1990). | No |
| *Ardea ibis* | Cattle Egret | M | | Occurs in tropical and temperate grasslands, wooded lands and terrestrial wetlands (Marchant and Higgins 1990). | No |
| *Botaurus poiciloptilus* | 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 |

| Scientific Name | Common Name | EPBC Act [1] | TSC Act [2] | Habitat | Potential habitat |
|---|---|---|---|---|---|
| *Callocephalon fimbriatum* | Gang-gang Cockatoo | | V | In summer, occupies tall montane forests and woodlands, particularly in heavily timbered and mature wet sclerophyll forests (Higgins 1999). Also occur in subalpine Snow Gum woodland and occasionally in temperate or regenerating forest (Forshaw and Cooper 1981). In winter, occurs at lower altitudes in drier, more open eucalypt forests and woodlands, particularly in box-ironbark assemblages, or in dry forest in coastal areas (Shields and Crome 1992). It requires tree hollows in which to breed (Gibbons and Lindenmayer 1997). | Yes |
| *Calyptorhynchus lathami* | Glossy Black-cockatoo | | V | Inhabits forest with low nutrients, characteristically with key Allocasuarina species. Tends to prefer drier forest types (NPWS 1999c) 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 |
| *Climacteris picumnus victoriae* | Brown Treecreeper (eastern subspecies) | | V | Live in eucalypt woodlands, especially areas of relatively flat open woodland typically lacking a dense shrub layer, with short grass or bare ground and with fallen logs or dead trees present (Traill and Duncan 2000). | No |
| *Coracina lineata* | 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). | No |
| *Gallinago hardwickii* | Latham's Snipe | M | | Typically found on wet soft ground or shallow water with good cover of tussocks. Often found in wet paddocks, seepage areas below dams (Pizzey and Knight 1997). | No |
| *Haliaeetus leucogaster* | White-bellied Sea-eagle | M | | A migratory species that is generally sedentary in Australia, although immatures and some adults are dispersive (Marchant and Higgins 1993). Found in terrestrial and coastal wetlands; favoring deep freshwater swamps, lakes and reservoirs; shallow coastal lagoons and saltmarshes (English and Predavec 2001). Also hunt over open terrestrial habitats. Feeds on birds, reptiles, fish, mammals, crustaceans and carrion. Roost and nest in trees (Marchant and Higgins 1993). | No |
| *Hirundapus caudacutus* | White-throated Needletail | M | | An aerial species found in feeding concentrations over cities, hilltops and timbered ranges. Breed in Asia (Pizzey and Knight 1997). | No, overfly only |
| *Ixobrychus flavicollis* | 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 |

| Scientific Name | Common Name | EPBC Act [1] | TSC Act [2] | Habitat | Potential habitat |
|---|---|---|---|---|---|
| *Lathamus discolor* | Swift Parrot | E | E1 | The Swift Parrot occurs in woodlands and forests of NSW from May to August, where it feeds on eucalypt nectar, pollen and associated insects (Forshaw and Cooper 1981). The Swift Parrot is dependent on flowering resources across a wide range of habitats in its wintering grounds in NSW (Shields and Crome 1992). This species is migratory, breeding in Tasmania, and also nomadic, moving about in response to changing food availability (Pizzey and Knight 1997). | Yes |
| *Lophoictinia isura* | Square-tailed Kite | | V | Typically inhabits coastal forested and wooded lands of tropical and temperate Australia (Marchant and Higgins 1993). In NSW it is often associated with ridge and gully forests dominated by Eucalyptus longifloria, Corymbia maculata, E. elata, or E. smithii (NPWS 1999f). Individuals appear to occupy large hunting ranges of more than 100 km2. They require large living trees for breeding, particularly near water with surrounding woodland /forest close by for foraging habitat. Nest sites are generally located along or near watercourses, in a tree fork or on large horizontal limbs (Marchant and Higgins 1993). | Yes |
| *Merops ornatus* | Rainbow Bee-eater | M | | Usually occurs in open or lightly timbered areas, often near water. Nest in emankments, including banks of creeks and rivers, in sand dunes, in quarries and in roadside cuttings. Breeding occurs from November to January. It has complex migratory movements in Australia. NSW populations migrate north for winter (Higgins 1999). | Yes |
| *Monarcha melanopsis* | Black-faced Monarch | M | | A migratory species found during the breeding season in damp gullies in temperate rainforests. Disperses after breeding into more open woodland (Pizzey and Knight 1997). | Yes |
| *Myiagra cyanoleuca* | Satin Flycatcher | M | | Migratory species that occurs in coastal forests, woodlands and scrubs during migration. Breeds in heavily vegetated gullies (Pizzey and Knight 1997). | Yes |
| *Neophema chrysogaster* | Orange-bellied Parrot | ZM | C1 | A single breeding population of fewer than 200 individuals occurs in a narrow coastal strip of south-west Tasmania. Adult birds depart Tasmania for the mainland in February, returning by November (OBPRT 1998). Critical winter habitat for the species includes natural saltmarshes, as well as the associated grassy or weedy pastures (DECC 2007a). Historical records indicate that the Orange-bellied Parrot was formerly more abundant and widespread in NSW than it is now, however the species' distribution continues to extend into south-eastern NSW where suitable habitat is still available (DECC 2007a). | No |

| Scientific Name | Common Name | EPBC Act [1] | TSC Act [2] | Habitat | Potential habitat |
|---|---|---|---|---|---|
| *Neophema pulchella* | Turquoise Parrot | | V | Occurs in open woodlands and eucalypt forests with a ground cover of grasses and understorey of low shrubs (Morris 1980). Generally found in the foothills of the Great Divide, including steep rocky ridges and gullies (Higgins 1999). Nest in hollow-bearing trees, either dead or alive; also in hollows in tree stumps. Prefer to breed in open grassy forests and woodlands, and gullies that are moist (Higgins 1999). | No |
| *Ninox connivens* | Barking Owl | | V | Generally found in open forests, woodlands, swamp woodlands and dense scrub. Can also be found in the foothills and timber along watercourses in otherwise open country. Nests in large hollows (Pizzey and Knight 1997). | Yes |
| *Ninox strenua* | Powerful Owl | | V | Occupies wet and dry eucalypt forests and rainforests. Can occupy both un-logged and lightly logged forests as well as undisturbed forests where it usually roosts on the limbs of dense trees in gully areas. It is most commonly recorded within Red Turpentine in tall open forests and Black She-oak within open forests (Debus and Chafer 1994b; Debus and Chafer 1994a). Large mature trees with hollows at least 0.5 m deep are required for nesting (Garnett 1992). Tree hollows are particularly important for the Powerful Owl because a large proportion of the diet is made up of hollow-dependent arboreal marsupials (Gibbons and Lindenmayer 1997). Nest trees for this species are usually emergent with a diameter at breast height of at least 100 cm (Gibbons and Lindenmayer 1997). | Yes |
| *Oxyura australis* | Blue-billed Duck | | V | Almost wholly aquatic, preferring deep water in large, permanent wetlands with an abundant aquatic flora (Marchant and Higgins 1990). | No |
| *Pachycephala olivacea* | Olive Whistler | | V | Found in a range of habitats including alpine thickets, wetter rainforest/woodlands, riparian vegetation and heaths (Pizzey and Knight 1997). | No |
| *Petroica rodinogaster* | 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). | No |
| *Ptilinopus magnificus* | Wompoo Fruit-Dove | | V | Mainly occurs in large undisturbed patches of tall tropical or subtropical rainforest. Occasionally occurs in patches of monsoon forest, closed gallery forest, wet sclerophyll forest, tall open forest, open woodland or vine thickets near rainforest (Higgins and Davies 1996). | No |
| *Ptilinopus regina* | Rose-crowned Fruit-Dove | | V | Occurs in tall tropical and subtropical, evergreen or semi-deciduous rainforest, especially with dense growth of vines. Prefers large patches of rainforest, but sometimes occurs in remnant patches surrounded by suboptimal habitat including farmlands (Higgins and Davies 1996). | No |

| Scientific Name | Common Name | EPBC Act [1] | TSC Act [2] | Habitat | Potential habitat |
|---|---|---|---|---|---|
| *Ptilinopus superbus* | Superb Fruit-Dove | | V | Mostly closed forests, including monsoon rainforests and mesophyll vine forests (Higgins and Davies 1996). | No |
| *Rhipidura rufifrons* | Rufous Fantail | M | | Migratory species that prefers dense, moist undergrowth of tropical rainforests and scrubs. During migration it can stray into gardens and more open areas (Pizzey and Knight 1997). | No |
| *Rostratula australis* | Australian Painted Snipe | VM | E1 | Usually found in shallow inland wetlands including farm dams, lakes, rice crops, swamps and waterlogged grassland. They prefer freshwater wetlands, ephemeral or permanent, although they have been recorded in brackish waters (Marchant and Higgins 1993). | No |
| *Tyto novaehollandiae* | Masked Owl | | V | Inhabits a diverse range of wooded habitat that provide tall or dense mature trees with hollows suitable for nesting and roosting (Higgins 1999). Mostly recorded in open forest and woodlands adjacent to cleared lands. Nest in hollows, in trunks and in near vertical spouts or large trees, usually living but sometimes dead (Higgins 1999). Nest hollows are usually located within dense forests or woodlands (Gibbons and Lindenmayer 1997). Masked owls prey upon hollow-dependent arboreal marsupials, but terrestrial mammals make up the largest proportion of the diet (Gibbons and Lindenmayer 1997; Higgins 1999). | Yes |
| *Tyto tenebricosa* | Sooty Owl | | V | Often found in tall old-growth forests, including temperate and subtropical rainforests. In NSW mostly found on escarpments with a mean altitude <500 m. Nests and roosts in hollows of tall emergent trees, mainly eucalypts (Higgins 1999) often located in gullies (Gibbons and Lindenmayer 1997). Nests have been located in trees 125 to 161 centimeters in diameter (Gibbons and Lindenmayer 1997). | Yes |
| *Xanthomyza phrygia* | Regent Honeyeater | E | E1 | A semi-nomadic species occurring in temperate eucalypt woodlands and open forests. Most records are from box-ironbark eucalypt forest associations and wet lowland coastal forests (NPWS 1999e; Pizzey and Knight 1997). | Yes |
| **Mammals** | | | | | |
| *Cercartetus nanus* | Eastern Pygmy-possum | | V | Inhabits rainforest through to sclerophyll forest and tree heath. Banksias and myrtaceous shrubs and trees are a favoured food source. Will often nest in tree hollows, but can also construct its own nest (Turner and Ward 1995). Because of its small size it is able to utilise a range of hollow sizes including very small hollows (Gibbons and Lindenmayer 1997). Individuals will use a number of different hollows and an individual has been recorded using up to 9 nest sites within a 0.5ha area over a 5 month period (Ward 1990). | Yes |

| Scientific Name | Common Name | EPBC Act [1] | TSC Act [2] | Habitat | Potential habitat |
|---|---|---|---|---|---|
| *Chalinolobus dwyeri* | Large-eared Pied Bat | V | V | Located in a variety of drier habitats, including the dry sclerophyll forests and woodlands to the east and west of the Great Dividing Range (Hoye and Dwyer 1995). Can also be found on the edges of rainforests and in wet sclerophyll forests (Churchill 1998). This species roosts in caves and mines in groups of between 3 and 37 individuals (Churchill 1998). | Yes |
| *Dasyurus maculatus maculatus* | Spotted-tailed Quoll (southeastern mainland) | E | V | Uses a range of habitats including sclerophyll forests and woodlands, coastal heathlands and rainforests (Dickman and Read 1992). Habitat requirements include suitable den sites, including hollow logs, rock crevices and caves, an abundance of food and an area of intact vegetation in which to forage (Edgar and Belcher 1995). | No |
| *Dasyurus viverrinus* | Eastern Quoll | | E1 | This species occurs in a variety of habitats including scrub, heathland, cultivated land and dry sclerophyll forest (Strahan 1995; NPWS 1999). Den sites can consist of a number of chambers in range of structure from underground burrows, hollow logs, rock piles and hay sheds. The Eastern Quoll is a solitary feeder with males often travelling over a kilometer in a night to forage (Strahan 1995). Females restrict their movements to a few hundred meters around their dens. This species feeds on agricultural pest, insect and large animals including ground-nesting birds and small mammals (NPWS 1999). | No |
| *Falsistrellus tasmaniensis* | Eastern False Pipistrelle | | V | Inhabit sclerophyll forests, preferring wet habitats where trees are more than 20 m high (Churchill 1998). Two observations have been made of roosts in stem holes of living eucalypts (Phillips 1995). There is debate about whether or not this species moves to lower altitudes during winter, or whether they remain sedentary but enter torpor (Menkhorst and Lumsden 1995). This species also appears to be highly mobile and records showing movements of up to 12 km between roosting and foraging sites (Menkhorst and Lumsden 1995). | Yes |
| *Isoodon obesulus* | Southern Brown Bandicoot | E | E1 | Prefers sandy soils with scrubby vegetation and/or areas with low ground cover that are burn from time to time (Braithwaite 1995). A mosaic of post fire vegetation is important for this species (Maxwell *et al.* 1996). | Yes |
| *Miniopterus schreibersii oceanensis* | Eastern Bentwing Bat | | V | Broad range of habitats including rainforest, wet and dry sclerophyll forest, paperbark forest and open grasslands. Roost in caves and man made habitats and under road culverts (Strahan 1995). | Yes* |

| Scientific Name | Common Name | EPBC Act [1] | TSC Act [2] | Habitat | Potential habitat |
|---|---|---|---|---|---|
| *Mormopterus norfolkensis* | Eastern Freetail Bat | | V | Most records are from dry eucalypt forests and woodlands to the east of the Great Dividing Range. Appears to roost in trees, but little is known of this species' habits (Allison and Hoye 1995; Churchill 1998). | Yes |
| *Myotis macropus (adversus)* | Large-footed Myotis | | V | Occurs in most habitat types as long as they are near permanent water bodies, including streams, lakes and reservoirs. Commonly roost in caves, but can also roost in tree hollows, under bridges and in mines (Richards 1995; Churchill 1998). | Yes |
| *Petaurus australis* | Yellow-bellied Glider | | V | Restricted to tall native forests in regions of high rainfall. Preferred habitats are productive, tall open sclerophyll forests where mature trees provide shelter and nesting hollows. Critical elements of habitat include sap-site trees, winter flowering eucalypts, mature trees suitable for den sites and a mosaic of different forest types (NPWS 1999g). | No |
| *Petrogale penicillata* | Brush-tailed Rock-wallaby | V | E1 | Found in rocky areas in a wide variety of habitats including rainforest gullies, wet and dry sclerophyll forest, open woodland and rocky outcrops in semi-arid country. Commonly sites have a northerly aspect with numerous ledges, caves and crevices (Eldridge and Close 1995). | No |
| *Phascolarctos cinereus* | Koala | | V | Inhabits eucalypt forests and woodlands. The suitability of these forests for habitation depends on the size and species of trees present, soil nutrients, climate and rainfall (Reed and Lunney 1990; Reed *et al*. 1990). | Yes |
| *Potorous tridactylus* | Long-nosed Potoroo | V | V | Inhabits coastal heath and wet and dry sclerophyll forests. Generally found in areas with rainfall greater than 760 mm. Requires relatively thick ground cover where the soil is light and sandy (Johnston 1995). | No |
| *Pteropus poliocephalus* | Grey-headed Flying-fox | V | V | This species is a canopy-feeding frugivore and nectarivore of rainforests, open forests, woodlands, melaleuca swamps and banksia woodlands. Bats commute daily to foraging areas, usually within 15 km of the day roost (Tidemann 1995) although some individuals may travel up to 70 km (Augee and Ford 1999). | Yes |
| *Scoteanax rueppellii* | Greater Broad-nosed Bat | | V | Prefer moist gullies in mature coastal forests and rainforests, between the Great Dividing Range and the coast. They are only found at low altitudes below 500 m (Churchill 1998). In dense environments they utilise natural and human-made opening in the forest for flight paths. Creeks and small rivers are favoured foraging habitat (Hoye and Richards 1995). This species roosts in hollow tree trunks and branches (Churchill 1998). | Yes |
| **Reptiles** | | | | | |

| Scientific Name | Common Name | EPBC Act [1] | TSC Act [2] | Habitat | Potential habitat |
|---|---|---|---|---|---|
| *Hoplocephalus bungaroides* | Broad-headed Snake | V | E1 | Mainly occurs in association with communities occurring on Triassic sandstone within the Sydney Basin. Typically found among exposed sandstone outcrops with vegetation types ranging from woodland to heath. Within these habitats they generally use rock crevices and exfoliating rock during the cooler months and tree hollows during summer (Webb 1996; Webb and Shine 1998). | No |
| *Varanus rosenbergi* | Rosenberg's Goanna | | V | This species is a Hawkesbury/Narrabeen sandstone outcrop specialist (Wellington and Wells 1985). Occurs in coastal heaths, humid woodlands and both wet and dry sclerophyll forests (Cogger 1992). | No |

*Habitat for this species will not be encountered underground. i.e. goaf areas targeted by the proposal will be contrary to life as they are sealed and will contain high volumes of methane. The proposal will not impact on cave or disused mine infratsruture which may provide habitat for this species.

# 5.0 IMPACT ASSESSMENT

## 5.1 Predicted Impacts

The disturbance footprint of each borehole site comprises a 50 m x 60 m compound with additional light vehicle parking. Additional construction of access tracks may be required. It is therefore assumed that a total area of 80 m x 80 m (0.6 ha) for all disturbed areas is adequate to consider all direct and indirect impacts associated with the proposal.

Impacts associated with the proposal include:

- Disturbance to 3.6 ha of Coastal Sandstone Ridgetop Woodland at boreholes AI02, AI03, AI12B, AI14, AI15, AI18;
- Disturbance to 0.6 ha of Coastal Sandstone Gully Forest at borehole AI04B;
- Disturbance to 1.2 ha of Coastal Upland Swamp at boreholes AI08, AI10;
- Fragmentation of Coastal Sandstone Gully Forest at AI04B; and,
- Disturbance to 6 ha of disturbed areas supporting regenerating common native and exotic species at boreholes AI01, AI04A, AI05, AI06, AI07, AI09, AI11, AI13, AI16, AI17. Provided appropriate amelioration measures are implemented (as detailed below), this disturbance is not anticipated to have an impact on any issues of an ecological significance. This impact has not been considered further in this report.

The indirect impacts associated with the proposal include (in the absence of adequate amelioration measures):

- the potential for erosion during and after construction at all sites;
- the possible provision of suitable conditions for weed invasion; and,
- increased human activity.

## 5.2 Proposed Amelioration Measures

The following measures have been recommended in order to ameliorate the impacts of the proposal:

- adjustment of the location of boreholes and access tracks to avoid native trees and significant habitat features such as sandstone outcropping, where required;
- trees with hollows should be retained and protected, with no drilling within the critical root zone (extending to 2 m beyond the drip line) of the trees;
- access to boreholes AI10, AI16, and AI18 may require trimming of branches along existing fire trails. Such branch trimming should be limited and restricted to smaller branches that do not support hollows. Should large branches with hollows be required to be removed, a suitably qualified ecologist should be on site during clearing to ensure no resident fauna are harmed. Cleared branches should be placed in adjoining vegetation, as they will provide habitat for fauna;
- access to boreholes AI10, AI16 and AI18 will involve two creek crossings. These crossings will use established crossings along the established Fire Road 10Q and will not divert into other areas of the creeklines. Caution should be taken to prevent sedimentation run off and minimise disturbance along the creek.
- where possible, proposed boreholes and access tracks should be located within existing cleared areas;
- sediment and erosion control measures should be implemented on all sites to prevent erosion during and after construction;
- disturbance to native vegetation should be minimised, or, where disturbance is unavoidable, borehole sites should be rehabilitated using locally sourced tubestock and brush-matting. Rehabiliation should be undertaken by suitably qualified bush regenerators;
- where clearing of native vegetation is unavoidable, native shrubs, logs and bush-rock should be stockpiled on the side of the proposed boreholes and access routes and replaced following completion of the works;

- if required, bush regeneration and weed control should be undertaken to ensure the flora and fauna of the locality are protected throughout the construction and operation phases of the proposal. This is particualry important for boreholes where intact native vegetation will be disturbed. Any bush regeneration and weed control should be undertaken by suitably qualified bush regenerators;

- any chemicals used on site will be taken off site after use and disposed of appropriately;

- machinery and vehicles should be washed down prior to use on site to avoid the transmission of weed seed or disease into intact areas of native vegetation; and,

- a suitably qualified ecologist should be on site during the initial site setup for each borehole, to ensure significant habitat features and species are not impacted by the proposal.

## 5.3 Part 3A Guidelines for Threatened Species Assessment (EP&A Act)

The impacts of the proposal on threatened biota listed under the TSC Act have been undertaken following the Guidelines for Threatened Species Assessment under Part 3A of the EP&A Act (DEC & DPI 2005). Where threatened biota **is recorded** within a Study Area, an impact assessment is required under the EP&A Act. When threatened biota **is not recorded** during a survey, the presence of potential habitat for this species is used to determine the need to undertake an impact assessment under the EP&A Act. Where there is no potential habitat in the Study Area for threatened biota, there is unlikely to be any impact on these species and therefore these species are not required to be considered further.

The impact assessments included in Appendix 4 incorporate a consideration of the predicted impacts and amelioration measures as outlined in Sections 5.1 and 5.2 respectively.

### 5.3.1 Endangered Ecological Communities

The Study Area does not support any Endangered Ecological communities listed under the TSC Act.

### 5.3.2 Flora

Coastal Sandstone Ridgetop Woodland provides potential habitat for the threatened plant species *Acacia bynoeana, Cryptostylis hunteriana, Persoonia acerosa, Persoonia hirsuta* and *Pomaderris adnata*.

Coastal Sandstone Gully Forest provides potential habitat for the threatened plant species *Callistemon linearifolius* and *Epacris purpurascens* var. *purpurascens*.

Coastal Upland Swamp provides potential habitat for the threatened plant species *Epacris purpurascens* var. *purpurascens* and *Pultenaea aristata.*

Each of these species is listed as threatened on the TSC Act and, as such, the impact of the proposal on these species has been considered in Appendix 4.

### 5.3.3 Fauna

No threatened fauna were recorded during the current survey. However, the Grey-headed Flying Fox, Koala, Red-crowned Toadlet, Giant Burrowing Frog, Greater Broad-nosed Bat, Eastern Freetail-bat, Eastern Bentwing-bat, Gang-gang Cockatoo, Powerful Owl, Sooty Owl and Eastern Pygmy-possum have been recorded within or in close vicinity of the Study Area. Where there is potential habitat (foraging or breeding resources) for a threatened species in the Study Area, further consideration must be given to the potential impact of the proposal on these species.

The proposal may significantly impact threatened species by causing any of the following situations to arise:

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

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

The Study Area contains potential habitat for the Grey-headed Flying Fox, Koala, Microchiropteran Bats (Greater Broad-nosed Bat, Eastern False Pipistrelle, Eastern Bentwing Bat, Large-eared Pied Bat, Eastern Freetail-bat, Large-footed Myotis), Regent Honeyeater, Swift Parrot, Red-crowned Toadlet,

Square-tailed Kite, Cockatoos (Gang-gang Cockatoo and Glossy Black-cockatoo), Forest Owls (Powerful Owl, Sooty Owl, Barking Owl and Masked Owl), Eastern Pygmy-possum, Migratory species (Rainbow Bee-eater, Satin Fly catcher, Black-faced Monarch) and Southern Brown Bandicoot.

Impact assessments have been prepared for these species in Appendix 4. The remaining 32 threatened species were not recorded within the Study Area and potential habitat for these species does not occur within the Study Area, therefore these species are not considered further.

### 5.3.4 Conclusions of the Impact Assessments

The impact assessments (Appendix 4) concluded that the proposal is likely to have a minor impact on threatened biota, as listed on the TSC Act, provided recommended ameliorative measures are adhered to.

### 5.3.5 Key Thresholds

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

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

Based on the impact assessments following the Part 3A Guidelines of the EP&A Act for Threatened Species Assessment (Appendix 4), the proposal is unlikely to reduce the long-term viability of, accelerate the extinction of and/or adversely affect critical habitat for threatened species and/or populations within the Study Area (Table 4).

**Maintenance of Biodiversity Values**

Given that a total of 5.4 ha of relatively intact native vegetation, that provides potential habitat for a number of threatened speices, will be impacted by the proposal, some biodiversity values of the locality will be lost. The loss of biodiveristy values can be minimised by incorporating the proposed amelioration measures detailed in Section 5.2, particularly measures to avoid significant habitat feratures and to rehabilitate where areas of intact native vegetation are disturbed.

Provided that the amelioration measures detailed in Section 5.2 are implemented, the proposal is likely to maintain the biodiversity values of the locality. Rehabilitation of disturbed area is critical to maintaining biodiversity values of the impacted areas.

**Table 4: Assessment of Key Thresholds**

| Threatened Biota | Whether or not the proposal, including actions to avoid or mitigate impacts or compensate to prevent unavoidable impacts, will maintain or improve biodiversity values. | Will the proposal reduce the long-term viability of a local population of the species, population or EEC? | Will the proposal accelerate the extinction of the species, population or EEC or place it at risk of extinction? | Will the proposal adversely affect critical habitat? |
|---|---|---|---|---|
| **Threatened Flora** | | | | |
| *Acacia bynoeana* | Likely to maintain biodiversity values | Unlikely | Unlikely | No |
| *Callistemon linearifolius* | Likely to maintain biodiversity values | Unlikely | Unlikely | No |
| *Cryptostylis hunteriana* | Likely to maintain biodiversity values | Unlikely | Unlikely | No |
| *Epacris purpurascens* var. *purpurascens* | Likely to maintain biodiversity values | Unlikely | Unlikely | No |
| *Persoonia acerosa* | Likely to maintain biodiversity values | Unlikely | Unlikely | No |
| *Persoonia hirsuta* | Likely to maintain biodiversity values | Unlikely | Unlikely | No |
| *Pomaderris adnata* | Likely to maintain biodiversity values | Unlikely | Unlikely | No |
| *Pultenaea aristata* | Likely to maintain biodiversity values | Unlikely | Unlikely | No |
| *Solanum celatum* | Likely to maintain biodiversity values | Unlikely | Unlikely | No |
| **Threatened Fauna** | | | | |
| Grey-headed Flying Fox | Likely to maintain biodiversity values | Unlikely | Unlikely | No |
| Koala | Likely to maintain biodiversity values | Unlikely | Unlikely | No |
| Microchiropteran Bats (Greater Broad-nosed Bat, Eastern False Pipistrelle, Eastern Bentwing Bat, Large-eared Pied Bat, Eastern Freetail-bat, Large-footed Myotis) | Likely to maintain biodiversity values | Unlikely | Unlikely | No |
| Regent Honeyeater and Swift Parrot | Likely to maintain biodiversity values | Unlikely | Unlikely | No |
| Red-crowned Toadlet | Likely to maintain biodiversity values | Unlikely | Unlikely | No |
| Square-tailed Kite | Likely to maintain biodiversity values | Unlikely | Unlikely | No |
| Cockatoos (Gang-gang Cockatoo and Glossy Black- cockatoo) | Likely to maintain biodiversity values | Unlikely | Unlikely | No |

| Threatened Biota | Whether or not the proposal, including actions to avoid or mitigate impacts or compensate to prevent unavoidable impacts, will maintain or improve biodiversity values. | Will the proposal reduce the long-term viability of a local population of the species, population or EEC? | Will the proposal accelerate the extinction of the species, population or EEC or place it at risk of extinction? | Will the proposal adversely affect critical habitat? |
|---|---|---|---|---|
| Forest Owls (Powerful Owl, Sooty Owl, Barking Owl and Masked Owl) | Likely to maintain biodiversity values | Unlikely | Unlikely | No |
| Eastern Pygmy-possum | Likely to maintain biodiversity values | Unlikely | Unlikely | No |
| Migratory bird species (Rainbow Bee-eater, Satin Fly catcher, Black-faced Monarch) | Likely to maintain biodiversity values | Unlikely | Unlikely | No |
| Southern Brown Bandicoot | Likely to maintain biodiversity values | Unlikely | Unlikely | No |

## 5.4 Commonwealth Significance Impact Criteria (EPBC Act)

Under the Commonwealth EPBC Act, if the proposal has the potential to have an adverse impact on threatened biota listed on the Act, the proposal must be referred to the Federal Minister for the Environment for further consideration. The Significant Impact Criteria are used to assess the likelihood of impact.

The address of Significant Impact Criteria included in Appendix 5 incorporates a consideration of the predicted impacts and amelioration measures as outlined in Sections 5.1 and 5.2 respectively.

### 5.4.1 Endangered Ecological Communities

The Study Area does not support any Endangered Ecological communities listed under the EPBC Act.

### 5.4.2 Flora

Coastal Sandstone Ridgetop Woodland provides potential habitat for the threatened plant species *Acacia bynoeana, Cryptostylis hunteriana, Persoonia acerosa* and *Persoonia hirsuta*.

Coastal Upland Swamp provides potential habitat for the threatened plant species *Pultenaea aristata.*

Each of these species is listed as threatened on the EPBC Act and, as such, the impact of the proposal on these species has been considered in Appendix 5.

### 5.4.3 Fauna

Twenty five threatened fauna species and migratory species were recorded as having the potential to occur in the locality (DEWHA online database). The Study Area contains potential habitat for the Grey-headed Flying-fox, Satin Flycatcher, Black-faced Monarch, Rainbow Bee-eater, Regent Honeyeater, Swift Parrot, Southern Brown Bandicoot and Large-eared Pied Bat.

Assessments of the Significance Impact Criteria have been prepared for these species in Appendix 5. Potential habitat for the remaining 17 threatened species does not occur within the Study Area or is not limiting (as defined in Section 5.3.3), and therefore Assessments of Significance are not required for these species.

### 5.4.4 Conclusions of the Significant Impact Criteria

The Significant Impact Criteria Assessments under the EPBC Act (Appendix 5) found that the proposal is not likely to have a significant impact on threatened species, endangered ecological communities or their habitats, as listed on the EPBC Act, provided recommended ameliorative measures are adhered to.

# 6.0 CONCLUSION

The proposal will involve clearing or modifying approximately 3.6 ha of Coastal Sandstone Ridgetop Woodland; 0.6 ha of Coastal Sandstone Gully Forest; 1.2 ha of Coastal Upland Swamp; and 6 ha of disturbed areas supporting regenerating common native and exotic species.

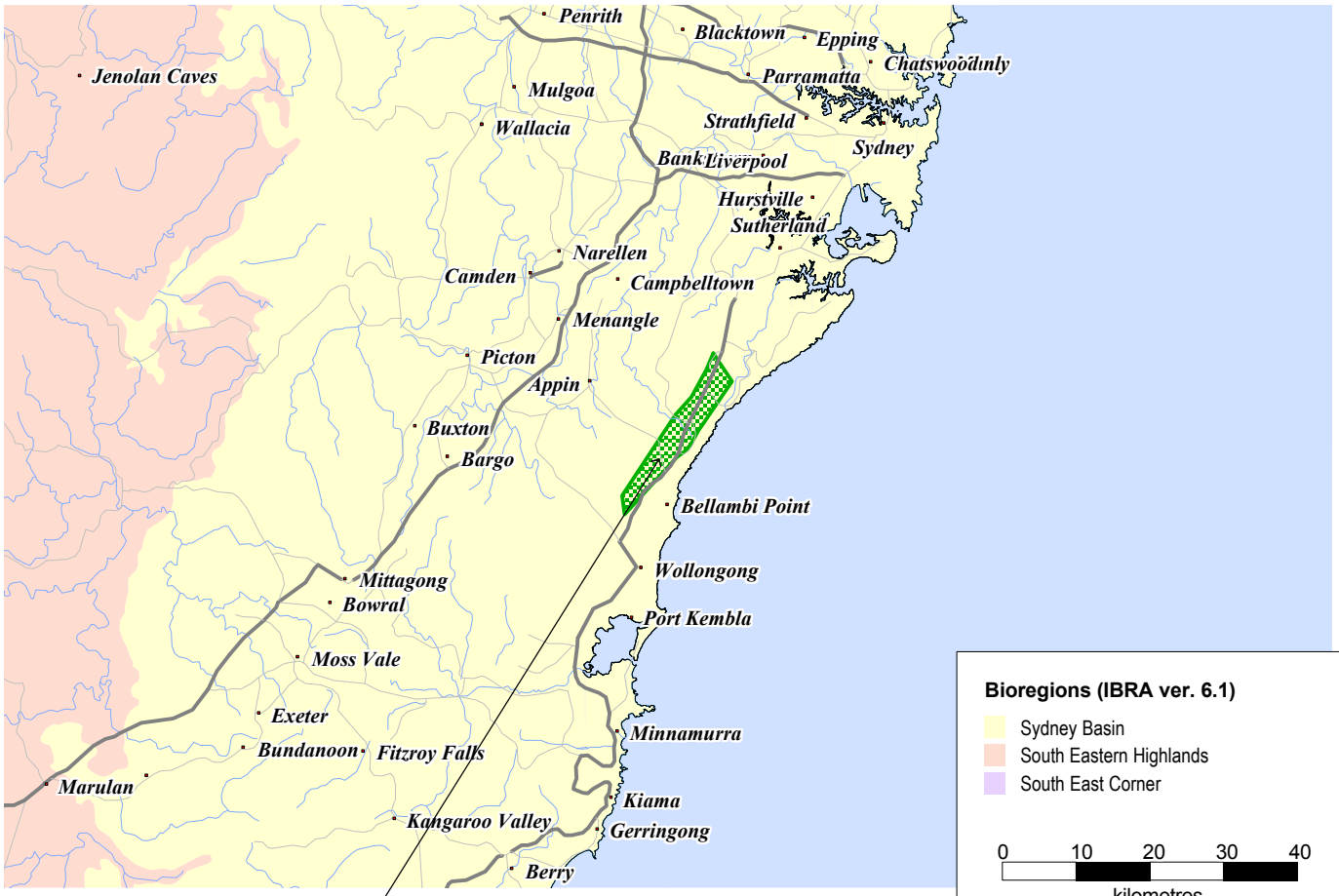
No Endangered Ecological Communities (EEC) listed on the TSC Act or EPBC Act were recorded in the Study Area. No threatened plant species were recorded within the Study Area. However, potential habitat for eight threatened species (*Acacia bynoeana, Callistemon linearifolius, Cryptostylis hunteriana, Epacris purpurascens* var. *purpurascens, Persoonia acerosa, Persoonia hirsuta, Pomaderris adnata* and *Pultenaea aristata*) occurs within the Study Area.

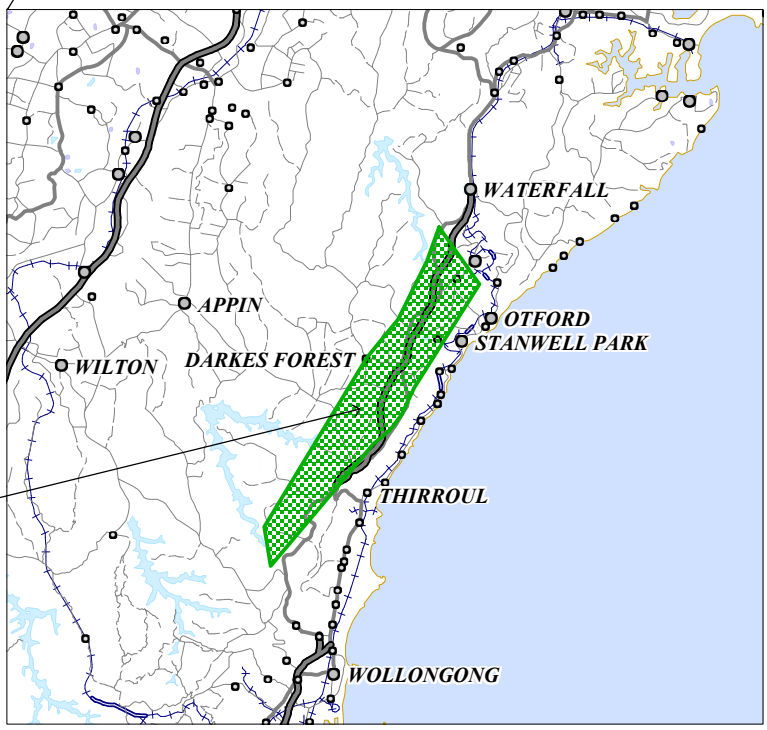
The proposal is likely to remove or modify potential habitat for 23 threatened or migratory animal species listed on the TSC Act and/or the EPBC Act (Koala, Greater Broad-nosed Bat, Eastern False Pipistrelle, Eastern Bentwing Bat, Eastern Freetail-bat, Large-footed Myotis, Red-crowned Toadlet, Square-tailed Kite, Gang-gang Cockatoo, Glossy Black- cockatoo, Powerful Owl, Sooty Owl, Barking Owl, Masked Owl, Eastern Pygmy-possum, Grey-headed Flying Fox, Satin Fly catcher, Black-faced Monarch, Rainbow Bee-eater, Regent Honeyeater, Swift Parrot, Southern Brown Bandicoot and Large-eared Pied Bat.

Impact Assessments following the Guidelines for Threatened Species Assessment under Part 3A of the EP&A Act (DEC & DPI 2005) and Significant Impact Guidelines under the EPBC Act (DEH 2006) were carried out for threatened biota occurring or with potential habitat in the Study Area. It was found the impacts of the proposal are likely to be minor.

A number of amelioration measures are recommended in Section 5.2 to reduce the potential impacts of the proposal on flora and fauna of the locality.

# FIGURES




Study area



BIOSIS RESEARCH Pty. Ltd.

8 Tate St
WOLLONGONG
NEW SOUTH WALES 2500

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

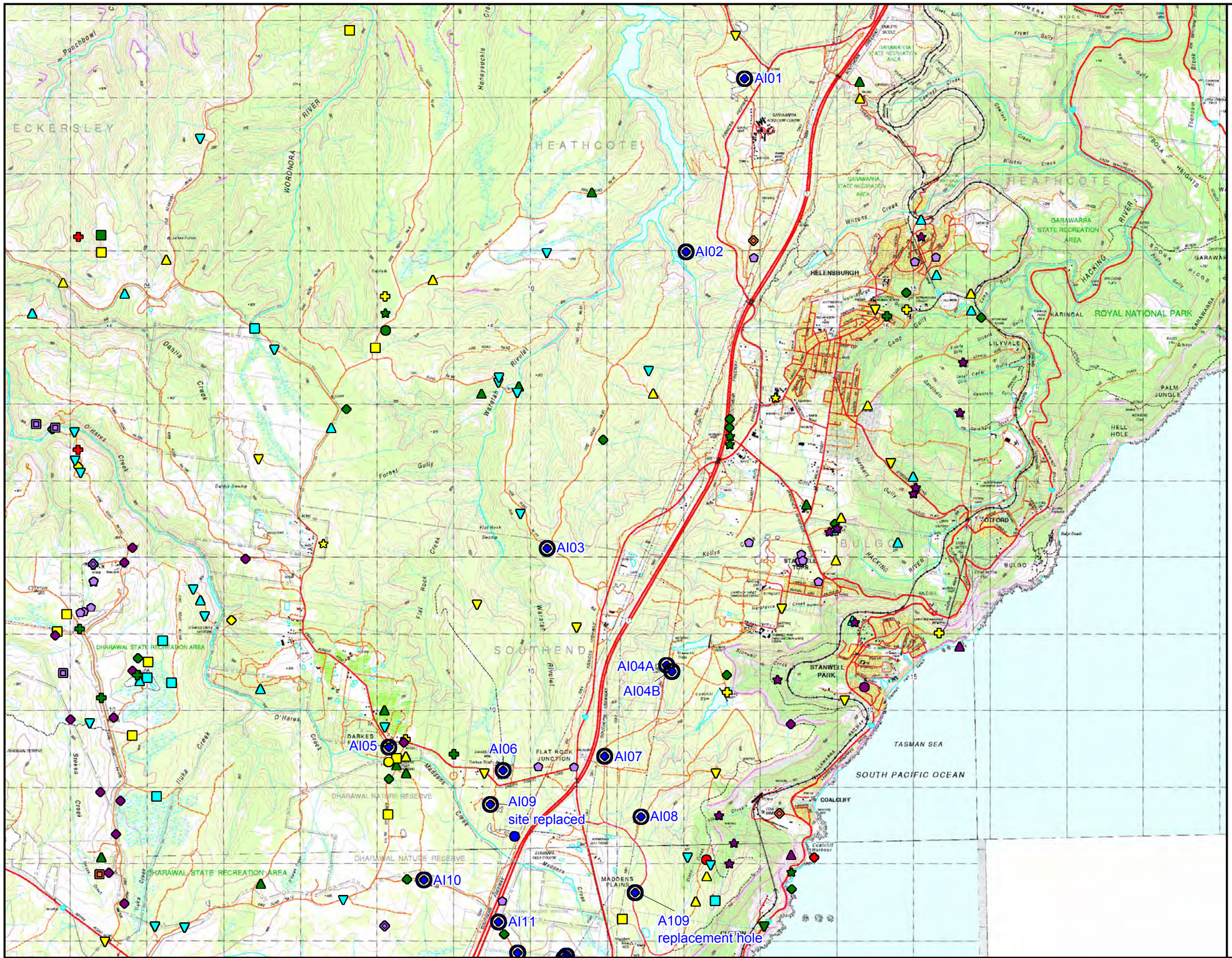
Date: 25 Sept 2008

Checked by: SEW | File number: S4806

Location:-...\4000\4800s\4806\Mapping\S4806 F1 locality.wor

Scale: 0 5 10 15 20 kilometres

N W E S




## Legend

### Threatened flora

- *Acacia baueri ssp aspera*
- *Callistemon linearifolius*
- *Chorizema parviflorum*
- *Daphnandra sp. C Illawarra*
- *Epacris purpurascens var. purpurascens*
- *Leucopogon exolasius*
- *Persoonia hirsuta*
- *Pomaderris adnata*
- *Pultenaea aristata*

### Threatened fauna

- Australasian Bittern
- Australian Fur-seal
- Barking Owl
- Barred Cuckoo-shrike
- Beach Stone-curlew
- Black Bittern
- Broad-headed Snake
- Brown Treecreeper
- Eastern Bentwing-bat
- Eastern False Pipistrelle
- Eastern Freetail-bat
- Eastern Pygmy-possum
- Eastern Quoll
- Gang-gang Cockatoo
- Giant Burrowing Frog
- Glossy Black-Cockatoo
- Greater Broad-nosed Bat
- Green and Golden Bell Frog
- Grey-headed Flying-fox
- Koala
- Large-footed Myotis
- Little Shearwater
- Littlejohn's Tree Frog
- Masked Owl
- Pied Oystercatcher
- Pink Robin
- Powerful Owl
- Red-crowned Toadlet
- Rose-crowned Fruit-Dove
- Rosenberg's Goanna
- Sooty Albatross
- Sooty Owl
- Sooty Oystercatcher
- Sooty Tern
- Southern Giant Petrel
- Southern Right Whale
- Spotted-tailed Quoll
- Square-tailed Kite
- Turquoise Parrot

### Survey areas

- Proposed borehole (June 2008)

BIOSIS RESEARCH Pty. Ltd.

8 Tate St
Wollongong
NEW SOUTH WALES 2500

Figure 2a: Project Layout (North) - Borehole locations and threatened flora and fauna species in the vicinity.

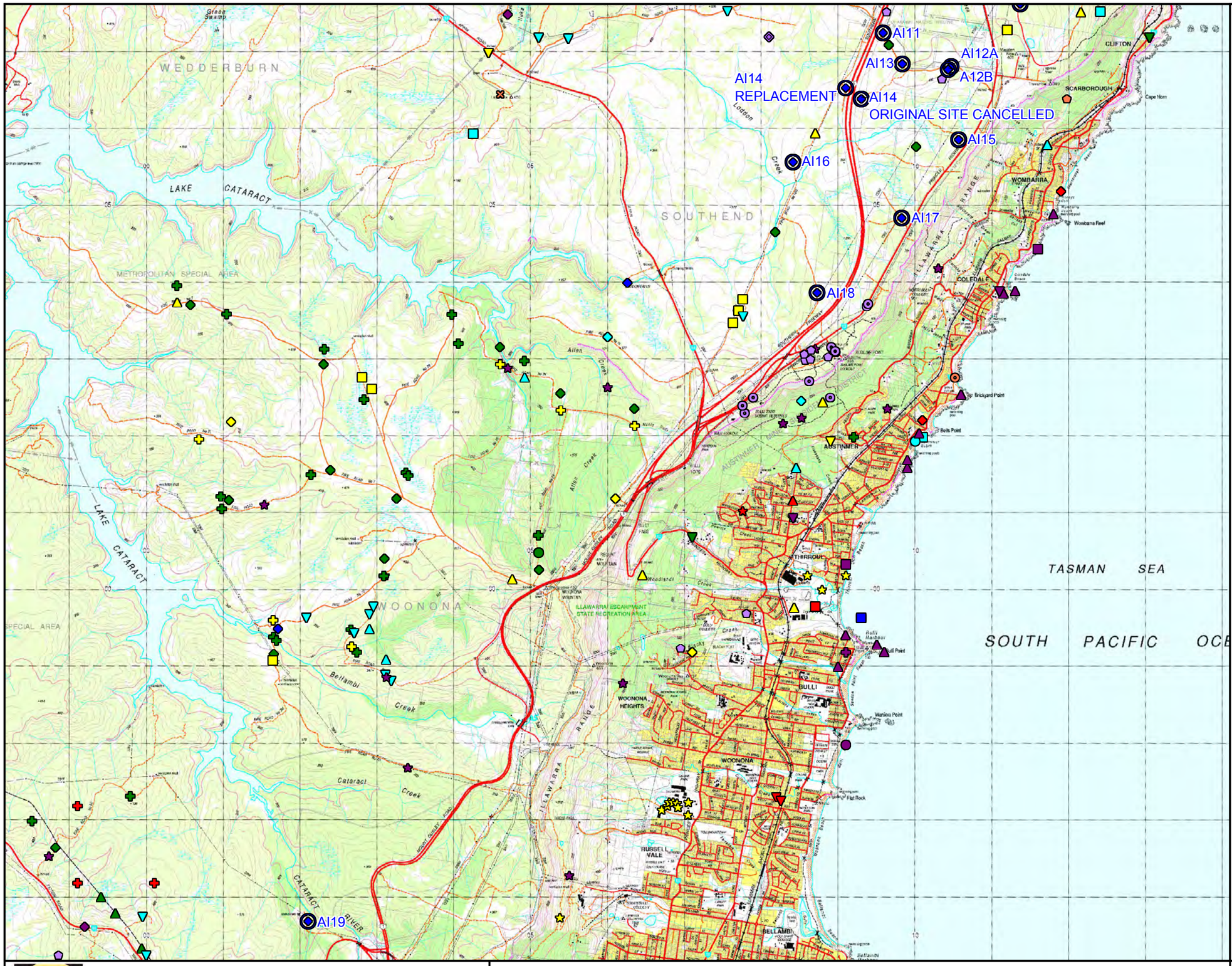
DATE: 26 September 2008

Checked by: SEW | File number: S4806

Location:-..4000\4800s\4806\Mapping\field\S4806 F2a Proposal.WOR

Scale: 0 0.5 1.0 1.5 2.0 2.5 kilometres

Figure 2a: Project Layout (North)- Borehole locations and threatened flora and fauna species in the vicinity.




**Legend**

**Threatened flora**

- *Acacia baueri ssp aspera*
- *Callistemon linearifolius*
- *Chorizema parviflorum*
- *Daphnandra sp. C Illawarra*
- *Epacris purpurascens var. purpurascens*
- *Leucopogon exolasius*
- *Persoonia hirsuta*
- *Pomaderris adnata*
- *Pultenaea aristata*

**Threatened fauna**

- Australasian Bittern
- Australian Fur-seal
- Barking Owl
- Barred Cuckoo-shrike
- Beach Stone-curlew
- Black Bittern
- Broad-headed Snake
- Brown Treecreeper
- Eastern Bentwing-bat
- Eastern False Pipistrelle
- Eastern Freetail-bat
- Eastern Pygmy-possum
- Eastern Quoll
- Gang-gang Cockatoo
- Giant Burrowing Frog
- Glossy Black-Cockatoo
- Greater Broad-nosed Bat
- Green and Golden Bell Frog
- Grey-headed Flying-fox
- Koala
- Large-footed Myotis
- Little Shearwater
- Littlejohn's Tree Frog
- Masked Owl
- Pied Oystercatcher
- Pink Robin
- Powerful Owl
- Red-crowned Toadlet
- Rose-crowned Fruit-Dove
- Rosenberg's Goanna
- Sooty Albatross
- Sooty Owl
- Sooty Oystercatcher
- Sooty Tern
- Southern Giant Petrel
- Southern Right Whale
- Spotted-tailed Quoll
- Square-tailed Kite
- Turquoise Parrot

**Survey areas**

- Proposed borehole (June 2008)

BIOSIS RESEARCH Pty. Ltd.
8 Tate St
Wollongong
NEW SOUTH WALES 2500

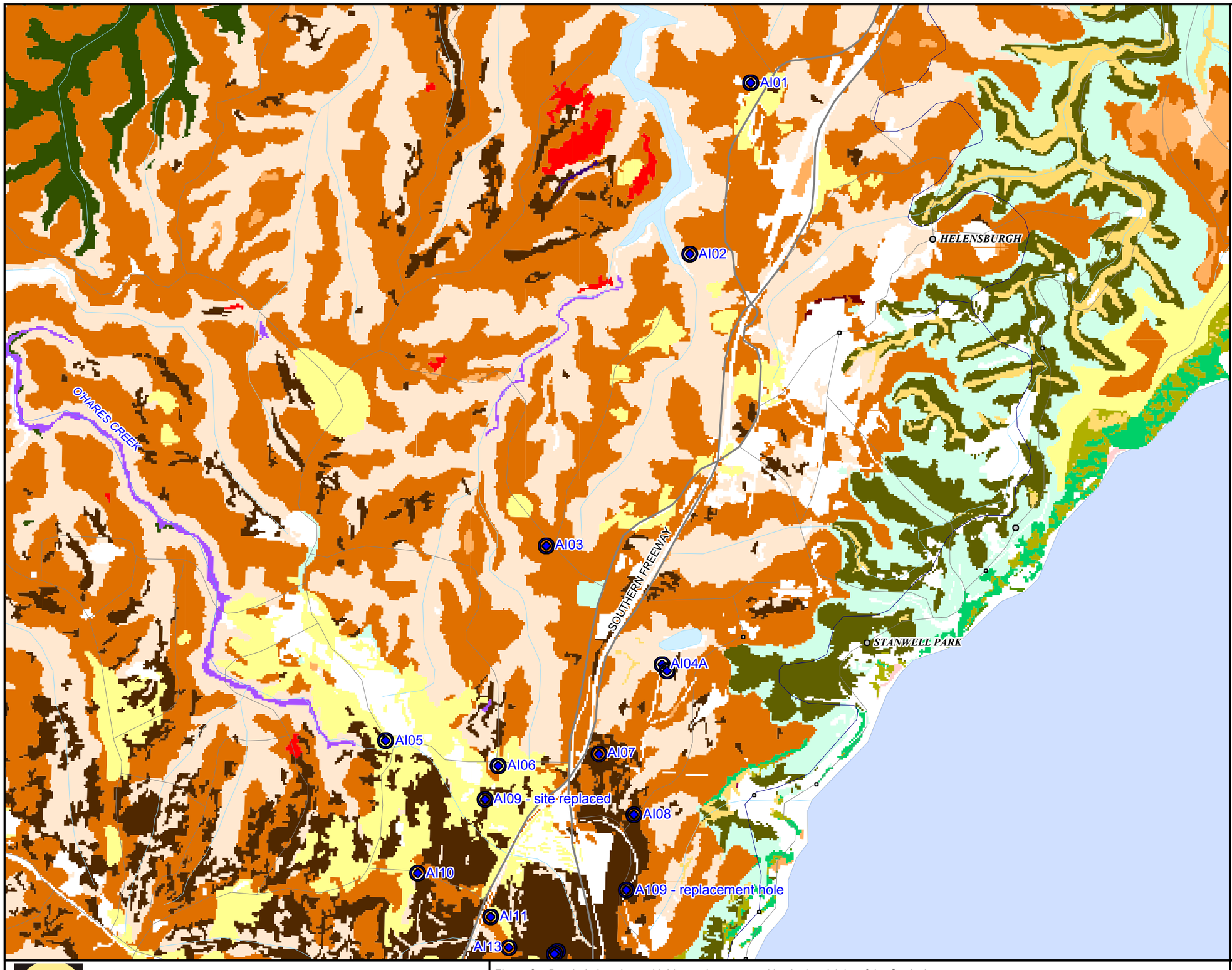
Figure 2b: Project Layout (South) - Borehole locations and threatened flora and fauna species in the vicinity.

DATE: 26 September 2008
Checked by: SEW
File number: S4806
Location:-..4000\4800s\4806\Mapping\field\S4806 F2b Proposal.WOR

Scale: 0 0.5 1.0 1.5 2.0 2.5 kilometres

N W E S

Figure 2b: Project Layout (South)- Borehole locations and threatened flora and fauna species in the vicinity.




**Vegetation communities**

- Coastal Foredune Scrub
- Coastal Freshwater Lagoon
- Coastal Rock Plate Heath
- Coastal Sand Forest
- Coastal Sandstone Gully Forest
- Coastal Sandstone Plateau Heath
- Coastal Sandstone Ridgetop Woodland
- Coastal Upland Swamp
- Coastal Warm Temperate Rainforest
- Escarpment Foothills Wet Forest
- Estuarine Creekflat Scrub
- Estuarine Saltmarsh
- Floodplain Swamp Forest
- Headland Grassland
- Hinterland Sandstone Gully Forest
- Illawarra Gully Wet Forest
- Illawarra Lowland Swamp Woodland
- Littoral Thicket
- Nepean Shale Cap Forest
- Sandstone Headland Scrub
- Sandstone Riparian Scrub
- Sandstone Scarp Warm Temperate Rainforest
- Shoalhaven Riparian Scrub
- South Coast Grassy Woodland
- Southern Highlands Basalt Forest
- Subtropical Complex Rainforest
- Subtropical Dry Rainforest
- Sydney Shale-Ironstone Cap Forest
- Temperate Dry Rainforest
- Temperate Littoral Rainforest
- Warm Temperate Layered Forest
- Yarrawarra Temperate Rainforest

**Key**

Proposed borehole

*Acknowledgements: NPWS*


BIOSIS RESEARCH Pty. Ltd.

8 Tate St
Wollongong
NEW SOUTH WALES 2500

Figure 3a: Borehole locations with Vegetation communities in the vicinity of the Study Area.

DATE: 26 September 2008
Checked by: SEW
File number: S4806
Location:-..4000\4800s\4806\Mapping\S4806 F3a vegcomm.WOR

Scale: 0 0.5 1.0 1.5 2.0 2.5 kilometres

N W E S

Figure 3a: Borehole locations with Vegetation communities in the vicinity of the Study Area.

AI13
AI12A
AI14 - REPLACEMENT
AI14 - ORIGINAL SITE CANCELLED
AI15
AI16
AI17
AI18
AI19
THIRROUL
BULLI

**Vegetation communities**

- Coastal Foredune Scrub
- Coastal Freshwater Lagoon
- Coastal Rock Plate Heath
- Coastal Sand Forest
- Coastal Sandstone Gully Forest
- Coastal Sandstone Plateau Heath
- Coastal Sandstone Ridgetop Woodland
- Coastal Upland Swamp
- Coastal Warm Temperate Rainforest
- Escarpment Foothills Wet Forest
- Estuarine Creekflat Scrub
- Estuarine Saltmarsh
- Floodplain Swamp Forest
- Headland Grassland
- Hinterland Sandstone Gully Forest
- Illawarra Gully Wet Forest
- Illawarra Lowland Swamp Woodland
- Littoral Thicket
- Nepean Shale Cap Forest
- Sandstone Headland Scrub
- Sandstone Riparian Scrub
- Sandstone Scarp Warm Temperate Rainforest
- Shoalhaven Riparian Scrub
- South Coast Grassy Woodland
- Southern Highlands Basalt Forest
- Subtropical Complex Rainforest
- Subtropical Dry Rainforest
- Sydney Shale-Ironstone Cap Forest
- Temperate Dry Rainforest
- Temperate Littoral Rainforest
- Warm Temperate Layered Forest
- Yarrawarra Temperate Rainforest

**Key**

Proposed borehole

*Acknowledgements: NPWS*


BIOSIS RESEARCH Pty. Ltd.
8 Tate St
Wollongong
NEW SOUTH WALES 2500

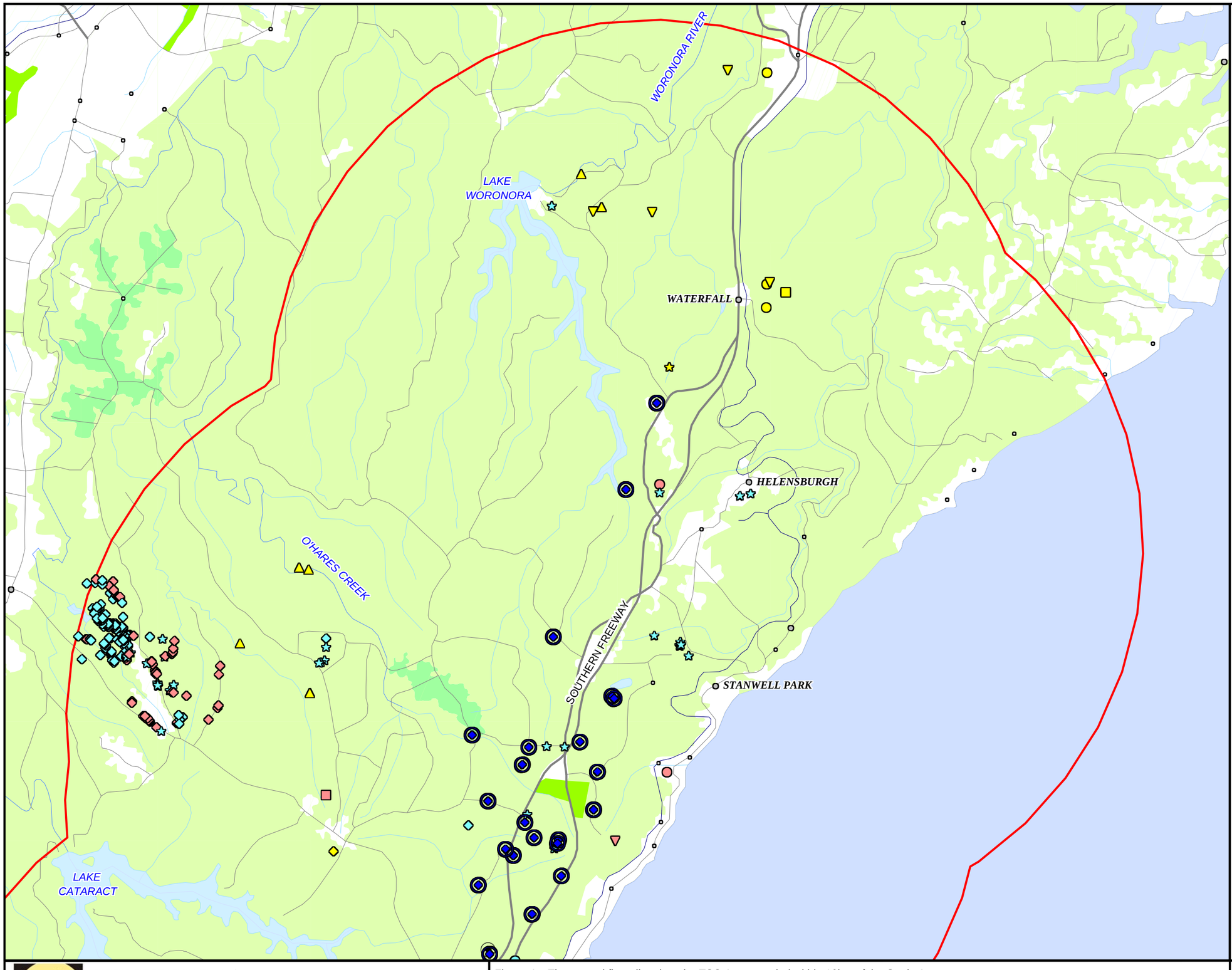
Figure 3b: Borehole locations with Vegetation communities in the vicinity of the Study Area (DEC 2004).

DATE: 26 September 2008
Checked by: SEW
File number: S4806
Location:-..4000\4800s\4806\Mapping\S4806 F3b vegcomm.WOR

Scale: 0 0.5 1.0 1.5 2.0 2.5 kilometres

N W E S

Figure 3b: Borehole locations with Vegetation communities in the vicinity of the Study Area.(DEC 2004)




**Legend**

Threatened flora

- *Acacia baueri subsp. aspera*
- *Acacia bynoeana*
- *Callistemon linearifolius*
- *Chorizema parviflorum*
- *Cynanchum elegans*
- *Daphnandra sp. C Illawarra*
- *Darwinia biflora*
- *Epacris purpurascens var. purpurascens*
- *Eucalyptus camfieldii*
- *Genoplesium baueri*
- *Leucopogon exolasius*
- *Melaleuca deanei*
- *Persoonia acerosa*
- *Persoonia hirsuta*
- *Pomaderris adnata*
- *Pultenaea aristata*
- *Solanum celatum*

Legend

- Proposed borehole locations
- 10km search

Topography

- City/Town
- Locality
- Dual Carriageway
- Major road
- Secondary/minor road
- Track
- Railway
- Rail tunnel
- River/creek - perennial
- River/creek - non-perennial
- Lake
- Reservoir
- Watercourse/Ocean
- Park
- Forest
- Orchard

*Acknowledgements: NPWS*


BIOSIS RESEARCH Pty. Ltd.

8 Tate Street
Wollongong
NEW SOUTH WALES 2500

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

DATE: 26 September 2008

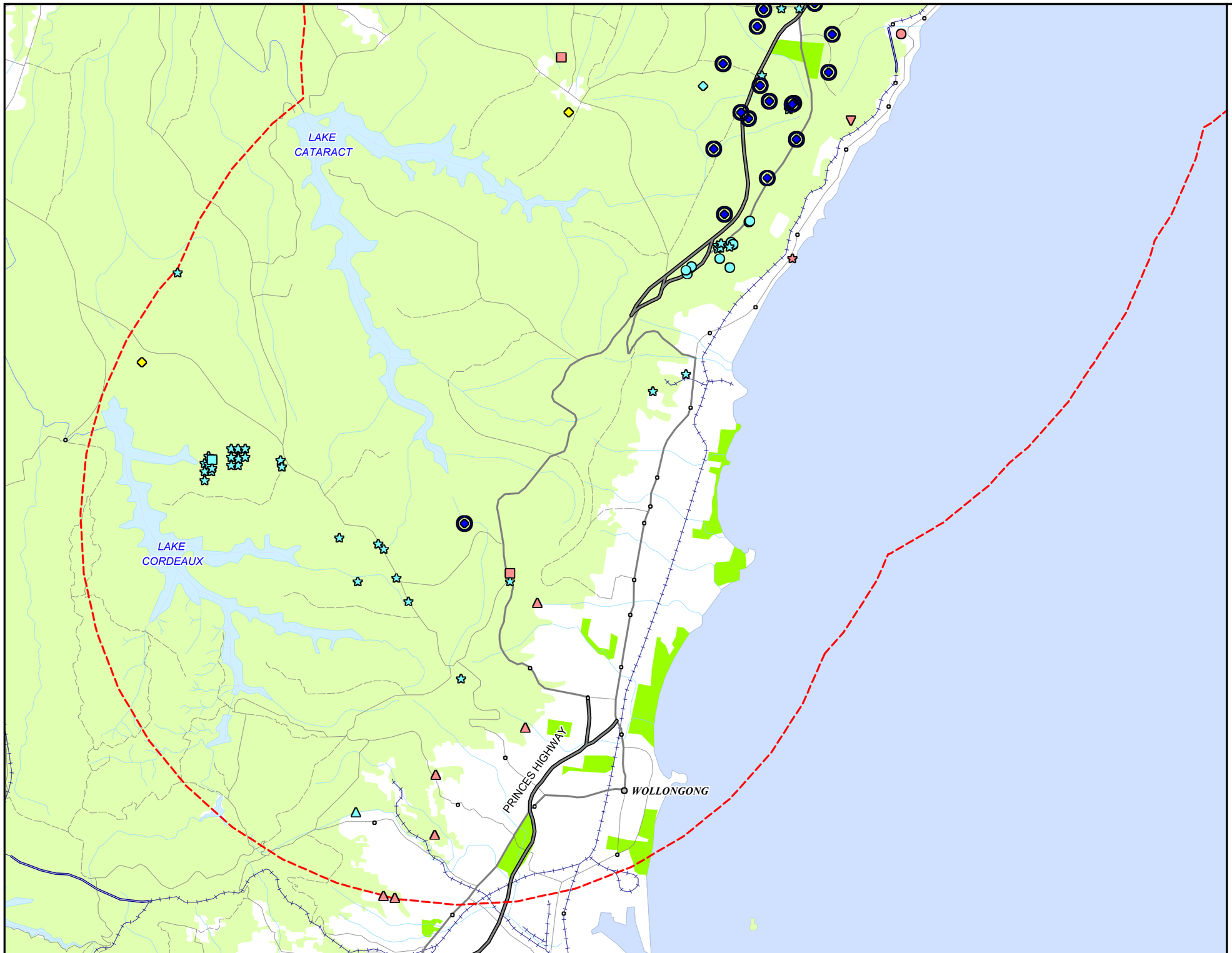
Checked by: SEW | File number: S4806

Location:-..4000\4800s\4806\Mapping\S4806 F4a Threatened flora.WOR

Scale: 0 1 2 3 4 5 kilometres

N W E S

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




**Legend**

**Threatened flora**

- *Acacia baueri subsp. aspera*
- *Acacia bynoeana*
- *Callistemon linearifolius*
- *Chorizema parviflorum*
- *Cynanchum elegans*
- *Daphnandra sp. C Illawarra*
- *Darwinia biflora*
- *Epacris purpurascens var. purpurascens*
- *Eucalyptus camfieldii*
- *Genoplesium baueri*
- *Leucopogon exolasius*
- *Melaleuca deanei*
- *Persoonia acerosa*
- *Persoonia hirsuta*
- *Pomaderris adnata*
- *Pultenaea aristata*
- *Solanum celatum*

Legend

- Proposed borehole locations
- 10km search

**Topography**

- City/Town
- Locality
- Dual Carriageway
- Major road
- Secondary/minor road
- Track
- Railway
- Rail tunnel
- River/creek - perennial
- River/creek - non-perennial
- Lake
- Reservoir
- Watercourse/Ocean
- Park
- Forest
- Orchard

*Acknowledgements: NPWS*


BIOSIS RESEARCH Pty. Ltd.
8 Tate Street
Wollongong
NEW SOUTH WALES 2500

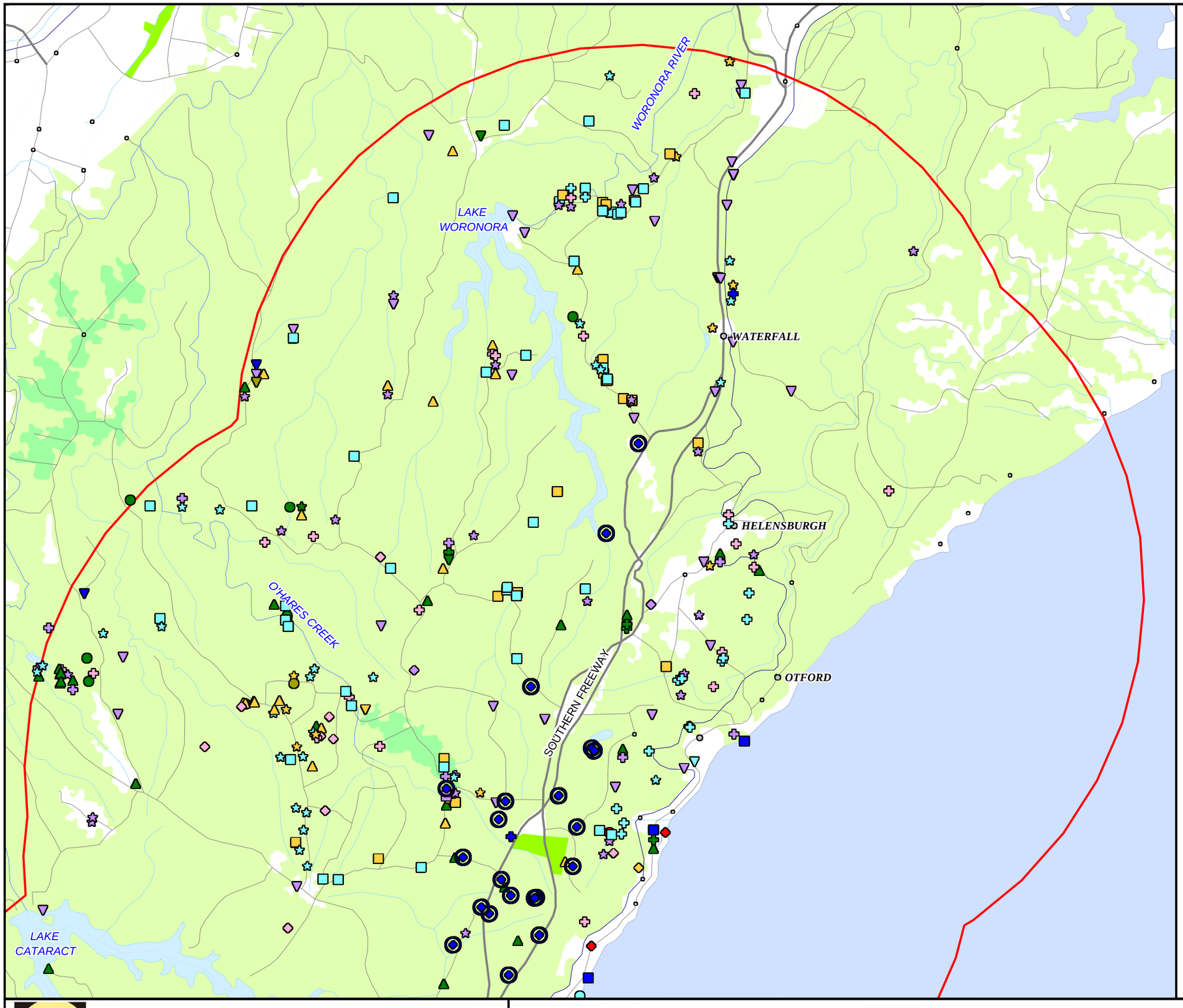
Figure 4b: Threatened flora, listed on the TSC Act, recorded within 10km of the Study Area.

DATE: 26 September 2008
Checked by: SEW
File number: S4806
Location:-..4000\4800s\4806\Mapping\S4806 F4b Threatened flora.WOR

Scale: 0 1 2 3 4 5 kilometres

N W E S

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




**Legend**

Threatened fauna

- Australasian Bittern
- Australian Fur-seal
- Barking Owl
- Barred Cuckoo-shrike
- Beach Stone-curlew
- Black Bittern
- Black-browed Albatross
- Blue-billed Duck
- Broad-billed Sandpiper
- Broad-headed Snake
- Brown Treecreeper
- Eastern Bentwing-bat
- Eastern False Pipistrelle
- Eastern Freetail-bat
- Eastern Pygmy-possum
- Eastern Quoll
- Flesh-footed Shearwater
- Gang-gang Cockatoo
- Giant Burrowing Frog
- Glossy Black-Cockatoo
- Gould's Petrel
- Greater Broad-nosed Bat
- Green and Golden Bell Frog
- Green Turtle
- Grey-headed Flying-fox
- Hooded Plover
- Koala
- Large-footed Myotis
- Little Shearwater
- Littlejohn's Tree Frog
- Masked Owl
- Olive Whistler
- Pied Oystercatcher
- Pink Robin
- Powerful Owl
- Red-crowned Toadlet
- Regent Honeyeater
- Rose-crowned Fruit-Dove
- Rosenberg's Goanna
- Sanderling
- Sooty Albatross
- Sooty Owl
- Sooty Oystercatcher
- Sooty Tern
- Southern Giant Petrel
- Southern Right Whale
- Sperm Whale
- Spotted-tailed Quoll
- Square-tailed Kite
- Superb Fruit-Dove
- Swift Parrot
- Turquoise Parrot
- Wandering Albatross
- Wompoo Fruit-Dove
- Yellow-bellied Glider

Legend

- Proposed borehole locations
- 10km search area
- City/Town
- Locality
- Dual Carriageway
- Major road
- Secondary/minor road
- Track
- Railway
- Rail tunnel
- River/creek - perennial
- River/creek - non-perennial
- Lake
- Reservoir
- Watercourse/Ocean
- Park
- Forest
- Orchard

*Acknowledgements: NPWS*
*This product incorporates Data which is copyright to the Commonwealth of Australia (c.2003-)*

BIOSIS RESEARCH Pty. Ltd.
8 Tate Street
Wollongong
NEW SOUTH WALES 2500

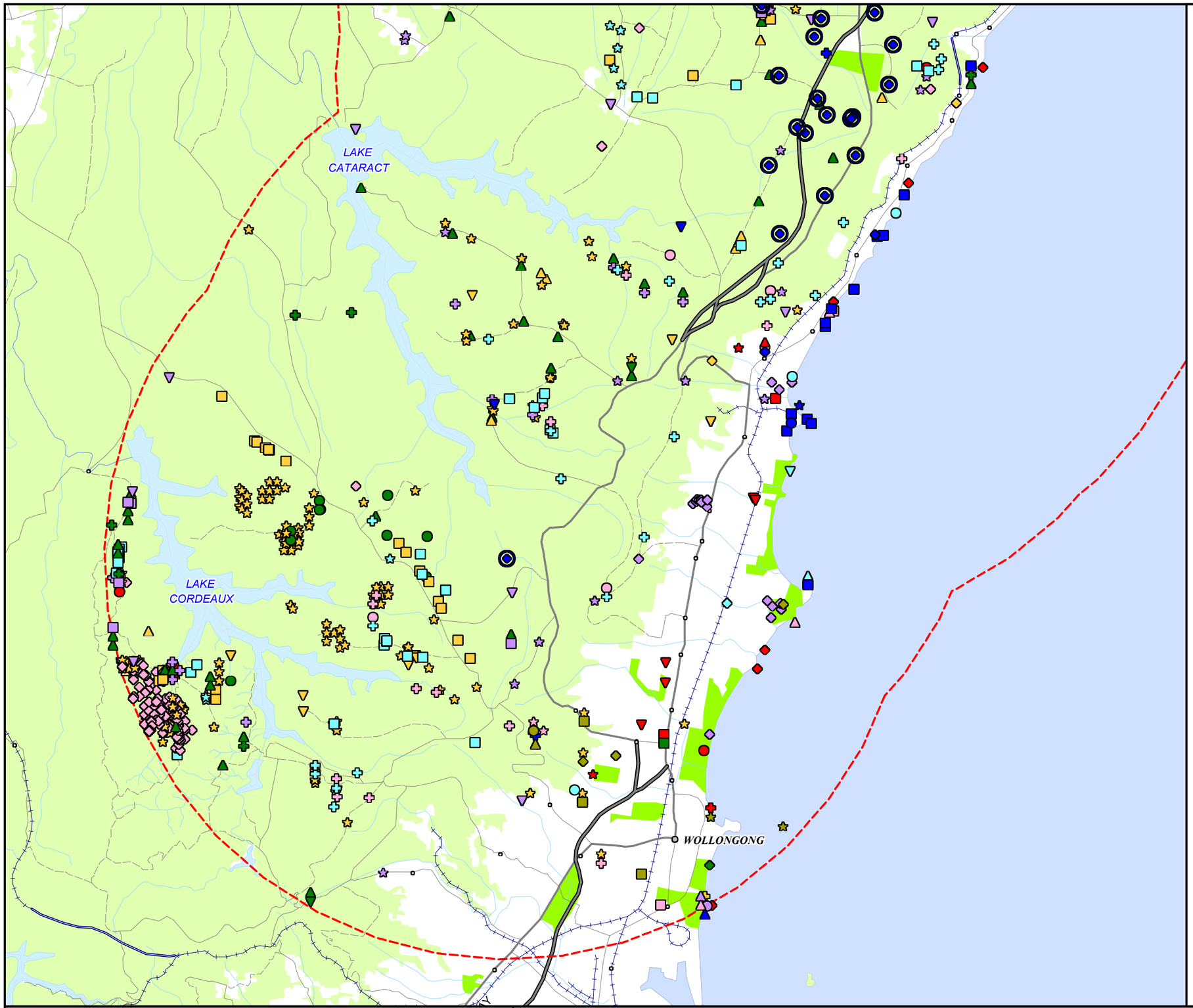
Figure 5a: Threatened fauna, listed on the TSC Act, recorded within 10km of the Study Area.

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

DATE: 26 September 2008
Checked by: MHS
File number: S4806
Location:-..4000\4800s\4806\Mapping\S4806 F5a Threatened fauna.WOR

Scale: 0 1 2 3 4 5 kilometres

N W E S




**Legend**

**Threatened fauna**

- Australasian Bittern
- Australian Fur-seal
- Barking Owl
- Barred Cuckoo-shrike
- Beach Stone-curlew
- Black Bittern
- Black-browed Albatross
- Blue-billed Duck
- Broad-billed Sandpiper
- Broad-headed Snake
- Brown Treecreeper
- Eastern Bentwing-bat
- Eastern False Pipistrelle
- Eastern Freetail-bat
- Eastern Pygmy-possum
- Eastern Quoll
- Flesh-footed Shearwater
- Gang-gang Cockatoo
- Giant Burrowing Frog
- Glossy Black-Cockatoo
- Gould's Petrel
- Greater Broad-nosed Bat
- Green and Golden Bell Frog
- Green Turtle
- Grey-headed Flying-fox
- Hooded Plover
- Koala
- Large-footed Myotis
- Little Shearwater
- Littlejohn's Tree Frog
- Masked Owl
- Olive Whistler
- Pied Oystercatcher
- Pink Robin
- Powerful Owl
- Red-crowned Toadlet
- Regent Honeyeater
- Rose-crowned Fruit-Dove
- Rosenberg's Goanna
- Sanderling
- Sooty Albatross
- Sooty Owl
- Sooty Oystercatcher
- Sooty Tern
- Southern Giant Petrel
- Southern Right Whale
- Sperm Whale
- Spotted-tailed Quoll
- Square-tailed Kite
- Superb Fruit-Dove
- Swift Parrot
- Turquoise Parrot
- Wandering Albatross
- Wompoo Fruit-Dove
- Yellow-bellied Glider

Legend

- Proposed borehole locations
- 10km search area
- City/Town
- Locality
- Dual Carriageway
- Major road
- Secondary/minor road
- Track
- Railway
- Rail tunnel
- River/creek - perennial
- River/creek - non-perennial
- Lake
- Reservoir
- Watercourse/Ocean
- Park
- Forest
- Orchard

*Acknowledgements: NPWS*


BIOSIS RESEARCH Pty. Ltd.

8 Tate Street
Wollongong
NEW SOUTH WALES 2500

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

DATE: 26 September 2008

Checked by: MHS | File number: S4806

Location:-..4000\4800s\4806\Mapping\S4806 F5b Threatened fauna.WOR

Scale: 0 1 2 3 4 5 kilometres

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

# APPENDICES

# APPENDIX 1

## Flora Results

| Family | | Scientific Name | Common Name |
|---|---|---|---|
| **Ferns and Fern-like Plants** | | | |
| Dennstaedtiaceae | | | |
| | | *Pteridium esculentum* | Bracken |
| Gleicheniaceae | | | |
| | | *Gleichenia dicarpa* | Pouched Coral-fern |
| Lindsaeaceae | | | |
| | | *Lindsaea linearis* | Screw Fern |
| **Conifers** | | | |
| Pinaceae | | | |
| | * | *Pinus radiata* | Radiata Pine |
| **Monocotyledons** | | | |
| Arecaceae | | | |
| | | *Livistona australis* | Cabbage Palm |
| Colchicaceae | | | |
| | | *Burchardia umbellata* | Milkmaids |
| Cyperaceae | | | |
| | | *Baumea teretifolia* | |
| | | *Caustis flexuosa* | Curly Wig |
| | | *Chorizandra* spp. | |
| | | *Cyathochaeta diandra* | Sheath Sedge |
| | | *Gahnia* spp. | |
| | | *Lepidosperma forsythii* | Large-flower Rapier-sedge |
| | | *Lepidosperma neesii* | Stiff Rapier-sedge |
| | | *Lepidosperma urophorum* | Tailed Rapier-sedge |
| | | *Ptilothrix deusta* | |
| | | *Schoenus brevifolius* | Zig-zag Bog-sedge |
| Doryanthaceae | | | |
| | | *Doryanthes excelsa* | Gymea/Giant Lily |
| Iridaceae | | | |
| | | *Patersonia sericea* | Silky Purple-flag |
| Lomandraceae | | | |
| | | *Lomandra filiformis* ssp. *coriacea* | Wattle Mat-rush |
| | | *Lomandra glauca* | Pale Mat-rush |
| | | *Lomandra longifolia* | Spiny-headed Mat-rush |
| | | *Lomandra obliqua* | |
| Orchidaceae | | | |
| | | *Caladenia* spp. | |
| | | *Thelymitra* spp. | |
| Phormiaceae | | | |
| | | *Dianella caerulea* var. *producta* | Blue Flax-lily |
| Poaceae | | | |
| | * | *Andropogon virginicus* | Whisky Grass |
| | | *Aristida vagans* | Threeawn Speargrass |
| | * | *Cortaderia selloana* | Pampas Grass |
| | | *Cynodon dactylon* | Common Couch |
| | | *Entolasia stricta* | Wiry Panic |
| | * | *Eragrostis curvula* | African Lovegrass |
| | | *Hemarthria uncinata* var. *uncinata* | Mat Grass |
| | | *Imperata cylindrica* var. *major* | Blady Grass |

| Family | | Scientific Name | Common Name |
|---|---|---|---|
| | * | *Pennisetum clandestinum* | Kikuyu Grass |
| | | *Themeda australis* | Kangaroo Grass |
| Restionaceae | | | |
| | | *Empodisma minus* | Spreading Rope-rush |
| | | *Leptocarpus tenax* | Slender Twine-rush |
| | | *Lepyrodia scariosa* | |
| Xanthorrhoeaceae | | | |
| | | *Xanthorrhoea media* | Forest Grass Tree |
| | | *Xanthorrhoea minor* ssp. *minor* | |
| Xyridaceae | | | |
| | | *Xyris complanata* | |
| **Dicotyledons** | | | |
| Apiaceae | | | |
| | | *Actinotus minor* | Lesser Flannel Flower |
| | | *Platysace linearifolia* | |
| Asteraceae | | | |
| | * | *Ageratina adenophora* | Crofton Weed |
| | * | *Hypochaeris radicata* | Catsear |
| | * | *Senecio madagascariensis* | Fireweed |
| Baueraceae | | | |
| | | *Bauera microphylla* | |
| Casuarinaceae | | | |
| | | *Allocasuarina littoralis* | Black Sheoak |
| Dilleniaceae | | | |
| | | *Hibbertia riparia* | Erect Guinea-flower |
| Epacridaceae | | | |
| | | *Epacris microphylla* var. *microphylla* | Coast Coral Heath |
| | | *Epacris obtusifolia* | Blunt-leaf Heath |
| | | *Epacris pulchella* | |
| | | *Leucopogon ericoides* | Pink Beard-heath |
| | | *Leucopogon juniperinus* | Long-flower Beard-heath |
| | | *Leucopogon lanceolatus* var. *lanceolatus* | Lance Beard-heath |
| | | *Monotoca elliptica* | Tree Broom-heath |
| Fabaceae (Mimosoideae) | | | |
| | | *Acacia longifolia* | Coast/Sallow Wattle |
| | | *Acacia mearnsii* | Black Wattle |
| | | *Acacia myrtifolia* | Red-stemmed Wattle |
| | | *Acacia suaveolens* | Sweet Wattle |
| | | *Acacia ulicifolia* | Prickly Moses |
| Fabaceae (Faboideae) | | | |
| | | *Aotus ericoides* | Common Aotus |
| | | *Bossiaea scolopendria* | |
| | | *Dillwynia floribunda* | |
| | | *Dillwynia retorta* | |
| | | *Gompholobium pinnatum* | Pinnate Wedge Pea |
| | | *Mirbelia rubiifolia* | Heathy Mirbelia |
| | | *Pultenaea elliptica* | |
| | | *Viminaria juncea* | Native Broom |
| Goodeniaceae | | | |
| | | *Dampiera stricta* | Blue Dampiera |
| Lauraceae | | | |

| Family | | Scientific Name | Common Name |
|---|---|---|---|
| | | *Cassytha glabella* f. *glabella* | Slender Dodder-laurel |
| | * | *Cinnamomum camphora* | Camphor Laurel |
| Myrtaceae | | | |
| | | *Angophora costata* | Sydney Red/Rusty Gum |
| | | *Baeckea imbricata* | |
| | | *Callistemon pinifolius* | Pine-leaved Bottlebrush |
| | | *Corymbia gummifera* | Red Bloodwood |
| | R | *Darwinia grandiflora* | |
| | R | *Eucalyptus luehmanniana* | Yellow-top Ash |
| | | *Eucalyptus piperita* | Sydney Peppermint |
| | | *Eucalyptus racemosa* | Narrow-leaved Scribbly Gum |
| | | *Eucalyptus robusta* | Swamp Mahogany |
| | | *Eucalyptus sieberi* | Silvertop Ash |
| | | *Eucalyptus stricta* | Mallee Ash |
| | | *Euryomyrtus ramosissima* ssp. *ramosissima* | |
| | | *Kunzea ambigua* | Tick Bush |
| | | *Kunzea ericoides* | Burgan |
| | | *Leptospermum arachnoides* | |
| | | *Leptospermum grandifolium* | Woolly Teatree |
| | | *Leptospermum juniperinum* | |
| | | *Leptospermum polygalifolium* ssp. *polygalifolium* | Tantoon |
| | | *Leptospermum squarrosum* | |
| | | *Leptospermum trinervium* | Paperbark Tea-tree |
| | | *Melaleuca squarrosa* | Scented Paperbark |
| | | *Melaleuca styphelioides* | Prickly-leaved Tea Tree |
| | | *Syncarpia glomulifera* ssp. *glomulifera* | Turpentine |
| Proteaceae | | | |
| | | *Banksia ericifolia* ssp. *ericifolia* | |
| | | *Banksia oblongifolia* | |
| | | *Banksia paludosa* ssp. *paludosa* | |
| | | *Banksia serrata* | Saw Banksia |
| | | *Conospermum ellipticum* | |
| | | *Conospermum tenuifolium* | |
| | | *Grevillea oleoides* | |
| | | *Grevillea sphacelata* | |
| | | *Hakea dactyloides* | Finger Hakea |
| | | *Hakea sericea* | Bushy Needlewood |
| | | *Hakea teretifolia* ssp. *teretifolia* | |
| | | *Isopogon anemonifolius* | |
| | | *Isopogon anethifolius* | |
| | | *Lambertia formosa* | Mountain Devil |
| | | *Persoonia lanceolata* | |
| | | *Persoonia levis* | Broad-leaved Geebung |
| | | *Persoonia linearis* | Narrow-leaved Geebung |
| | | *Persoonia pinifolia* | Pine-leaved Geebung |
| | | *Petrophile pulchella* | |
| | | *Petrophile sessilis* | |
| Rutaceae | | | |
| | | *Leionema diosmeum* | |
| | | *Zieria smithii* | Sandfly Zieria |
| Stylidiaceae | | | |

| Family | | Scientific Name | Common Name |
|---|---|---|---|
| | | *Stylidium spp.* | |

Note - * signifies exotic species

R signifies rare species (listed as a ROTAP)

# APPENDIX 2

## Conservation Rating According to Briggs and Leigh (1995)

## Conservation Rating According to Briggs and Leigh (1996)

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

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

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

# APPENDIX 3

## Fauna Results

| Common Name | Latin Name | Observation |
|---|---|---|
| **Amphibians** | | |
| Verreaux's Frog | *Litoria verreauxii* | W |
| Common Eastern Froglet | *Crinia signifera* | W |
| **Birds** | | |
| Australian Wood Duck | *Chenonetta jubata* | O |
| Grey Butcherbird | *Cracticus torquatus* | W |
| Pied Currawong | *Strepera graculina* | OW |
| Sulphur-crested Cockatoo | *Cacatua galerita* | OW |
| Galah | *Cacatua roseicapilla* | OW |
| Yellow-tailed Black-Cockatoo | *Calyptorhynchus funereus* | W |
| Black-faced Cuckoo-shrike | *Coracina novaehollandiae* | W |
| Eastern Whipbird | *Psophodes olivaceus* | W |
| Australian Raven | *Corvus coronoides* | OW |
| Fan-tailed Cuckoo | *Cacomantis flabelliformis* | W |
| Shining Bronze-Cuckoo | *Chrysococcyx lucidus* | W |
| Grey Fantail | *Rhipidura albiscapa* | OW |
| Laughing Kookaburra | *Dacelo novaeguineae* | OW |
| Welcome Swallow | *Hirundo neoxena* | OW |
| Unidentified Fairy-wren | *Malurus* sp. | W |
| Eastern Spinebill | *Acanthorhynchus tenuirostris* | OW |
| Red Wattlebird | *Anthochaera carunculata* | OW |
| Little Wattlebird | *Anthochaera chrysoptera* | W |
| Yellow-faced Honeyeater | *Lichenostomus chrysops* | W |
| New Holland Honeyeater | *Phylidonyris novaehollandiae* | OW |
| Grey Shrike-thrush | *Colluricincla harmonica* | W |
| Golden Whistler | *Pachycephala pectoralis* | W |
| Brown Thornbill | *Acanthiza pusilla* | W |
| Unidentified Thornbill | *Acanthiza sp.* | W |
| Spotted Pardalote | *Pardalotus punctatus* | W |
| Eastern Yellow Robin | *Eopsaltria australis* | OW |
| Australian King-Parrot | *Alisterus scapularis* | OW |
| Masked Lapwing | *Vanellus miles* | OW |
| Rainbow Lorikeet | *Trichoglossus haematodus* | OW |
| Crimson Rosella | *Platycercus elegans* | OW |
| **Mammals** | | |
| Swamp Wallaby | *Wallabia bicolor* | OI |
| Unidentified macropod | *Macropod sp.* | I |
| Common Wombat | *Vombatus ursinus* | I |
| Rabbit* | *Oryctolagus cuniculus* | OI |
| glider | *Petaurus* sp. | I |
| **Reptiles** | | |
| Jacky Lizard | *Amphibolurus muricatus* | O |
| Mountain Dragon | *Tympanocryptis diemensis* | O |
| unidentified grass skink | *Lampropholis* sp. | O |
| unidentified snake sp. (skin) | *Snake* sp. | I |

**Key:** **O:** Observed, **W:** Heard, **I:** Indirect (tracks, scats etc.), ***:** Introduced species

# APPENDIX 4

## Impact Assessment following the Guidelines for Threatened Species Assessment under Part 3A of the EP&A Act

# Flora

Impact assessments are undertaken for eight threatened plant species with potential habitat in the Study Area:

- *Acacia bynoeana;*
- *Cryptostylis hunteriana;*
- *Callistemon linearifolius;*
- *Epacris purpurascens* var. *purpurascens;*
- *Persoonia acerosa;*
- *Persoonia hirsuta;*
- *Pomaderris adnata;* and,
- *Pultenaea aristata*.

## *Acacia bynoeana*

*Acacia bynoeana* is listed as Endangered on the TSC Act and Vulnerable on the EPBC Act. *Acacia bynoeana* is a small prostrate shrub to 1 m high (DEC 2005a).

*Acacia bynoeana* was not recorded in the Study Area during the current surveys, however potential habitat for the species exists in Coastal Sandstone Ridgetop Woodland in the Study Area.

**How is the proposal likely to affect the lifecycle of a threatened species and/or population?**

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. The proposal is unlikely to alter the existing fire regime of the Study Area.

From observations made by Biosis Research within local occurrences of this species outside of the Study Area, 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.

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. It is not anticipated that the proposal would be likely to significantly impact the movements, shelter or foraging opportunities of these insect vectors.

Both direct and indirect impacts could potentially affect the lifecycle of *Acacia bynoeana*. Direct impacts may occur if the plant is cleared or trampled during construction while indirect impacts may include disturbance of the vegetation/habitats within which it may be present. Direct impacts on the lifecycle of *Acacia bynoeana* are unlikely, as the species was not recorded during the current surveys. Potential indirect impacts resulting from the proposal are considered unlikely to affect the lifecycle of *Acacia bynoeana*. It unlikely that the proposal will have an affect on the lifecycle of *Acacia bynoeana*.

**How is the proposal likely to affect the habitat of a threatened species, population or ecological community?**

*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. This species appears to prefer open, sometimes disturbed sites such as trail margins, edges of roadside spoil mounds and recently burnt open patches (DEC 2005a).

*Acacia bynoeana* was not recorded during the field surveys. *Acacia bynoeana* was not recorded in the Study Area during the current surveys, however has previously been recorded approximately 7 km to the west of the Study Area (Figure 6). Potential habitat for the species exists in Coastal Sandstone Ridgetop Woodland in the Study Area, which occurs at boreholes AI02, AI03, AI12B, AI14, AI15 and AI18.

The proposal will involve impacts to approximately 3.6 ha of Coastal Sandstone Ridgetop Woodland, which is considered potential habitat for *Acacia bynoeana*. These impacts will include clearing of native vegetation. Approximately 20,800 ha of potential habitat for *Acacia bynoeana* exists within the locality (10 km radius of the Study Area, based on vegetation mapping by Tindall (2004)). The area of habitat in the Study Area to be impacted (directly and indirectly) by the proposal equates to 0.02% of similar habitat types in the locality and this is not considered to be a significant amount of habitat.

The proposal has the potential to introduce weed seed to habitats that are currently relatively free of weed invasion. Mitigation measures listed in Section 5.2 should be undertaken to reduce the potential of the introduction of weed seed. Further, the site would be actively revegetated using local native species by qualified bush regenerators on completion of works. Sedimentation controls, such as silt fencing, are also required to minimise the impact of sedimentation on adjoining habitats.

The proposal is not likely to have a significant effect on the habitat of the species in the locality.

**Does the proposal affect any threatened species or populations that are at the limit of its known distribution?**

The species is endemic to central eastern NSW, and is distributed from the Hunter district on the Central Coast south to Berrima and Mittagong in the Southern Highlands (DEC 2005a) and Nowra. The Study Area is not at the limit of the distribution for *Acacia bynoeana*.

**How is the proposal likely to affect current disturbance regimes?**

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. The proposal is unlikely to alter the existing fire regime of the Study Area.

*Acacia bynoeana* is not known to be dependant on a certain flooding regime. The proposal is unlikely to affect the natural flooding regime of the Study Area.

The proposal is not likely to alter current disturbance regimes.

**How is the proposal likely to affect habitat connectivity?**

Despite the removal and modification of 3.6 ha of potential habitat for *Acacia bynoeana* within the Study Area, the impact areas for the proposal are generally restricted to the edge of existing tracks and will not require additional fragmentation of habitat for this species. The proposal will not significantly affect habitat connectivity for *Acacia bynoeana.*

**How is the proposal likely to affect critical habitat?**

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).

**Conclusion:**

The impact of the proposal on *Acacia bynoeana* is likely to be minor as:

- The proposal is unlikely to have a major impact on the lifecycle of *Acacia bynoeana*.
- The proposal is unlikely to have a major impact on the composition of potential habitat for *Acacia bynoeana* within the locality.
- Impacts to 0.02% of the local occurrence of potential habitat for *Acacia bynoeana* is not considered to be a major amount of habitat.
- The proposal will not result in fragmentation of habitat for the species.
- No critical habitat has been declared for *Acacia bynoeana*.

## *Cryptostylis hunteriana*

*Cryptostylis hunteriana* is a leafless saprophytic terrestrial orchid with the only above-ground growth being a 15-45 cm long green inflorescence that is present between December and 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 in the Study Area during the current surveys, however potential habitat for the species exists in Coastal Sandstone Ridgetop Woodland in the Study Area.

**How is the proposal likely to affect the lifecycle of a threatened species and/or population?**

*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 well drained sandy soils from both moist and dry habitats (Bell 2001). 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 (Bell 2001).

*Cryptostylis hunteriana* was not recorded in the Study Area, however, surveys were not undertaken in the appropriate season to detect this species. Impact assessment on this species is based on potential habitat only. Impacts associated

with the proposal include the removal or modification of approximately 3.6 ha of potential habitat. The proposal is unlikely to interfere with known pollination mechanisms (wasps) and likely modes of dispersal (wind) for *C. hunteriana.* Therefore, it is unlikely that the lifecycle of *C. hunteriana* would be disrupted by the proposal.

**How is the proposal likely to affect the habitat of a threatened species, population or ecological community?**

*Cryptostylis hunteriana* was not recorded in the Study Area during the current surveys, nor has the species been previously recorded within a 10 km radius of the Study Area (Figure 6). Potential habitat for the species exists in Coastal Sandstone Ridgetop Woodland in the Study Area, which occurs at boreholes AI02, AI03, AI12B, AI14, AI15 and AI18.

Approximately 3.6 ha of potential habitat (Coastal Sandstone Ridgetop Woodland) would be impacted by the proposal. Approximately 20,800 ha of Coastal Sandstone Ridgetop Woodland is mapped as occurring in the locality (10 km radius, based on vegetation mapping by Tindall (2004)). The disruption of 3.6 ha corresponds to approximately 0.02% of potential habitat within the region. This is not considered to be a significant area of habitat for this species.

The proposal has the potential to introduce weed seed to habitats that are currently relatively free of weed invasion. Mitigation measures listed in Section 5.2 should be undertaken to reduce the potential of the introduction of weed seed. Further, the site will be actively revegetated using local native species by qualified bush regenerators on completion of works. Sedimentation controls, such as silt fencing, are also required to minimise the impact of sedimentation on adjoining habitats.

The proposal is not likely to have a significant effect on the habitat of the species in the locality.

**Does the proposal affect any threatened species or populations that are at the limit of its known distribution?**

*Cryptostylis hunteriana* has a wide but sporadic distribution from Rainbow Beach in Queensland, inland to the Gibralter 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). The Study Area is not at the limit of known distribution of *Cryptostylis hunteriana*.

**How is the proposal likely to affect current disturbance regimes?**

*Cryptostylis hunteriana* usually appears in areas burnt one to three years previously (Bell 2001). The proposal is unlikely to alter the existing fire regime of the Study Area.

*Cryptostylis hunteriana* is not known to be dependant on a certain flooding regime. The proposal is unlikely to affect the natural flooding regime of the Study Area.

The proposal is not likely to alter current disturbance regimes.

**How is the proposal likely to affect habitat connectivity?**

Potential habitat for *Cryptostylis hunteriana* that would be disturbed as part of the proposal occurs along the edge of existing roads and tracks. The proposal is unlikely to significantly increase existing fragmentation or isolate areas of potential habitat for *Cryptostylis hunteriana*.

**Will the proposal impact critical habitat (either directly or indirectly)?**

Under the TSC Act, the Director-General maintains a register of critical habitat. To date, no critical habitat has been declared for this species. The proposal is not likely to impact on critical habitat for this species (directly or indirectly).

**Conclusion**

The impact of the proposal on *Cryptostylis hunteriana* is likely to be minor as:

- The proposal is unlikely to have a major impact on the lifecycle of *Cryptostylis hunteriana*;
- The proposal is unlikely to have a major impact on the composition of potential habitat for *Cryptostylis hunteriana*;
- Impact to 0.02% of the local occurrence of potential habitat for *Cryptostylis hunteriana* is not considered to be a major amount of habitat;
- The proposal will not result in fragmentation of habitat for the species; and,
- No critical habitat has been declared for *Cryptostylis hunteriana*.

## *Callistemon linearifolius*

*Callistemon linearifolius* is listed as a Vulnerable species on Schedule 2 of the TSC Act. *Callistemon linearifolius* is a large shrub to 4 m high (DEC 2005c).

*Callistemon linearifolius* was not recorded in the Study Area; however potential habitat does exist in Coastal Sandstone Gully Forest in the Study Area.

**How is the proposal likely to affect the lifecycle of a threatened species and/or population?**

Based on the known pollinators of other *Callistemon* species (Benson and McDougal 1998), the pollinators of *C. linearifolius* are likely to include both insects and birds. Impacts on pollinators for this species are already present in the Study Area (fragmentation). The proposal would not increase these impacts such that pollination of local populations of this species were detrimentally affected. Based on the fruit and seed morphology of this species and other *Callistemon* species (Benson and McDougal 1998), seed dispersal is likely to be local (e.g. in the immediate vicinity of adult plants) and is unlikely to be significantly impacted by the proposal.

It is unknown whether germination of seed from this species responds to fire, however, given that the woody seed capsules remain on the plant for several years (Benson and McDougal 1998), seed is likely to be released immediately post fire. Survival of adults in response to fire is also unknown, however, based on observations of other *Callistemon* species (Benson and McDougal 1998), *C. linearifolius* is likely to resprout following fire. Existing fire regimes in the Study Area will not be impacted by the proposal.

Based on the likely pollinators for this species, it is unlikely that the proposal would significantly reduce the capacity for the pollination of individuals occurring within the locality.

The proposal is not likely to impact on the lifecycle of *C. linearifolius.*

**How is the proposal likely to affect the habitat of a threatened species, population or ecological community?**

*Callistemon linearifolius* grows in dry sclerophyll forest on the coast and adjacent ranges, chiefly in the Sydney area from the Georges River to the Hawkesbury River (Harden 2002) and north to the Nelson Bay area.

*Callistemon linearifolius* was not recorded in the Study Area; however potential habitat does exist in Coastal Sandstone Gully Forest in the Study Area. The proposal will result in impacts to approximately 0.6 ha of Coastal Sandstone Gully Forest at borehole AI04B.

Approximately 0.6 ha of potential habitat (Coastal Sandstone Gully Forest) would be impacted by the proposal. Approximately 12,500 ha of Coastal Sandstone Gully Forest is mapped as occurring in the locality (10 km radius, based on vegetation mapping by Tindall (2004)). The disruption of 0.6 ha

corresponds to less than 0.01% of potential habitat within the region. This is not considered to be a significant area of habitat for this species.

The proposal has the potential to introduce weed seed to habitats that are currently relatively free of weed invasion. Mitigation measures listed in Section 5.2 should be undertaken to reduce the potential of the introduction of weed seed. Further, the site will be actively revegetated using local native species by qualified bush regenerators on completion of works. Sedimentation controls, such as silt fencing, are also required to minimise the impact of sedimentation on adjoining habitats.

The proposal is not likely to have a significant effect on the habitat of the species in the locality.

**Does the proposal affect any threatened species or populations that are at the limit of its known distribution?**

This species has been recorded from the Georges to Hawkesbury River in the Sydney area, north to the Nelson Bay area and south to Coal Cliff in the Southern River CMA (DEC 2005c). The Study Area is near the southern limit of distribution for this species.

**How is the proposal likely to affect current disturbance regimes?**

Given that the woody seed capsules remain on the plant for several years (Benson and McDougal 1998), seed of *Callistemon linearifolius* is likely to be released immediately post fire. *Callistemon linearifolius* is likely to resprout following fire. The proposal is unlikely to alter the existing fire regime of the Study Area.

*Callistemon linearifolius* is not known to be dependant on a certain flooding regime. The proposal is unlikely to affect the natural flooding regime of the Study Area.

The proposal is not likely to alter current disturbance regimes.

**How is the proposal likely to affect habitat connectivity?**

Potential habitat for *Callistemon linearifolius* that would be disturbed as part of the proposal will be fragmented by the construction of a 5 m x 80 m track for access to borehole AI04B. Further, the borehole location itself is located within a relatively intact patch of Coastal Sandstone Gully Forest. The borehole at this location will increase fragmentation of potential habitat for *Callistemon linearifolius.*

**Will the proposal impact critical habitat (either directly or indirectly)?**

Under the TSC Act, the Director-General maintains a register of critical habitat. To date, no critical habitat has been declared for this species. The proposal is not likely to impact on critical habitat for this species (directly or indirectly).

**Conclusion:**

Despite the proposal resulting in fragmentation of habitat for the species, the impact of the proposal on *Callistemon linearifolius* is likely to be minor as:

- The proposal is unlikely to have a major impact on the lifecycle of *Callistemon linearifolius*;
- The proposal is unlikely to have a major impact on the composition of potential habitat for *Callistemon linearifolius*;
- Impact to less than 0.01% of the local occurrence of potential habitat for *Callistemon linearifolius* is not considered to be a major amount of habitat; and,
- No critical habitat has been declared for *Callistemon linearifolius*.

## *Epacris purpurascens* var. *purpurascens*

*Epacris purpurascens* var. *purpurascens* is listed as a Vulnerable species on Schedule 2 of the TSC Act. *Epacris purpurascens* var. *purpurascens* was not recorded in the Study Area. However, potential habitat for the species in the Study Area includes Coastal Upland Swamp and Coastal Sandstone Gully Forest.

**How is the proposal likely to affect the lifecycle of a threatened species and/or population?**

*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 proposal is unlikely to alter the existing fire regime of the Study Area.

As with most Epacris it is likely that *Epacris purpurascens* var. *purpurascens* is pollinated by insects (e.g. large adult carrion flies) (Department of Environment 2008). It is not anticipated that the proposal would be likely to significantly impact the movements, shelter or foraging opportunities of these insect vectors.

It unlikely that the proposal will have a significant impact on the lifecycle of *Epacris purpurascens* var. *purpurascens* in the locality.

**How is the proposal likely to affect the habitat of a threatened species, population or ecological community?**

*Epacris purpurascens* var. *purpurascens* 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).

*Epacris purpurascens* var. *purpurascens* was not recorded in the Study Area. However, potential habitat for the species in the Study Area includes Coastal Upland Swamp and Coastal Sandstone Gully Forest. These habitats will be impacted by the proposal, with:

- Disturbance to 0.6 ha of Coastal Sandstone Gully Forest at borehole AI04B; and,
- Disturbance to 1.2 ha of Coastal Upland Swamp at boreholes AI08, AI10.

Figure 6 shows the known records of this species within 10 km of the Study Area. One record *Epacris purpurascens* var. *purpurascens* occurs to the west of the Study Area.

Habitat for this species in the region is widespread and common. The area of habitat in the Study Area which may be subject to impacts from the proposal (1.8 ha) is insignificant compared to the potential habitat for the species in the locality (approximately 15,800 ha, based on vegetation mapping by Tindall (2004)). It is not anticipated that the proposal would result in the removal of individual plants.

The proposal has the potential to introduce weed seed to habitats that are currently relatively free of weed invasion. Mitigation measures listed in Section 5.2 should be undertaken to reduce the potential of the introduction of weed seed. Further, the site will be actively revegetated using local native species by qualified bush regenerators on completion of works. Sedimentation controls, such as silt fencing, are also required to minimise the impact of sedimentation on adjoining habitats.

The proposal is not likely to have a significant effect on the habitat of the species in the locality.

**Does the proposal affect any threatened species or populations that are at the limit of its known distribution?**

The species is known from Gosford in the north, to Narrabeen in the east, Silverdale in the west and the Avon Dam vicinity in the south (DEC 2005q). The Study Area is therefore not near the limit of known distribution of the species.

**How is the proposal likely to affect current disturbance regimes?**

The species is killed by fire and re-establishes itself from a soil-stored seedbank (DEC 2005x). The proposal is unlikely to alter the existing fire regime of the Study Area.

*Epacris purpurascens* var. *purpurascens* is not known to be dependant on a certain flooding regime, though given its habitat, is likely to require certain levels of soil moisture to be available. The proposal is unlikely to affect the natural flooding regime or moisture availability of the habitats in the Study Area.

The proposal is not likely to alter current disturbance regimes.

**How is the proposal likely to affect habitat connectivity?**

Potential habitat for *Epacris purpurascens* var. *purpurascens* that would be disturbed as part of the proposal will be fragmented by the construction of a 5 m x 80 m track for access to borehole AI04B. Further, the borehole location itself is located within a relatively intact patch of Coastal Sandstone Gully Forest. The borehole at this location will increase fragmentation of potential habitat for *Epacris purpurascens* var. *purpurascens.*

**Will the proposal impact critical habitat (either directly or indirectly)?**

Under the TSC Act, the Director-General maintains a register of critical habitat. To date, no critical habitat has been declared for this species. The proposal is not likely to impact on critical habitat for this species (directly or indirectly).

**Conclusion:**

Despite the proposal resulting in fragmentation of habitat for the species, the impact of the proposal on *Epacris purpurascens* var. *purpurascens* is likely to be minor as:

- The proposal is unlikely to have a major impact on the lifecycle of *Epacris purpurascens* var. *purpurascens*;
- The proposal is unlikely to have a major impact on the composition of potential habitat for *Epacris purpurascens* var. *purpurascens*;

- Impact to approximately 0.01% of the local occurrence of potential habitat for *Epacris purpurascens* var. *purpurascens* is not considered to be a major amount of habitat; and,

- No critical habitat has been declared for *Epacris purpurascens* var. *purpurascens*.

## *Persoonia acerosa*

*Persoonia acerosa* is listed as Vulnerable on the TSC Act. The species is a small, erect to spreading shrub one to two metres tall (NPWS 2000). Potential habitat for *Persoonia acerosa* within the Study Area is considered to occur within Coastal Sandstone Ridgetop Woodland.

**How is the proposal likely to affect the lifecycle of a threatened species and/or population?**

*Persoonia acerosa* is likely to be killed by fire, although the species will regenerate from seed (NPWS 2000). Therefore, the survival of the species is dependent on an appropriate fire regime. The proposal is considered unlikely to result in any alteration to fire regimes in the Study Area.

Pollinators of *Persoonia acerosa* are likely to be native bees (NPWS 2000). Dispersers are likely to be large birds and mammals (Benson and McDougall 2000a). Germination is likely to be triggered by mechanical disturbance and fire (NPWS 2000). Pollination, dispersal and germination are considered important stages of the lifecycle of *P. acerosa.* None of these lifecycle stages are considered likely to be affected by the proposal.

On the basis of the above, it is considered unlikely that the proposal will have an adverse impact on the lifecycle of the species in the locality.

**How is the proposal likely to affect the habitat of a threatened species, population or ecological community?**

*Persoonia acerosa* occurs in dry sclerophyll forest, scrubby low-woodland and heath on low fertility soils (DEC 2005o).

*Persoonia acerosa* was not recorded during the field surveys. Potential habitat for the species in the Study Area includes Coastal Sandstone Ridgetop Woodland. The proposal will result in impacts to a total of 3.6 ha of Coastal Sandstone Ridgetop Woodland at boreholes AI02, AI03, AI12B, AI14, AI15, AI18. These impacts would include clearing of native vegetation. Approximately 20,860 ha of potential habitat for *Persoonia acerosa* exists within the locality (10 km radius of the Study Area). The area of habitat in the Study

Area to be impacted (directly and indirectly) by the proposal equates to less than 0.01% of similar habitat types in the locality and this is not considered to be a significant amount of habitat.

The proposal has the potential to introduce weed seed to habitats that are currently relatively free of weed invasion. Mitigation measures listed in Section 5.2 should be undertaken to reduce the potential of the introduction of weed seed. Further, the site will be actively revegetated using local native species by qualified bush regenerators on completion of works. Sedimentation controls, such as silt fencing, are also required to minimise the impact of sedimentation on adjoining habitats.

The proposal is not likely to have a significant effect on the habitat of the species in the locality.

**Does the proposal affect any threatened species or populations that are at the limit of its known distribution?**

*Persoonia acerosa* has been recorded only on the central coast and in the Blue Mountains, from Mt Tomah in the north to as far south as Hill Top where it is now believed to be extinct. It now occurs mainly in the Katoomba, Wentworth Falls and Springwood area (DEC 2005o). The Study Area is considered to be outside the limit of the distribution for this species, though known records of the species do occur in the locality (Figure 4).

**How is the proposal likely to affect habitat connectivity?**

Despite the removal and modification of 3.6 ha of potential habitat for *Persoonia acerosa* within the Study Area, the impact areas for the proposal are generally restricted to the edge of existing tracks and will not require additional fragmentation of habitat for this species. The proposal will not significantly affect habitat connectivity for *Persoonia acerosa.*

**How is the proposal likely to affect critical habitat?**

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 acerosa.*

The proposal will not have an adverse effect on critical habitat (directly or indirectly).

**Conclusion:**

The impact of the proposal on *Persoonia acerosa* is likely to be minor as:

- The proposal is unlikely to have a major impact on the lifecycle of *Persoonia acerosa*;
- The proposal is unlikely to have a major impact on the composition of potential habitat for *Persoonia acerosa* within the locality;
- Impacts to less than 0.01% of the local occurrence of potential habitat for *Persoonia acerosa* is not considered to be a major amount of habitat;
- The proposal will not result in fragmentation of habitat for the species; and,
- No critical habitat has been declared for *Persoonia acerosa*.

## *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. Potential habitat for *Persoonia hirsuta* within the Study Area is considered to occur within Coastal Sandstone Ridgetop Woodland.

**How is the proposal likely to affect the lifecycle of a threatened species and/or population?**

*Persoonia hirsuta* is usually present as isolated individuals or very small populations (DEC 2005q). Known occurrences of this species generally support one to three plants (DEC 2005q) although larger populations of this species are known from the region (pers. obs.). 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.* It is not anticipated that the proposal would be likely to significantly impact the movements, shelter or foraging opportunities of these pollinators or dispersers.

Plants of *Persoonia hirsuta* are likely to be killed by fire but the species will regenerate from seed (DEC 2005q). Therefore the survival of the species is dependent on an appropriate fire regime. The proposal is unlikely to alter the existing fire regime of the Study Area.

It unlikely that the proposal will have a significant impact on the lifecycle of the species.

**How is the proposal likely to affect the habitat of a threatened species, population or ecological community?**

*Persoonia hirsuta* occurs in woodlands and dry sclerophyll forest on sandstone or very rarely on shale (NSW Scientific Committee 1998).

*Persoonia hirsuta* was not recorded during the field surveys. Potential habitat for the species in the Study Area includes Coastal Sandstone Ridgetop Woodland. The proposal will result in impacts to a total of 3.6 ha of Coastal Sandstone Ridgetop Woodland at boreholes AI02, AI03, AI12B, AI14, AI15, AI18.

These impacts would include clearing of native vegetation. Approximately 20,860 ha of potential habitat for *Persoonia hirsuta* exists within the locality (10 km radius of the Study Area, based on vegetation mapping by Tindall (2004)). The area of habitat in the Study Area to be impacted (directly and indirectly) by the proposal equates to less than 0.01% of similar habitat types in the locality and this is not considered to be a significant amount of habitat.

The proposal has the potential to introduce weed seed to habitats that are currently relatively free of weed invasion. Mitigation measures listed in Section 5.2 should be undertaken to reduce the potential of the introduction of weed seed. Further, the site will be actively revegetated using local native species by qualified bush regenerators on completion of works. Sedimentation controls, such as silt fencing, are also required to minimise the impact of sedimentation on adjoining habitats.

The proposal is not likely to have a significant effect on the habitat of the species in the locality.

**Does the proposal affect any threatened species or populations that are at the limit of its known distribution?**

*Persoonia hirsuta* has been recorded in the Sydney coastal area, the Blue Mountains area and the Southern Highlands (DEC 2005q). The Study Area is at the south-eastern limit of the distribution for this species.

**How is the proposal likely to affect habitat connectivity?**

Despite the removal and modification of 3.6 ha of potential habitat for *Persoonia hirsuta* within the Study Area, the impact areas for the proposal are generally restricted to the edge of existing tracks and will not involve additional fragmentation of habitat for this species. The proposal will not significantly affect habitat connectivity for *Persoonia hirsuta.*

**How is the proposal likely to affect critical habitat?**

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).

**Conclusion:**

The impact of the proposal on *Persoonia hirsuta* is likely to be minor as:

- The proposal is unlikely to have a major impact on the lifecycle of *Persoonia hirsuta*.
- The proposal is unlikely to have a major impact on the composition of potential habitat for *Persoonia hirsuta* within the locality;
- Impacts to less than 0.01% of the local occurrence of potential habitat for *Persoonia hirsuta* is not considered to be a major amount of habitat;
- The proposal will not result in fragmentation of habitat for the species; and,
- No critical habitat has been declared for *Persoonia hirsuta*.

## *Pomaderris adnata*

*Pomaderris adnata* is listed as Endangered on the TSC Act. The species is a spreading shrub to two metres tall (DEC 2005r). Potential habitat for *Pomaderris adnata* within the Study Area is considered to occur within Coastal Sandstone Ridgetop Woodland.

**How is the proposal likely to affect the lifecycle of a threatened species and/or population?**

*Pomaderris adnata* is likely to be killed by fire (DEC 2005r). Therefore, the survival of the species is dependent on an appropriate fire regime. The proposal is considered unlikely to result in any alteration to fire regimes in the Study Area.

*Pomaderris adnata* flowers in late September and the fruit matures in November - December. The plant has an estimated longevity of 10 to 25 years (DEC 2005r). Pollination, dispersal and germination are considered important stages of the lifecycle of *P. adnata.* None of these lifecycle stages are considered likely to be affected by the proposal.

On the basis of the above, it is considered unlikely that the proposal would have an adverse impact on the lifecycle of the species in the locality.

**How is the proposal likely to affect the habitat of a threatened species, population or ecological community?**

The species occurs at the edge of the plateau behind the Illawarra escarpment and is associated with *Eucalyptus sieberi* and *Corymbia gummifera* forest with occasional *Hakea salicifolia* (DEC 2005r).

*Pomaderris adnata* was not recorded during the field surveys. Potential habitat for the species in the Study Area includes Coastal Sandstone Ridgetop Woodland. he proposal would result in impacts to a total of 3.6 ha of Coastal Sandstone Ridgetop Woodland at boreholes AI02, AI03, AI12B, AI14, AI15, AI18. These impacts would include clearing of native vegetation. Approximately 20,860 ha of potential habitat for *Pomaderris adnata* exists within the locality (10 km radius of the Study Area, based on vegetation mapping by Tindall (2004)). The area of habitat in the Study Area to be impacted (directly and indirectly) by the proposal equates to less than 0.01% of similar habitat types in the locality and this is not considered to be a significant amount of habitat.

The proposal has the potential to introduce weed seed to habitats that are currently relatively free of weed invasion. Mitigation measures listed in Section 5.2 should be undertaken to reduce the potential of the introduction of weed seed. Further, the site would be actively revegetated using local native species by qualified bush regenerators on completion of works. Sedimentation controls, such as silt fencing, are also required to minimise the impact of sedimentation on adjoining habitats.

The proposal is not likely to have a significant effect on the habitat of the species in the locality.

**Does the proposal affect any threatened species or populations that are at the limit of its known distribution?**

*Pomaderris adnata* is known from only one site at Sublime Point, north of Wollongong (DEC 2005r). Given the limited distribution of this species, the Study Area is considered to be at the limit of the distribution for this species.

**How is the proposal likely to affect habitat connectivity?**

Despite the removal and modification of 3.6 ha of potential habitat for *Pomaderris adnata* within the Study Area, the impact areas for the proposal are generally restricted to the edge of existing tracks and would not involve additional fragmentation of habitat for this species. The proposal would not significantly affect habitat connectivity for *Pomaderris adnata.*

**How is the proposal likely to affect critical habitat?**

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 would not have an adverse effect on critical habitat (directly or indirectly).

**Conclusion:**

The impact of the proposal on *Pomaderris adnata* is likely to be minor as:

- The proposal is unlikely to have a major impact on the lifecycle of *Pomaderris adnata*;
- The proposal is unlikely to have a major impact on the composition of potential habitat for *Pomaderris adnata* within the locality;
- Impacts to less than 0.01 % of the local occurrence of potential habitat for *Pomaderris adnata* is not considered to be a major amount of habitat;
- The proposal would not result in fragmentation of habitat for the species; and,
- No critical habitat has been declared for *Pomaderris adnata*.

## *Pultenaea aristata*

*Pultenaea aristata* is a small shrub, up to one metre tall, and is listed as Vulnerable on both the TSC and EPBC Acts. *Pultenaea aristata* was not recorded in the Study Area, however potential habitat is considered to occur in Coastal Upland Swamps in the Study Area.

**How is the proposal likely to affect the lifecycle of a threatened species and/or population?**

*Pultenaea aristata* is probably killed by fire (as are other *Pultenaea* species) (DEC 2005w). The proposal unlikely to alter the existing fire regime of the Study Area.

Pollination and dispersal are considered important stages of the lifecycle of *Pultenaea aristata*. Based on the ecology of the species, pollinators and dispersers are likely to be insects and ants. It is not anticipated that the proposal would be likely to significantly impact the movements, shelter or foraging opportunities of insect vectors.

It unlikely that the proposal would have a significant impact on the lifecycle of *Pultenaea aristata* in the locality.

**How is the proposal likely to affect the habitat of a threatened species, population or ecological community?**

The species occurs in either dry sclerophyll woodland or wet heath on sandstone (DEC 2005w). During the field surveys, *Pultenaea aristata* was not recorded within the Study Area although it has potential habitat within Coastal Upland Swamps. The proposal would result in disturbance to a total of 1.2 ha of Coastal Upland Swamp at boreholes AI08 and AI10.

Habitat for this species in the region is widespread and common. The area of habitat in the Study Area which may be subject to impacts from the proposal (1.2 ha) is insignificant compared to the potential habitat for the species in the locality (approximately 3,315 ha, based on vegetation mapping by Tindall (2004)). It is not anticipated that the proposal would result in the removal of individual plants.

The proposal has the potential to introduce weed seed to habitats that are currently relatively free of weed invasion. Mitigation measures listed in Section 5.2 should be undertaken to reduce the potential of the introduction of weed seed. Further, the site would be actively revegetated using local native species by qualified bush regenerators on completion of works. Sedimentation controls, such as silt fencing, are also required to minimise the impact of sedimentation on adjoining habitats.

The proposal is not likely to have a significant effect on the habitat of the species in the locality.

**Does the proposal affect any threatened species or populations that are at the limit of its known distribution?**

*Pultenaea aristata* is restricted to the Woronora Plateau ranging from Helensburgh to Mt Keira (DEC 2005w). The Study Area is at the limit of known distribution of the species.

**How is the proposal likely to affect current disturbance regimes?**

*Pultenaea aristata* is probably killed by fire (DEC 2005w).The proposal is unlikely to alter the existing fire regime of the Study Area.

*Pultenaea aristata* is not known to be dependant on a certain flooding regime, though given its habitat, is likely to require certain levels of soil moisture to be available. The proposal is unlikely to affect the natural flooding regime or moisture availability of the habitats in the Study Area.

The proposal is not likely to alter current disturbance regimes.

**How is the proposal likely to affect habitat connectivity?**

Despite the removal and modification of 1.2 ha of potential habitat for *Pultenaea aristata* within the Study Area, the impact areas for the proposal are generally restricted to the edge of existing tracks and would not involve additional fragmentation of habitat for this species. The proposal would not significantly affect habitat connectivity for *Pultenaea aristata.*

**Will the proposal impact critical habitat (either directly or indirectly)?**

Under the TSC Act, the Director-General maintains a register of critical habitat. To date, no critical habitat has been declared for this species. The proposal is not likely to impact on critical habitat for this species (directly or indirectly).

**Conclusion:**

Despite the proposal resulting in fragmentation of habitat for the species, the impact of the proposal on *Pultenaea aristata* is likely to be minor as:

- The proposal is unlikely to have a major impact on the lifecycle of *Pultenaea aristata*;
- The proposal is unlikely to have a major impact on the composition of potential habitat for *Pultenaea aristata*;
- Impact to approximately 0.04 % of the local occurrence of potential habitat for *Pultenaea aristata* is not considered to be a major amount of habitat;
- The proposal would not result in fragmentation of habitat for the species; and,
- No critical habitat has been declared for *Pultenaea aristata*

# Fauna

Impact assessments are undertaken for 23 threatened animal species with potential habitat in the Study Area:

- Red-crowned Toadlet
- Square-tailed Kite
- Cockatoos:
    - Gang-gang Cockatoo
    - Glossy Black-cockatoo
- Forest Owls:
    - Barking Owl
    - Powerful Owl
    - Masked Owl
    - Sooty Owl
- Koala
- Southern Brown Bandicoot
- Grey-headed Flying-fox
- Migratory bird species
    - Black faced Monarch
    - Satin Flycatcher
    - Rainbow Bee-eater
- Microchiropteran Bats – hollow/cave-dependant species
        - Eastern Freetail-bat
        - Large-footed Myotis
        - Greater Broad-nosed Bat
        - Eastern False Pipistrelle
        - Eastern Bentwing Bat
        - Large-eared Pied Bat
- Eastern Pygmy-possum
- Swift Parrot and Regent Honeyeater

## Red-crowned Toadlet *Pseudophryne australis*

The Red-crowned Toadlet 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.

Potential habitat for this species occurs within the Study Area in 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.

**How is the proposal likely to affect the lifecycle of a threatened species and/or population?**

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 1997).

The Red-crowned Toadlet was not recorded within the Study Area during the current survey, however it has been recorded within 1 km of impact sites inside the Study Area. There is potential habitat for this species within the Study Area however the proposal is unlikely to directly impact potential breeding sites for the Red-crowned Toadlet as no rocky outcrops would be removed.

The proposal would cause direct impacts to a rock outcrop (~3m radius) in the Study Area, however permanent impacts would be minimal. Rock outcrops would not be removed, but some outcrops or exfoliating rock may be disturbed. While these frogs have a small home range and are dependent on suitable rock outcrops to provide shelter and food resources, the impacts are not likely to interrupt the lifecycle of a local population.

**How is the proposal likely to affect the habitat of a threatened species, population or ecological community?**

The Red-crowned Toadlet was not recorded during the field surveys. Potential habitat for the species in the Study Area includes Sandstone Ridgetop Woodland, Gully Forest and Upland Swamps.

There are 18 proposed borehole sites, of which 11 have potential Red-crowned Toadlet habitat in the vicinity of the impact sites. Taking a worst case scenario (direct and indirect impact to 80 x 80 m area for each borehole site), approximately 5.4 ha of potential habitat may be impacted which is 0.02 % of the local occurrence of potential habitat within the Study Area. A few sandstone outcrops did occur within the impact areas in the Study Area and also within 15 m of the impact areas, however these would not be removed.

Red-crowned Toadlet habitat within the Study Area and adjacent woodland is of moderate quality. It contains a small number of exposed outcrops and exfoliating rock as well as a few ephemeral streams and soaks. Habitat in vegetation outside the area of direct impact is of similar (or better) quality, therefore the overall quality of potential Red-crowned Toadlet habitat within the greater area is unlikely to have a significant effect by the proposal.

**Does the proposal affect any threatened species or populations that are at the limit of its known distribution?**

The Red-crowned Toadlet has a restricted distribution. It is confined to the Sydney Basin, from Pokolbin in the north, the Nowra area to the south, and west to Mt Victoria in the Blue Mountains. The Study Area is not at the limit of the distribution for the Red-crowned Toadlet.

**How is the proposal likely to affect current disturbance regimes?**

The Red-crowned Toadlet is not known to be dependant on a certain flooding regime. The Proposal is unlikely to affect fire regimes or the natural flooding regime of the Study Area.

**How is the proposal likely to affect habitat connectivity?**

The impact areas for the proposal are generally restricted to the edge of existing tracks and would not cause major fragmentation of habitat for this species. However borehole AI04B is located in a relatively undisturbed patch of Coastal Sandstone Gully Forest. A clearing for a 5m x 80m access track to the borehole site is proposed which would increase fragmentation of potential habitat for this species. The vegetation types which provide habitat for the Red-crowned Toadlet are continuous in the greater locality. As such, the proposed works would not significantly affect habitat connectivity or result in long-term isolation of habitat for this species.

**How is the proposal likely to affect critical habitat?**

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 of DECC maintains a register of critical habitat. To date, no critical habitat has been declared for this species.

**Conclusion:**

The impact of the proposal on the Red-crowned Toadlet is likely to be minor as:

- The proposal is unlikely to have a major impact on the lifecycle of the Red-crowned Toadlet;

- The proposal is unlikely to have a major impact on the composition of potential habitat for the Red-crowned Toadlet within the locality;
- The Study Area contains approximately 5.4 ha of Ridgetop Woodland, Gully Forest and Upland Swamp habitat for this species. Impacts to 0.02 % of the local occurrence of potential habitat for the Red-crowned Toadlet is not considered to be a major amount of habitat;
- The proposal would not result in significant long-term isolation or fragmentation of habitat for this species; and,
- No critical habitat has been declared for the Red-crowned Toadlet.

**Koala** ***Phascolarctos cinereus***

The Koala is listed as Vulnerable on Schedule 2 of 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.

Potential Koala habitat exists in the Study Area within woodlands and forests however few feed trees were observed during the current survey.

**How is the proposal likely to affect the lifecycle of a threatened species and/or population?**

The Koala has been recorded in the Study Area. There is a large population occurring in the Dharawal State Conservation Area within the locality. Effects of the proposal on Koala feed trees would be minimal, as there would be no clearing of any Koala feed trees. Movement of Koalas between fragments is restricted by the risk of predation by feral species (e.g. dogs, foxes) and road associated fatalities. The potential habitat within the Study Area occurs in a small, degraded stand adjacent to an old shaft site. These factors make it less likely that the Study Area supports a population of Koalas.

Considering the above, it is unlikely that the proposal would have an adverse effect on the lifecycle of a viable Koala population if such a population is still present in the Study Area.

**How is the proposal likely to affect the habitat of a threatened species, population or ecological community?**

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 Swamp Mahogany (*Eucalyptus robusta*) that is listed as a Koala feed tree in Schedule 2

of SEPP 44. There have been a number of Koalas recorded throughout the Study Area and locality (DECC Atlas of NSW Wildlife). Large populations have been recorded in the Dharawal State Conservation Area and adjacent continuous vegetation within the locality. Potential Koala habitat exists in the Study Area within woodlands and forests where feed trees occur. Potential habitat for Koalas exists elsewhere in the locality in larger, more continuous stands and of higher quality. There would be no Koala feed trees to be to be removed.

Approximately 4.2 ha of potential Koala habitat would be modified or cleared as part of the proposal which represents 0.01 % of the broader distribution of these habitat types within the locality (36,260 ha). Given the extent of higher quality potential habitat within the locality it is unlikely that the proposal would have a significant impact on the habitats for this species.

As such, it is unlikely that the proposal would have a major impact on the local population of Koalas or affect the long-term survival of a local population of Koalas.

**Does the proposal affect any threatened species or populations that are at the limit of its known distribution?**

The Koala has a fragmented distribution throughout eastern Australia from north-east Queensland to the Eyre Peninsula in South Australia. In NSW it mainly occurs on the central and north coasts with some populations in the western region. It was historically abundant on the south coast of NSW, but now occurs in sparse and possibly disjunct populations. Koalas are also known from several sites on the southern tablelands (DEC 2005l). The Study Area is not at the limit of the distribution of the Koala.

**How is the proposal likely to affect current disturbance regimes?**

The Proposal is unlikely to affect fire regimes or the natural flooding regime of the Study Area.

**How is the proposal likely to affect habitat connectivity?**

The proposal would involve no clearing of any Koala feed trees therefore the proposal would not directly fragment any existing vegetation stands into fragments.

There is only one small *Eucalyptus robusta* stand observed in the Study Area at Borehole site AI06 adjacent to a carpark. This area has previously been modified and cleared with no understory intact. The impact areas for the proposal are generally restricted to the edge of existing tracks and would not cause major fragmentation of habitat for this species. However borehole AI04B is located in a relatively undisturbed patch of Coastal Sandstone Gully Forest. A clearing for a

5m x 80m access track to the borehole site is proposed which would increase fragmentation of potential habitat for this species. Overall, it is also unlikely that the Proposal would create a major barrier to the movement of this species in the area or isolate portions of potential habitat. As such, the proposed works would not significantly affect habitat connectivity for the Koala.

**How is the proposal likely to affect critical habitat?**

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 this species (DECC Threatened Species Unit).

In addition, the Koala is listed on the Predation by the Red Fox – Threat Abatement Plan (NPWS 2001b). However, the proposal is unlikely to increase the threat of the Red Fox on a population of Koalas within the Study Area.

**Conclusion**

The impact of the proposal on the Koala is likely to be minor as:

- The proposal is unlikely to have a major impact on the lifecycle of the Koala.
- The proposal is unlikely to have a major impact on the composition of potential habitat for the Koala within the locality;
- There would be no clearing of any Koala feed trees within the Study Area. Impact to 0.01 % of the local occurrence of potential habitat for the Koala is not considered to be a major amount of habitat;
- The proposal would not result in significant long-term isolation or fragmentation of habitat for this species; and,
- No critical habitat has been declared for the Koala.

## Forest Owls

The Barking Owl, Masked Owl, Powerful Owl and Sooty Owl are listed as Vulnerable on Schedule 2 of the TSC Act.

Powerful Owl, Masked Owl, Sooty Owl and Barking Owl have been grouped on the basis of their similar habitat requirements.

These species inhabit woodland and/or forest habitats and are dependent upon tree hollows for nesting sites and habitat for hollow-dwelling arboreal marsupials (possums and gliders), which comprise a large proportion of the owls' diet,

(Higgins 1999). The potential foraging and roosting habitat for these species occurs within the Study Area in Coastal Sandstone Ridgetop Woodland and Gully Forest habitats.

**How is the proposal likely to affect the lifecycle of a threatened species and/or population?**

The Proposal is likely to remove and/or modify approximately 4.2 ha of ridgetop woodland and gully forest habitat. There are minimal trees to be removed and all hollow bearing trees would be retained. Clearing would lead to a reduction in potential foraging habitat, however, given the extant of potential foraging habitat within the locality it is unlikely that foraging resources in the Study Area would be significantly impacted for a local population of these species. Given the extent of potential habitat for these species in the locality and the large home-range and mobility of these species, it is unlikely that the proposal would impact on the lifecycle of the four species of forest owls.

**How is the proposal likely to affect the habitat of a threatened species, population or ecological community?**

All four owl species have a large home range, which is in the order of several hundred hectares (Gibbons and Lindenmayer 1997). The Proposal is likely to modify (including direct and indirect impacts) approximately 4.2 ha of potential woodland/forest habitat within the Study Area. Given the mobility of this species and the extent of higher quality potential habitat within the locality it is unlikely that the proposal would have a significant impact on the habitats for these species. The vegetation types which provide habitat for the Owls are continuous in the greater locality and are considered to be in good condition. The amount of potential habitat likely to be modified and /or removed represents approximately 0.01% of suitable foraging and roosting habitat for these Owl's species within the locality.

The proposal is not likely to have a significant effect on the habitat of these species in the locality.

**Does the proposal affect any threatened species or populations that are at the limit of its known distribution?**

The Powerful Owl has been recorded along the eastern coast of Australia from south-eastern Queensland to Victoria (Debus, 1994). Records are concentrated on the coastward side of the Great Dividing Range but in many places its distribution extends to the inland slopes, mostly within approximately 200km of the coast.

The Masked Owl occurs along coastal mainland Australia from north-western Australia to Tasmania (where it is most common) but is considered to have very sparse distribution. It is also occurs in the south-western and southern regions of Australia.

The Barking Owls occurs in forests and woodlands or tropical, temperate and arid zones (NPWS 2003b).

The Sooty Owl is generally confined to the east of the Great Dividing Range south to the Melbourne and north to southeast Queensland with a patchy distribution (Higgins 1999; DEC 2005{). The Illawarra Escarpment may contain the best habitat for the Sooty Owl in the Sydney Basin Bioregion (NPWS 1998).

The Study Area is not at the limit of known distribution for any of these forest owl species.

**How is the proposal likely to affect current disturbance regimes?**

The Proposal is unlikely to affect fire regimes or the natural flooding regime of the Study Area.

**How is the proposal likely to affect habitat connectivity?**

Given the extent of potential habitat within the locality, mobility and home range of the four owl species, it is unlikely that the Proposal would result in the fragmentation or isolation of potential habitat for these species.

The potential habitat for the forest owls within the Study Area is considered to be in good condition providing foraging and nesting habitat opportunities. These habitat features are widely distributed throughout the locality hence it is unlikely the removal and/or modification of 4.2 ha of potential habitat in the Study Area would significantly affect habitat connectivity of forest owls in the locality.

**How is the proposal likely to affect critical habitat?**

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.

**Conclusion**

The impact of the proposal on the four species of forest owl is likely to be minor as:

- The proposal is unlikely to have a major impact on the lifecycle of the Forest owls;

- The proposal is unlikely to have a major impact on the composition of potential habitat for forest owls within the locality;
- The Study Area contains approximately 3.6 ha of Sandstone Ridgetop Woodland and 0.6 ha of Gully Forest habitat for this species. Impact to 0.01% of the local occurrence of potential habitat for this species is not considered to be a major amount of habitat;
- There would be no clearing of any hollow bearing trees therefore there would be limited impact on potential habitat for these species;
- The proposal would not result in significant long-term isolation or fragmentation of habitat for this species; and,
- No critical habitat has been declared for the four forest owl species.

## Square-tailed Kite *Lophoictinia isura*

The Square-tailed Kite is listed as Vulnerable under Schedule 2 of the TSC Act. The Square-tailed Kite is found in a variety of timbered habitats including dry woodlands and open forests, timbered watercourses, rocky hills and gorges (Marchant and Higgins 1993).

**How is the proposal likely to affect the lifecycle of a threatened species and/or population?**

The Proposal is likely to remove and/or modify approximately 4.2 ha of ridgetop woodland and gully forest habitat. This area could provide foraging resources or make up a small portion of a raptor's territory. This species has a very large territory, typically greater than 100 $km^2$. Additional habitat is present within the Study Area and the wider locality. The Square-tailed Kite requires large living trees for breeding, particularly near water with surrounding woodland /forest close by for foraging habitat. Nest sites are generally located along or near watercourses, in a tree fork or on large horizontal limbs (Marchant and Higgins 1993). Given the extent of potential habitat for this species in the locality and the large territory and mobility of this species, it is unlikely that the proposal would impact on the lifecycle of the Square-tailed Kite.

**How is the proposal likely to affect the habitat of a threatened species, population or ecological community?**

The Square-tailed Kite is found in a variety of timbered habitats including dry woodlands and open forests, timbered watercourses, rocky hills and gorges (Marchant and Higgins 1993). They show a particular preference for timbered watercourses. In NSW they are known to occur in ridge and gully forests

dominated by *Eucalyptus longifolia, Corymbia maculata,* or peppermints such as *E. elata* and *E. smithii.* They are also found in early regrowth after logging, and forests of eucalypts or Angophora or Callitris with shrubby understorey, and box-ironbark woodlands (Marchant and Higgins 1993).

The Square-tailed Kite has not been recorded on the subject site. Approximately 4.2 ha of potential foraging habitat would be removed as a result of the proposal.

The area to be impacted (directly and indirectly) by the proposal equates to 0.01 % of similar habitat types in the locality. This is not considered to be a significant amount of habitat.

The potential habitat within the Study Area is considered to be in Moderate-Good condition in most places, with a range of vegetation types supporting a diversity of potential prey for these species. These habitat features are likely to be widely distributed within the locality. This bird species is very mobile and has a large territory, Therefore, the proposal is not likely to have a significant effect on the habitat of this species in the locality.

**Does the proposal affect any threatened species or populations that are at the limit of its known distribution?**

In Australia, the Square-tailed Kite is widespread, but sparse. It occurs in coastal and sub-coastal areas from south-western to northern Australia, Queensland, NSW and Victoria. In NSW, scattered records of the species throughout the state indicate that the species is a regular resident in the north, northeast and along the major west-flowing river systems (DEC 2005|). The Study Area is not at the limit of the known distribution of the Square-tailed Kite.

**How is the proposal likely to affect current disturbance regimes?**

The Proposal is unlikely to affect fire regimes or the natural flooding regime of the Study Area.

**How is the proposal likely to affect habitat connectivity?**

Potential habitat for this species occurs within the locality is fragmented by roads, powerline easements, rivers, industry, agriculture and towns. Potential habitat within the Study Area is currently fragmented by roads and powerline easements. The proposal would lead to a reduction in the size of habitat however there would be no further fragmentation and isolation of habitat as impact sites occur adjacent to existing roads and tracks. This bird species is highly mobile with an extremely large territory. It is unlikely that the impacts of this proposal would significantly affect habitat connectivity of the Square-tailed Kite in the locality.

**How is the proposal likely to affect critical habitat?**

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 Square-tailed Kite.

**Conclusion**

The impact of the proposal on the Square-tailed Kite is likely to be minor as:

- The proposal is unlikely to have a major impact on the lifecycle of the Square-tailed Kite;
- The proposal is unlikely to have a major impact on the composition of potential habitat for the Square-tailed Kite within the locality;
- Approximately 4.2 ha of potential foraging habitat would be cleared for this species. Impact to 0.01 % of the local occurrence of potential habitat for this species is not considered to be a major amount of habitat. Therefore considering the mobility and large territory of the Square-tailed Kite there would be limited impact on potential foraging habitat for this species;
- The proposal would not result in fragmentation of habitat for the species; and,
- No critical habitat has been declared for the Square-tailed Kite.

## Cockatoos

The Gang-gang Cockatoo and Glossy Black-cockatoo are listed as Vulnerable under Schedule 2 of the TSC Act. Potential habitat for these threatened cockatoos exists in the Study Area. These species have been grouped together for their similar habitat requirements.

**How is the proposal likely to affect the lifecycle of a threatened species and/or population?**

No Glossy Black-cockatoos or Gang-gang Cockatoos were recorded during the field assessment, although there have been numerous records of both species throughout the Study Area (DEC Atlas of NSW Wildlife).

The Proposal would remove approximately 4.2 ha of potential habitat for these species. This habitat may provide foraging resources and contains hollows that

may be suitable for breeding. No hollow bearing trees would be removed for this proposal.

The Glossy Black-cockatoo relies almost entirely on the seeds of a few species of *Allocasuarina* for food, these being *A. littoralis, A. torulosa* and *A. verticillata.* 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 also forage on *Angophora* fruit, sunflower seeds, pine cones and grubs in 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. 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.

The Gang-gang Cockatoo occurs in a variety of forest and woodland habitats dominated by Eucalyptus species. It forages in the canopy of trees on seeds of native and introduced trees, especially eucalypts. Gang-gang Cockatoos are dependent on tree hollows for breeding purposes, nesting in large trunks or large limbs (Gibbons and Lindenmayer 1997). The species prefers live trees near water. Although not much is known about the movements of this species, it is considered to be mobile and known to migrate in response to food availability and seasonal changes.The Gang-gang Cockatoo forages for seeds in the canopies of native and introduced trees, especially eucalypts.

It is therefore unlikely that the Proposed Project would have a significant impact on the life cycle for these cockatoo species.

**How is the proposal likely to affect the habitat of a threatened species, population or ecological community?**

Gang-gang Cockatoos and Glossy Black-cockatoos nest in tree hollows and are therefore dependent on hollows for the perpetuation of local populations. Many hollow-bearing trees were recorded within the Study Area, and are also likely to be present throughout forest habitats in the locality. No hollow bearing trees are to be removed for this proposal.

The Proposal would remove approximately 4.2 ha of potential habitat for these 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 proposed development are continuous and abundant within the wider region. The Proposal would remove 0.01 % of these habitat types in the locality. Habitat for these cockatoo species 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.

Therefore the proposal is unlikely to have major impacts on the habitat of these cockatoos.

**Does the proposal affect any threatened species or populations that are at the limit of its known distribution?**

These species have a broad distribution. The Gang-gang Cockatoo is distributed in the south-east of NSW and Victoria. The Glossy Black-cockatoo is widespread in the east of Australia, occurring from Eungella, Queensland, south to East Gippsland, and inland to south-central Queensland and the Central-Western Plains and Riverina in NSW (Higgins 1999). The Study Area is not at the limit of the distribution for these two Cockatoo species (DEC Threatened Species Unit).

**How is the proposal likely to affect current disturbance regimes?**

The Proposal is unlikely to affect fire regimes or the natural flooding regime of the Study Area.

**How is the proposal likely to affect habitat connectivity?**

The vegetation types which provide habitat for the Gang-gang Cockatoo and Glossy Black-cockatoo within the Study Area are continuous and of similar quality in the locality. Given the mobility of these species, it is unlikely that the Proposal would fragment any potential or known habitat or remove wildlife corridors. The impact areas for the proposal are generally restricted to the edge of existing tracks and would not cause major fragmentation of habitat for this species. However borehole AI04B is located in a relatively undisturbed patch of Coastal Sandstone Gully Forest. A clearing for a 5m x 80m access track to the borehole site is proposed which would increase fragmentation of potential habitat for this species. Overall, it is also unlikely that the Proposal would create a major barrier to the movement of the species in the area or isolate portions of potential habitat for these two Cockatoo species.

**How is the proposal likely to affect critical habitat?**

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.

**Conclusion**

The impacts of the proposal on the Gang-gang Cockatoo and Glossy Black-cockatoo are likely to be minor as:

- The proposal is unlikely to have a major impact on the lifecycle of the Gang-gang Cockatoo and Glossy Black-cockatoo;
- The proposal is unlikely to have a major impact on the composition of potential habitat for these Cockatoos within the locality;
- Approximately 4.2 ha of potential habitat within the Study Area would be cleared. Impact to 0.01 % of the local occurrence of potential habitat for this species is not considered to be a major amount of habitat, considering the quality of potential habitat within the locality;
- The proposal would not result in significant long-term isolation or fragmentation of habitat for this species; and,
- No critical habitat has been declared for the Gang-gang Cockatoo and Glossy Black-cockatoo.

**Eastern Pygmy-possum** ***Cercartetus nanus***

The Eastern Pygmy-possum 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. Potential habitat for this species occurs within the Study Area in the Ridgetop Woodland, Gully Forest and Upland Swamp fauna habitat types.

**How is the proposal likely to affect the lifecycle of a threatened species and/or population?**

Eastern Pygmy-possums will often nest and shelter in tree hollows, rotten stumps, holes in the ground, abandoned bird-nests, Ringtail Possum (*Pseudocheirus peregrinus*) dreys or thickets of vegetation, (eg. grass-tree skirts); but 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 ha and females about 0.35 ha (DEC 2005g). Young can be born whenever food sources are readily available, with most births occurring between late spring and early autumn (DEC 2005g).

No individuals were recorded during the survey, however, there have been a number of records of the Eastern Pygmy-possum within the Study Area (Figure 5). Potential habitat for this species occurs within the Ridgetop Woodland, Gully Forest and Upland Swamp habitats types.

The proposed works are likely to remove and/or modify approximately 5.4 ha 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. The proposal would directly impact on 0.02 % of potential habitat within the locality.

The small home range of this species indicates individuals do not normally move large distances. Introduced predatory species such as cats (*Felis cattus*), dogs (*Canis lupus familiaris*) and foxes (*Vulpes vulpes*) have been recorded within the locality. Given the susceptibility of Eastern Pygmy-possums to predation by these introduced species, individuals may have difficulty relocating.

Research has indicated that within the Eastern Pygmy-possum's patchy distribution, individuals exist at low abundance therefore a population may be significantly affected through the loss of only a comparatively small number of individuals.While this species has a solitary nature, small home range, patchy distribution, low overall abundance and dependence on a constant food source for reproduction, it is unlikely that the impacts of the proposal would significantly affect the lifecycle of a local population.

**How is the proposal likely to affect the habitat of a threatened species, population or ecological community?**

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 (DEC 2005g). 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 eaten when flowers are less available (DEC 2005g). Although the Eastern Pygmy-possum is broadly distributed, within its range the species appears to be patchily distributed and its overall abundance is low.

Potential habitat for this species occurs in the Woodland, Forest and Upland Swamp habitats 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. The proposal is likely to impact approximately 5.4 ha 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 0.02 % of the available habitat within the locality.

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 for the Eastern Pygmy-possum. 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 if they disperse to other areas following the removal of their small home range. Overall quality of potential Eastern Pygmy-possum habitat within the greater area is unlikely to have a significant effect on potential habitat by the proposal.

**Does the proposal affect any threatened species or populations that are at the limit of its known distribution?**

The Eastern Pygmy-possum has a wide distribution between south-east Queensland through eastern New South Wales to South Australia and Tasmania. Although the Eastern Pygmy-possum is broadly distributed, within its range the species appears to be patchily distributed and its overall abundance is low. The Study Area is not at the limit of the distribution for this species.

**How is the proposal likely to affect current disturbance regimes?**

The Proposal is unlikely to affect fire regimes or the natural flooding regime of the Study Area.

**How is the proposal likely to affect habitat connectivity?**

The vegetation types which provide habitat for the Eastern Pygmy-possum within the subject site are continuous in the greater locality and the surrounding potential habitat is of similar quality to the habitat within the Study Area. The impact areas for the proposal are generally restricted to the edge of existing tracks and would not cause major fragmentation of habitat for this species. However borehole AI04B is located in a relatively undisturbed patch of Coastal Sandstone Gully Forest. A clearing for a 5m x 80m access track to the borehole site is proposed which would increase fragmentation of potential habitat for this species. Overall it is unlikely that the Proposal would create a major barrier to the movement of the species in the area or isolate portions of potential habitat for the Eastern Pygmy-possum.

As such, the proposed works are unlikely to cause significant long-term isolation or fragmentation of existing habitat.

**How is the proposal likely to affect critical habitat?**

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 of DECC maintains a register of critical habitat. To date, no critical habitat has been declared for this species (DEC Threatened Species Unit).

**Conclusion**

The impacts of the proposal on the Eastern Pygmy-possum are likely to be minor as:

- The proposal is unlikely to have a major impact on the lifecycle of the Eastern Pygmy-possum;
- The proposal is unlikely to have a major impact on the composition of potential habitat for the Eastern Pygmy-possum within the locality;
- The Study Area contains approximately 5.4 ha of Ridgetop Woodland, Gully Forest and Upland Swamp habitat for this species. There would be impacts to 0.02 % of the local occurrence of potential habitat for the Eastern Pygmy-possum however this is not considered to be a major amount of habitat considering the quality of potential habitat within the locality;
- The proposal would not result in significant long-term isolation or fragmentation of habitat for this species; and,
- No critical habitat has been declared for the Eastern pygmy-possum.

## Southern Brown Bandicoot (eastern) *Isoodon obesulus obesulus*

The Southern Brown Bandicoot is listed as Endangered on Schedule 1 of the TSC Act and as Endangered on the EPBC Act.

No records of the Southern Brown Bandicoot exist within the Study Area or locality, however potential habitat for the Southern Brown Bandicoot within the Study Area is considered to be within Gully Forest, Ridgetop Woodland and Upland Swamp habitats where there is a heathy understorey on sandy soil.

**How is the proposal likely to affect the lifecycle of a threatened species and/or population?**

The Southern Brown Bandicoot nests during the day in a shallow depression in the ground covered by leaf litter, grass or other plant material (DEC 2005ˆ), but may also utilise rabbit burrows, rock ledges or crevices. Mating occurs any time of the year, usually following heavy rain. Two or three litters of 2-4 young may be produced annually. They have a short gestation period of 11-12 days and young become independent around 60 days after being born (DEC 2005ˆ). They feed on a variety of ground-dwelling invertebrates and the fruit-bodies of hypogeous (underground-fruiting) fungi. Males have a home range of approximately 5-20 ha whilst females forage over smaller areas of about 2-3 ha (DEC 2005ˆ). Fungal material is part of their diet (Broughton and Dickman

1991). Fungal sporocarps are typically distributed as discrete clusters often in association with host tree roots (Claridge *et al.* 1993).

There are no records of Southern Brown Bandicoots in the Study Area or locality, however, potential habitat for this species occurs in Woodland, Forest, and Upland Swamp habitats within the Study Area.

Foraging resources could be impacted by the proposal, but impacts are unlikely to be significant. There is a limited possibility of individual trees (which could be hosts to the fungal sporocarps which make up part of this species diet) which area unlikely to be significantly impacted.

Southern Brown Bandicoots inhabit relatively small home ranges but these home ranges are relatively flexible with individuals able to shift their home range depending on resource availability (Broughton and Dickman 1991). They are not solely dependent on rocky areas for refuge and would also nest amongst soil litter and plant material. Southern Brown Bandicoots would be able to use resources in the forest and woodlands adjacent to impacted areas. While there is the potential for some individuals to be affected by the proposal, it is unlikely that the impacts of the proposal would significantly affect the lifecycle of a local population.

**How is the proposal likely to affect the habitat of a threatened species, population or ecological community?**

Southern Brown Bandicoots are generally only found in heath or open forest with a heathy understorey on sandy or friable soils (DEC 2005ˆ). A mosaic of post fire vegetation is an important component of habitat for this species (Maxwell *et al.* 1996).

Known and potential habitat for Southern Brown Bandicoot occurs in Coastal Sandstone Gully forest, Coastal Sandstone Ridgetop Woodland and Coastal Upland Swamp plant communities within the Study Area where suitable breeding, foraging and sheltering resources occur. Only where such resources occur, and not the entire extent of these plant communities, is considered potential habitat for the species. The Study Area contains approximately 5.4 ha of potential habitat for the Southern Brown Bandicoot in Upland Swamps, Woodlands, and Forests. Specifically, habitats where there is a heathy understorey on sandy soil are likely to be important for the species within the Study Area. These potential habitats are widely distributed within the locality (approximately 39,575 ha). The potential habitat for the Southern Brown Bandicoot in the Study Area represents 0.01 % of potential habitat within the locality.

Known and potential habitat for the Southern Brown Bandicoot within the Study Area is considered to be in good condition, containing mixed eucalypts and understorey heath. The current distribution and population size of the Southern Brown Bandicoot is poorly understood and therefore, any populations are to be treated as being of the highest conservation priority (DEC 2005Ž). While the Southern Brown Bandicoot may be able to utilise a range of habitat types, and suitable habitat within the Study Area is continuous with habitat of a similar quality within the locality, known and potential habitat within the Study Area should be considered of high importance to the long-term survival of the Southern Brown Bandicoot, if a population is present. It is unlikely that this proposal would have a major impact on the composition of potential habitat for these species.

**Does the proposal affect any threatened species or populations that are at the limit of its known distribution?**

The Southern Brown Bandicoot has a patchy distribution. It is found in south-eastern NSW, east of the Great Dividing Range south from the Hawkesbury River, southern coastal Victoria and the Grampian Ranges, south-eastern South Australia, south-west Western Australia and the northern tip of Queensland (DECC Threatened Species Unit). The Study Area is not at the limit of the distribution for this species.

**How is the proposal likely to affect current disturbance regimes?**

The Proposal is unlikely to affect fire regimes or the natural flooding regime of the Study Area.

**How is the proposal likely to affect habitat connectivity?**

The Proposal is unlikely to result in fragmentation or isolation of potential habitat for the species and good quality potential habitat for the Southern Brown Bandicoot is continuous within the locality. The impact areas for the proposal are generally restricted to the edge of existing tracks and would not require additional fragmentation of habitat for this species. Southern Brown Bandicoots may use Upland Swamps, riparian habitats and rocky outcrops, but they would not be solely reliant on these habitats and would be able to use the surrounding forest and woodland habitats that would be less impacted by the Proposal. Furthermore, the woodland and forest habitat types are continuous into the greater locality and are of similar quality to the habitat within the Study Area; they also would not be significantly fragmented or isolated by the Proposal.

**How is the proposal likely to affect critical habitat?**

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 Southern Brown Bandicoot.

**Conclusion**

The impacts of the proposal on the Southern Brown Bandicoot are likely to be minor as:

- The proposal is unlikely to have a major impact on the lifecycle of the Southern Brown Bandicoot;
- The proposal is unlikely to have a major impact on the composition of potential habitat for the Southern Brown Bandicoot within the locality;
- The Study Area contains approximately 5.4 ha of Ridgetop Woodland, Gully Forest and Upland Swamp potential habitat for this species. There would be impacts to 0.02 % of the local occurrence of potential habitat for the Southern Brown Bandicoot however this is not considered to be a major amount of habitat considering the quality of potential habitat within the locality;
- The proposal would not result in significant long-term isolation or fragmentation of habitat for this species; and,
- No critical habitat has been declared for the Southern Brown Bandicoot.

## Regent Honeyeater (*Xanthomyza Phrygia)* and Swift Parrot (*Lathamus discolor*)

The Regent Honeyeater is listed as Endangered under Schedule 1 of the TSC Act and as Endangered under the EPBC Act. The Swift Parrot is listed as Endangered on Schedule 2 of the TSC Act and as Endangered on the EPBC Act.

Potential habitat for these threatened birds exists within the Study Area. These species have been grouped together for their similar habitat requirements.

**How is the proposal likely to affect the lifecycle of a threatened species and/or population?**

The Swift Parrot breeds in Tasmania during spring and summer, migrating in the autumn and winter months to south-eastern Australia from Victoria and the eastern parts of South Australia to south-east Queensland. In NSW the species mostly occurs on the coast and south west slopes (DEC 2005r).

The Regent Honeyeater breeds at only three known key breeding regions: north-east Victoria (Chiltern-Albury), and in NSW at Capertee Valley and the Bundarra-Barraba region. In NSW the distribution is very patchy and mainly confined to the two main breeding areas and surrounding fragmented woodlands (DEC 2005x). However, significant breeding events have also been recorded in the winter foraging habitat of the Quorrobolong and Kurri areas of the Hunter Valley (DECC unpublished, 2007). The Study Area is not located near any of the key breeding areas for this species.

Therefore it is unlikely that the Study Area supports a local population of the Swift Parrot or Regent Honeyeater, however it is possible that the Regent Honeyeater and Swift Parrot utilise the woodland and forest habitats within the Study Area to forage. These habitat types are widely distributed throughout the locality (36,260 ha). Given that these species are highly mobile and the extent of potential habitat within the locality, it is unlikely that the Regent Honeyeater and Swift parrot would be dependant on the habitat resources within the Study Area for continued survival. Therefore it is unlikely the removal and/or modification of 4.2 ha of potential habitat (0.01 % of available habitat within the locality) would have a major impact on the lifecycle of these species.

**How is the proposal likely to affect the habitat of a threatened species, population or ecological community?**

The Regent Honeyeater has a patchy distribution throughout a large geographic range. The Regent Honeyeater is considered to be a highly mobile species occurring in temperature eucalypt woodlands and open forests (NPWS 1999e; Higgins *et al.* 2001). Most records are from box-ironbark eucalypt forests associations and wet lowland coastal forests (NPWS 1999e; Pizzey and Knight 2007). The species is known to breed at a small number of sites containing a variety of key *Eucalyptus* spp., particularly *E. sideroxylon, E. melliodora* and *E. albens, E. robusta,* but also *E. tereticornis* and *E. moluccana* (Schedvin 1996; Webster & Menkhorst 1992; Franklin *et al*. 1989). There are particular box-ironbark woodlands usually associated with breeding for the Regent Honeyeater which were not observed during the survey and there are no known breeding sites within the locality.

In NSW the Swift Parrot mostly occurs on the coast and south west slopes (DEC 2005r). When migrating during the non-breeding season, the Swift Parrot can occur on the mainland in areas where eucalypts are flowering profusely or where there are abundant lerp (from sap-sucking bugs) infestations. Favoured feed trees include winter flowering species such as *Eucalyptus robusta, Corymbia maculata, C. gummifera, E. sideroxylon,* and *E. albens*. Commonly used lerp infested trees include *E. microcarpa, E. moluccana* and *E. pilularis* (DEC 2005r).

The Swift Parrot and Regent Honeyeater were not recorded during the current survey or within the Study Area but have been recorded on a few occasions within the locality. Potential foraging habitat exists in the Study Area in Ridgetop Woodland and Gully Forests. It is unlikely this proposal would have major impacts on the composition of potential habitat of these bird species. Further, given the lack of preferred foraging trees within the Study Area it is unlikely to constitute prime or core habitat for this species. It is possible that these species would use the resources within the Study Area on occasion however it is unlikely to be dependant on them.

The proposal is likely to impact 0.6 ha of potential Gully Forest habitat (Coastal Sandstone Gully Forest) and 3.6 ha of potential woodland habitat (Coastal Sandstone Ridgetop Woodland). Given this represents only 0.01 % of the broader distribution of these habitats within the locality, it is unlikely that the proposal would have a significant impact on the habitats for both these species. Larger, higher quality areas of potential habitat occur within the locality and as such it is unlikely that the habitat to be removed is important to the long-term survival of the species.

**Does the proposal affect any threatened species or populations that are at the limit of its known distribution?**

The Swift Parrot breeds in Tasmania during spring and summer, migrating in the autumn and winter months to south-eastern Australia from Victoria and the eastern parts of South Australia to south-east Queensland.

The Regent Honeyeater mainly inhabits temperate woodlands and open forests of the inland slopes of south-east Australia. Birds are also found in drier coastal woodlands and forests in some years. Once recorded between Adelaide and the central coast of Queensland, its range has contracted dramatically in the last 30 years to between north-eastern Victoria and south-eastern Queensland.

The Study Area is not at the limit of the distribution for the Regent Honeyeater or the Swift parrot.

**How is the proposal likely to affect current disturbance regimes?**

The Proposal is unlikely to affect fire regimes or the natural flooding regime of the Study Area.

**How is the proposal likely to affect habitat connectivity?**

The proposal would remove 4.2 ha of potential Swift Parrot and Regent Honeyeater foraging habitat from within woodland and forest habitats in the Study Area. This potential habitat contains one site with *E. robusta* which is a preferred feed tree for both species. Potential foraging habitat types are widely distributed within the

locality (36,260 ha), meaning the proposal would clear 0.01 % of potential foraging habitat for these two species within the locality. The proposal would not fragment any stands of vegetation which present potential habitat for these species into two or more fragments. The impact areas for the proposal are generally restricted to the edge of existing tracks and would not cause major fragmentation of habitat for this species. However borehole AI04B is located in a relatively undisturbed patch of Coastal Sandstone Gully Forest. A clearing for a 5m x 80m access track to the borehole site is proposed which would increase fragmentation of potential habitat for this species. Given the mobility of these species, and the extent of similar potential foraging habitat in the locality, it is unlikely that the proposal would significantly fragment or isolate any areas of potential foraging habitat or movement corridors for this species.

**How is the proposal likely to affect critical habitat?**

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 or Swift Parrot.

**Conclusion**

The impacts of the proposal on the Regent Honeyeater and Swift Parrot are likely to be minor as:

- The proposal is unlikely to have a major impact on the lifecycle of these two species;
- The proposal is unlikely to have a major impact on the composition of potential habitat for the Regent Honeyeater and Swift Parrot within the locality;
- The Study Area contains approximately 4.2 ha of Ridgetop Woodland, and Gully Forest habitat for these species. Potential habitat within the Study Area is not considered to be prime or core habitat for the Regent Honeyeater or Swift Parrot given the lack of preferred winter flowering trees. There would be impacts to 0.01 % of the local occurrence of potential habitat for the Regent Honeyeater and Swift Parrot however this is not considered to be a major amount of habitat considering the quality of potential habitat within the locality;
- The proposal would not result in significant long-term isolation or fragmentation of habitat for these two bird species; and,
- No critical habitat has been declared for the Regent Honeyeater or Swift Parrot.

## Grey-headed Flying-fox *Pteropus poliocephalus*

The Grey-headed Flying-fox is listed as Vulnerable on Schedule 2 of the TSC Act and as Vulnerable on the EPBC Act. The Grey-headed Flying-fox was not recorded during the current survey but has been recorded in the past within the Study Area (DECC Atlas of NSW Wildlife). Potential foraging habitat for this species occurs within the woodland and forest habitat where flowering eucalypts provide potential foraging resources.

**How is the proposal likely to affect the lifecycle of a threatened species and/or population?**

This species congregates in large numbers at roosting sites (camps) in a wide range of vegetation types. Individuals generally exhibit a high fidelity to traditional camps and return annually to give birth and rear offspring. Grey-headed Flying-foxes are known to travel up to 50 km from their camps to forage (NPWS 2001a). The diet of the Grey-headed Flying-fox is varied, encompassing a wide range of fruits and blossoms from both native and non-native trees (Strahan 1995).

The Grey-headed Flying-fox has been recorded at a number of sites within the Study Area and at other locations within the locality. The proposal would remove 4.2 ha of potential foraging habitat for this species in the form of woodland and forest habitats containing flowering, nectar producing eucalypts. Potential habitat for the Grey-headed Flying-fox occurs in the Study Area and also in larger, continuous, higher quality stands of vegetation within the locality. The total extent of similar habitat types within the locality is 36,260 ha, meaning the area proposed to be cleared/modified represents 0.01 % of the potential habitat for this species within the locality.

There area no known camps within the Study Area, however there is one known Grey-headed Flying-fox camp within the locality in the Illawarra Escarpment near Bulli Pass. There are also two other camps just outside the locality at Mt Kembla and on the Cumberland Plain at Menangle (DECC 2007b). It is unlikely that the proposal would interfere with breeding of the Grey-headed Flying-fox at these camp sites.

Given the mobility of this species, the lack of camps within the Study Area and the extent of higher quality potential habitat within the locality, it is unlikely that the proposal would disrupt the lifecycle of the Grey-headed Flying-fox.

**How is the proposal likely to affect the habitat of a threatened species, population or ecological community?**

The proposal is likely to directly impact 0.6 ha of potential forest habitat (Coastal Sandstone Gully Forest) and 3.6 ha of potential woodland habitat (Coastal

Sandstone Ridgetop Woodland). The area to be modified or cleared as part of the proposal represents 0.01 % of the broader distribution of these habitat types within the locality (36,260 ha). This potential habitat contains flowering, nectar producing eucalypts that may provide the species with foraging opportunities. Large areas of continuous, higher quality stands of vegetation are present outside the Study Area within the locality. The proposal would not fragment any stands of vegetation which present potential habitat for the Grey-headed Flying-fox into two or more fragments. The Grey-headed Flying-fox may forage at a distance of up to 50 km from its camp each night (NPWS 2001a). Given the mobility of this species, the lack of camps within the Study Area and the extent of higher quality potential habitat within the locality it is unlikely that the proposal would have a significant impact on the habitats for this species.

**Does the proposal affect any threatened species or populations that are at the limit of its known distribution?**

Grey-headed Flying-foxes are found within 200 km of the eastern coast of Australia, from Bundaberg in Queensland to Melbourne in Victoria. The Study Area is not at the limit of the distribution for this species.

**How is the proposal likely to affect current disturbance regimes?**

The Proposal is unlikely to affect fire regimes or the natural flooding regime of the Study Area.

**How is the proposal likely to affect habitat connectivity?**

The proposal would remove 4.2 ha of Grey-headed Flying-fox potential foraging habitat from within woodland and forest habitats in the Study Area. Potential foraging habitat types are widely distributed within the locality (36,260 ha), meaning the proposal would clear 0.01 % of potential foraging habitat for this species within the locality. The proposal would not fragment any stands of vegetation which present potential habitat for these species into two or more fragments. The impact areas for the proposal are generally restricted to the edge of existing tracks and would not cause major fragmentation of habitat for this species. However borehole AI04B is located in a relatively undisturbed patch of Coastal Sandstone Gully Forest. A clearing for a 5m x 80m access track to the borehole site is proposed which would increase fragmentation of potential habitat for this species. Given the mobility of these species, and the extent of similar potential foraging habitat in the locality, it is unlikely that the proposal would significantly fragment or isolate any areas of potential foraging habitat or movement corridors for the Grey-headed Flying-fox.

**How is the proposal likely to affect critical habitat?**

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.

**Conclusion**

The impacts of the proposal on the Grey-headed Flying fox are likely to be minor as:

- The proposal is unlikely to have a major impact on the lifecycle of the Grey-headed Flying-fox;
- The proposal is unlikely to have a major impact on the composition of potential habitat for the Grey-headed Flying fox within the locality;
- The Study Area contains approximately 4.2 ha of Ridgetop Woodland and Gully Forest potential habitat for this species. There would be impacts to 0.01 % of the local occurrence of potential habitat for the Grey-headed Flying fox however this is not considered to be a major amount of habitat considering the quality of potential habitat within the locality;
- The proposal would not result in significant long-term isolation or fragmentation of habitat for this species; and,
- No critical habitat has been declared for the Grey-headed Flying fox.

## Microchiropteran Bats

The Greater Broad-nosed Bat, Eastern False Pipistrelle, Eastern Freetail-bat, Eastern Bentwing Bat, and Large-footed Myotis are listed as Vulnerable on Schedule 2 of the TSC Act and the Large-eared Pied Bat is listed as Vulnerable on Schedule 2 of the TSC Act and Vulnerable on the EPBC Act.

The Eastern Bentwing Bat and Large-eared Pied Bat are cave-roosting species, where the Greater Broad-nosed Bat, Eastern False Pipistrelle, Eastern Freetail-bat are hollow–roosting species. The Large-footed Myotis is a cave and hollow roosting species. These six Microchiropteran Bat species have been grouped on the basis of their similar foraging habitat requirements and local recordings.

Potential habitat for these species occurs within the Study Area in Upland Swamp, Ridgetop Woodland and Gully Forest habitats. Cave or disused mine infrastrure which may be utilised by these bat species will not be impacted by the proposal.

**How is the proposal likely to affect the lifecycle of a threatened species and/or population?**

Factors likely to disrupt the life cycle of these bat species include the loss, disruption or modification of roost sites, which include tree hollows, bark of trees, caves, culverts, drains and mines. No potential roost sites or hollow bearing trees would be removed or modified for this proposal. However, the loss of suitable foraging areas and habitat for prey items can disrupt the life cycle of these species. The Proposal would remove and /or modify approximately 5.4 ha of potential foraging habitat. These habitats are widely distributed throughout the locality (39,575 ha). The removal and /or modification of potential foraging habitat for these species represents approximately 0.01 % of the available habitat within the locality.

It is possible that individuals would find suitable roosting habitat in adjacent areas. Given the mobility of these species and extant of potential habitat in the immediate vicinity of the study area it is unlikely to have a significant effect on the lifecycle of these species.

**How is the proposal likely to affect the habitat of a threatened species, population or ecological community?**

Potential habitat for this species occurs in the Woodland, Forest and Upland Swamp habitats types. The proposal is likely to impact approximately 5.4 ha of potential habitat for this species. These habitat types are widely distributed within the locality. The removal and /or modification of potential habitat for Microchiropteran Bats represents approximately 0.01 % of the available habitat within the locality.

Potential habitat within the study area is considered to be in moderate condition. Finer scale habitat features such as abundant tree hollows, bark and watercourses provide foraging and roosting habitat for these Bat species. These habitat features have also been widely identified in the local area. No hollow bearing trees or potential roosting sites would be removed for the current proposal. Overall quality of potential foraging and roosting habitat within the greater area is unlikely to have a significant effect on potential habitat by the proposal.

**Does the proposal affect any threatened species or populations that are at the limit of its known distribution?**

The Large-footed Myotis is found in the coastal band from the north-west of Australia, across the top-end and south to western Victoria. It is rarely found more than 100 km inland, except along major rivers.

The Eastern Freetail-bat is found along the east coast from south Queensland to southern NSW.

The Eastern False Pipistrelle is found on the south-east coast and ranges of Australia, from southern Queensland to Victoria and Tasmania.

The Eastern Bentwing-bat has a wide distribution throughout non-arid regions of NSW, including the Sydney Basin Bioregion. The species appears to be moderately common within the region but is most frequently found along the coast.

The distribution of the Greater Broad-nosed Bat is poorly known. It is restricted to east coast and adjacent Great Dividing Range from the Queensland to the Victorian border (Parnaby and Cherry 1992**).**

The Study Area is not at the limit of the distribution of the above five species.

The Large-eared Pied Bat is found from the northern border of NSW to the south coast as far inland as the western slopes of the Great Dividing Range. Most records within the region occur in the Blue Mountains to the north-west of the Study Area. (DEC 2005Ž). The Study Area is close to the southern extremities of the species' known distribution. Records become sparser farther south.

**How is the proposal likely to affect current disturbance regimes?**

The proposal is unlikely to alter the existing fire regime of the Study Area.

These bat species are not known to be dependant on a certain flooding regime. The proposal is unlikely to affect the natural flooding regime of the Study Area.

The proposal is not likely to alter current disturbance regimes.

**How is the proposal likely to affect habitat connectivity?**

The Proposal is unlikely to result in fragmentation or isolation of potential habitat for these Microchiropteran Bat species and good quality potential habitat is continuous within the Locality. The impact areas for the proposal are generally restricted to the edge of existing tracks and would not cause major fragmentation of habitat for these species. Overall it is unlikely that the Proposal would create a major barrier to the movement of the species in the area or isolate portions of potential habitat.

**How is the proposal likely to affect critical habitat?**

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.

**Conclusion**

The impacts of the proposal on these bat species are likely to be minor as:

- The proposal is unlikely to have a major impact on the lifecycle of these six species;
- The proposal is unlikely to have a major impact on the composition of potential habitat for these Bat species within the local area;
- The Study Area contains approximately 5.4 ha of Ridgetop Woodland, Gully Forest and Upland Swamp habitat for this species. Impacts to 0.02 per cent of the local occurrence of potential habitat for these Bat species is not considered to be a major amount of habitat considering the quality of potential habitat within the locality;
- The proposal would not result in significant long-term isolation or fragmentation of habitat for these six Microchiropteran Bat species; and,
- No critical habitat has been declared for these Microchiropteran Bat species.

# APPENDIX 5

## EPBC Act Significant Impact Criteria

# Significant Impact Guidelines

The EPBC Act Significant Impact Guidelines (DEH 2006) list Significant Impact Criteria for matters of national environmental significance that should be taken into consideration to determine whether a proposal is likely to have a significant impact on threatened species, populations or ecological communities that are known to occur or potentially occur in the Study Area.

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

# Endangered Species

## Flora

Potential habitat occurs within the Study Area for one Endangered plant species listed on the EPBC Act: *Persoonia hirsuta.* The potential impacts of the proposal on this species are assessed against the Significant Impact Criteria of the EPBC Act below.

This species was not recorded within the Study Area during the current survey.

### *Persoonia hirsuta*

Potential habitat for *Persoonia hirsuta* occurs in Coastal Sandstone Ridgetop Woodland in the Study Area, 3.6 ha of which would be impacted by the proposal.

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

*Persoonia hirsuta* was not recorded in the Study Area. The Study Area is not likely to support a population of the species and the species was not recorded in the study area and is relatively conspicuous. The proposal is therefore unlikely to lead to a long-term decrease in the size of a population of the species.

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

*Persoonia hirsuta* has been recorded in the Sydney coastal area, the Blue Mountains area and the Southern Highlands (DEC 2005q). The Study Area is at the south-eastern limit of the distribution for this species.

*Persoonia hirsuta* was not recorded in the Study Area. The removal or modification of 3.6 ha of vegetation that is potential habitat for *Persoonia hirsuta* is not likely to reduce the area of occupancy of the species.

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

Since the species was not recorded in the Study Area, the proposal is not likely to fragment an existing population into two or more populations.

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

'Habitat critical to the survival of a species or ecological community' is defined by DEH (2006) as areas that are necessary:

- for activities such as foraging, breeding, roosting, or dispersal;
- for the long-term maintenance of the species or ecological community (including the maintenance of species essential to the survival of the species or ecological community, such as pollinators);
- to maintain genetic diversity and long term evolutionary development; or
- for the reintroduction of populations or recovery of the species or ecological community.

Such habitat may be, but is not limited to: habitat identified in a recovery plan for the species or ecological community as habitat critical for that species or ecological community; and/or habitat listed on the Register of Critical Habitat maintained by the Minister under the EPBC Act (DEH 2006).

To date, no critical habitat for *Persoonia hirsuta* has been listed on the Register of Critical Habitat. A recovery plan for this species is in preparation, but not yet available to the public.

The potential habitat for *Persoonia hirsuta* in the Study Area is not likely to be critical habitat, as the species was not recorded in the Study Area and so the area is not likely to be necessary for breeding, dispersal, long-term maintenance, to maintain genetic diversity and long term evolutionary development or for the reintroduction of populations.

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

*Persoonia hirsuta* is usually present as isolated individuals or very small populations (DEC 2005q). Known occurrences of this species generally support one to three plants (DEC 2005q) though larger populations of this species are known from the region (pers. obs.). 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.* It is not anticipated that the proposal would be likely to significantly impact the movements, shelter or foraging opportunities of these pollinators or dispersers.

The proposed modification of a total of 3.6 ha of vegetation that is potential habitat for *Persoonia hirsuta* is considered unlikely to disrupt the breeding cycle of a population of the species.

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

*Persoonia hirsuta* was not recorded during the field surveys. Potential habitat for the species in the Study Area includes Coastal Sandstone Ridgetop Woodland.

The proposal would involve impacts to approximately 3.6 ha of Coastal Sandstone Ridgetop Woodland, which is considered potential habitat for *Persoonia hirsuta*. These impacts would include clearing of native vegetation. Approximately 20,860 ha of potential habitat for *Persoonia hirsuta* exists within the locality (10 km radius of the Study Area, based on vegetation mapping by Tindall (2004)). The area of habitat in the Study Area to be impacted (directly and indirectly) by the proposal equates to less than 0.01 % of similar habitat types in the locality and this is not considered to be a significant amount of habitat.

Despite the removal and modification of 3.6 ha of potential habitat for *Persoonia hirsuta* within the Study Area, the impact areas for the proposal are generally restricted to the edge of existing tracks and would not require additional fragmentation of habitat for this species. The proposal would not significantly affect habitat connectivity for *Persoonia hirsuta.*

The proposal is not likely to modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.

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

The proposal has the potential to introduce weed seed to habitats that are currently relatively free of weed invasion. Mitigation measures listed in Section 5.2 should be undertaken to reduce the potential of the introduction of weed seed.

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

The removal or modification of 3.6 ha of potential habitat for *Persoonia hirsuta* is not likely to introduce disease that may cause the species to decline. However as a precaution, vehicles should be washed prior to use on site.

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

The recovery plan for *Persoonia hirsuta* is currently being prepared and is not yet available to the public.

**Conclusion**

Based on the above assessment, *Persoonia hirsuta* is unlikely to be significantly impacted by the proposal and as such a referral under the provisions of the EPBC Act is not recommended for this species.

## Fauna

Potential habitat occurs within the Study Area for three Endangered animal species listed on the EPBC Act, the Swift Parrot, Regent Honeyeater and Southern Brown Bandicoot. The potential impacts of the proposal on these species are assessed against the Significant Impact Criteria of the EPBC Act below.

### Swift Parrot (*Lathamus discolor*)

The proposal is likely to directly impact 0.6 ha of potential forest habitat (Coastal sandstone Gully Forest) and 3.6 ha of potential woodland habitat (Coastal Sandstone Ridgetop Woodland).

**Is there a real chance or a possibility that the action would lead to a long-term decrease in the size of a population of a species?**

The Study Area does not contain breeding habitat and only one of the species' key feed trees (if infested with lerp). Given the range and mobility of this species it is unlikely to be wholly dependent upon resources within the Study Area. Additionally, the species has not been recorded within the Study Area (Figure 5). Given the above, it is unlikely that the proposal would lead to a long-term decrease in the size of a population of the Swift Parrot.

**Is there a real chance or a possibility that the action will reduce the area of occupancy of the species?**

The proposal would not impact breeding sites (which exist in Tasmania only), although foraging habitat (flowering eucalypts and lerp infested trees) for this species may be affected. The proposal is likely to directly impact 0.6 ha of potential forest habitat (Coastal sandstone Gully Forest) and 3.6 ha of potential woodland habitat (Coastal Sandstone Ridgetop Woodland). The total extent of similar foraging habitat types within the locality is 36,260 ha, meaning the area proposed to be cleared/modified represents 0.01 % of the potential habitat for this species within the locality.

Therefore, it is unlikely that the proposal would reduce the area of occupancy of a population of the Swift Parrot.

**Is there a real chance or a possibility that the action will fragment an existing population into two or more populations?**

The Study Area is already fragmented by existing roads and powerlines. Considering the mobility of the species and that the proposed boreholes are not located in such a way as to further fragment vegetation stands, the proposal is unlikely to fragment an existing population of the Swift Parrot into two or more populations.

**Is there a real chance or a possibility that the action will adversely affect habitat critical to the survival of a species?**

The Commonwealth Environment Minister may identify and list habitat critical to the survival of a listed threatened species or ecological community. Details of this identified habitat will be recorded in a Register of Critical Habitat. To date no areas of critical habitat have been listed for Swift Parrot.

**Is there a real chance or a possibility that the action will disrupt the breeding cycle of a population?**

The Swift Parrot breeds in Tasmania during spring and summer, migrating in the autumn and winter months to south-eastern Australia from Victoria and the eastern parts of South Australia to south-east Queensland. In NSW the species mostly occurs on the coast and south west slopes (DEC 2005r).

When migrating during the non-breeding season, the Swift Parrot can occur on the mainland in areas where eucalypts are flowering profusely or where there are abundant lerp (from sap-sucking bugs) infestations. Favoured feed trees include winter flowering species such as Swamp Mahogany *Eucalyptus robusta*, Spotted Gum *Corymbia maculata*, Red Bloodwood *C. gummifera*, Mugga Ironbark *E. sideroxylon*, and White Box *E. albens*. Commonly used lerp infested trees include Grey Box *E. microcarpa*, Grey Box *E. moluccana* and Blackbutt *E. pilularis* (DEC 2005r). The Study Area does not contain any breeding habitat for the Swift Parrot.

The Swift Parrot was not recorded during the current survey or within the Study Area but has been recorded on a number of occasions within the locality. (DECC Atlas of NSW Wildlife). Potential foraging habitat exists in the Study Area in woodlands and forests. However, given the lack of preferred foraging trees within the Study Area it is unlikely to constitute prime or core habitat for this species. It is possible that the Swift Parrot would use the resources within the Study Area on occasion however it is unlikely to be dependant on them.

The proposal is unlikely to disrupt the breeding cycle of a population of the Swift Parrot.

**Is there a real chance or a possibility that the action will modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline?**

The proposal is likely to directly impact approximately 4.2 ha of potential foraging habitat which represents 0.01 % of the distribution of similar potential habitat within the locality (36,260 ha). The impact areas for the proposal are generally restricted to the edge of existing tracks and would not cause major fragmentation of habitat for this species. Given the range of this species, extent of potential habitat of the same quality within the locality and lack of breeding sites within the Study Area, it is unlikely that the proposal would decrease the availability or quality of habitat to the extent that the species is likely to decline.

**Is there a real chance or a possibility that the action will result in invasive species that are harmful to an endangered species becoming established in the endangered species' habitat?**

Potential habitat within the Study Area has been previously disturbed and is subject to ongoing disturbance, due to adjacent roads and roads including weed invasion. It is possible that the proposal would exacerbate the existing weed invasion in the impacted patches of vegetation, with increased edge effects. However with suitable mitigation measures as outlined in Section 5.2, any impacts on the potential habitat would be minimised.

**Is there a real chance or a possibility that the action will introduce disease that may cause the species to decline?**

Infection by *Psittacine circoviral* (beak and feather) disease (PCD) affecting endangered psittacine species is listed as a key threatening process (NSW Scientific Committee 2008; DEH 2005). Swift Parrots are considered to have a high potential for being adversely impacted by PCD due to their low population numbers and that PCD has been recorded in wild birds in NSW (NSW Scientific Committee 2008). The Proposal is unlikely to result in the introduction of PCD into the Study Area, or increase the incidence of PCD in birds in NSW.

Clearing vegetation and the associated construction works have the potential to introduce or increase incidence of external diseases into vegetation or fauna populations. However, as the potential habitat for the Swift Parrot in the Study Area is already degraded and fragmented by existing roads and powerlines, it is unlikely that the proposal would introduce new diseases into the area which could result in the species' decline.

**Is there a real chance or a possibility that the action will interfere with the recovery of the species?**

The Australian Government Minister for the Department of Environment and Water Resources may make or adopt and implement recovery plans for threatened fauna, threatened flora (other than conservation dependent species) and threatened ecological communities listed under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

There is a recovery plan for the Swift Parrot (DEW). Recovery Actions identified in the plan include:

- Action 1. Identify the extent and quality of foraging habitat;
- Action 2. Manage Swift Parrot habitat at a landscape scale;
- Action 3. Reduce the incidence of collisions;
- Action 4. Population and habitat monitoring;
- Action 5. Community education and information; and,
- Action 6. Manage the recovery process through a recovery team.

The proposal would result in the clearing of 4.2 ha of potential foraging habitat for the Swift Parrot. Although clearing of potential habitat is identified as a threat to the recovery of the Swift Parrot in the plan, the proposed area to be cleared is estimated to be a small percentage (0.01%) of the broader distribution of potential habitat in the locality (36,260 ha). In addition, potential habitat within the Study Area is considered to be of moderate quality and contains no breeding sites. Considering the above, it is unlikely that the proposal would interfere with the recovery of the Swift Parrot.

**Conclusion**

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

## Regent Honeyeater (*Xanthomyza phrygia*)

Potential foraging habitat for this species occurs within the woodland and forest habitat where flowering eucalypts provide potential foraging resources. The proposal is likely to directly impact 0.6 ha of potential forest habitat (Coastal Sandstone Gully Forest) and 3.6 ha of potential woodland habitat (Coastal Sandstone Ridgetop Woodland).

**Is there a real chance or a possibility that the action will lead to a long-term decrease in the size of a population of a species?**

The Study Area does not contain known breeding sites and only one clump of the species' key feed trees. Given the range and mobility of this species it is unlikely to be wholly dependent upon resources within the Study Area. Additionally, the species has been recorded within the locality on a few occasions. Given the above, it is unlikely that the proposal would lead to a long-term decrease in the size of a population of the Regent Honeyeater.

**Is there a real chance or a possibility that the action will reduce the area of occupancy of the species?**

The proposal is unlikely to impact breeding sites, although foraging habitat (flowering eucalypts) for this species may be affected. The total extent of similar foraging habitat types within the locality is 36,260 ha, meaning the area proposed to be cleared/modified represents 0.01 % of the potential habitat for this species within the locality.

Therefore, it is unlikely that the proposal would reduce the area of occupancy of a population of the Regent Honeyeater.

**Is there a real chance or a possibility that the action will fragment an existing population into two or more populations?**

The Study Area is already fragmented by existing roads and powerlines. Considering the mobility of the species and that the proposed boreholes are not located in such a way as to further fragment vegetation stands, the proposal is unlikely to fragment an existing population of the Regent Honeyeater into two or more populations.

**Is there a real chance or a possibility that the action will adversely affect habitat critical to the survival of a species?**

The Commonwealth Environment Minister may identify and list habitat critical to the survival of a listed threatened species or ecological community. Details of this identified habitat will be recorded in a Register of Critical Habitat. To date no areas of critical habitat have been listed for Regent Honeyeater.

**Is there a real chance or a possibility that the action will disrupt the breeding cycle of a population?**

This species is known to nest solitarily or in small colonies within three key breeding locations in northern NSW, western NSW and north-eastern Victoria (Higgins *et al.* 2001). Breeding of this species is well known (Higgins *et al.* 2001) and the Study Area does not contain any known breeding sites. Therefore

the proposed action is unlikely to disrupt the breeding cycle of a population of the Regent Honeyeater.

**Is there a real chance or a possibility that the action will modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline?**

The Regent Honeyeater has a patchy distribution throughout a large geographic range. The species is known to forage on a variety of key Eucalypts, particularly *E. sideroxylon*, *E. melliodora* and *E. albens*, and *E. robusta*.

Potential foraging habitat for this species occurs within the woodland and forest habitat where flowering eucalypts provide potential foraging resources. However, given the lack of preferred foraging trees within the Study Area it is unlikely to constitute prime or core habitat for this species. It is possible that the Regent Honeyeater would use the resources within the Study Area, however it is unlikely to be dependant on them for survival.

The proposal is likely to directly impact approximately 4.2 ha of potential foraging habitat which represents 0.01 % of the distribution of similar potential habitat within the locality (36,260 ha). Given the range of this species, extent of potential habitat within the locality, the moderate quality of the potential habitat and lack of breeding sites within the Study Area, it is unlikely that the proposal would decrease the availability or quality of habitat to the extent that the Regent Honeyeater is likely to decline.

**Is there a real chance or a possibility that the action will result in invasive species that are harmful to an endangered species becoming established in the endangered species' habitat?**

Potential habitat within the Study Area has been previously disturbed and is subject to ongoing disturbance, due to adjacent roads and roads including weed invasion. It is possible that the proposal would exacerbate the existing weed invasion in the impacted patches of vegetation, with increased edge effects. However with suitable mitigation measures as outlined in Section 5.2, any impacts on the potential habitat would be minimised.

**Is there a real chance or a possibility that the action will introduce disease that may cause the species to decline?**

Diseases have not been identified as a threat to populations of the Regent Honeyeater (DEC 2005o).

Clearing vegetation and the associated construction works have the potential to introduce or increase incidence of external diseases into vegetation or fauna populations. However, as the potential habitat for the Regent Honeyeater in the

Study Area is already modified and fragmented by existing roads andpowerlines, it is unlikely that the proposal would introduce new diseases into the area which could result in the species' decline.

**Is there a real chance or a possibility that the action will interfere with the recovery of the species?**

The Australian Government Minister for the Department of Environment and Water Resources may make or adopt and implement recovery plans for threatened fauna, threatened flora (other than conservation dependent species) and threatened ecological communities listed under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

There is a recovery plan for the Regent Honeyeater (DEW). Recovery Actions identified in the plan include:

- Action 1. Organisational arrangement including continued use of the Regent Honeyeater Recovery team to guide and review progress as well as close liaison with the Regent Honeyeater Recovery team, state agencies and other groups;
- Action 2. Active management including preparation of regional work plans in four key regions by Operations Groups;
- Action 3. Monitor population levels and changes in distribution;
- Action 4. Conduct research on post-breeding movements, isolation between population, habitat availability and resource use;
- Action 5. Maintain and develop community participation and awareness; and,
- Action 6. Maintain and improve captive population management.

In addition, with relation to Regent Honeyeater habitat, Objective 2 of the recovery plan states: 'Maintain and enhance the value of Regent Honeyeater habitat at the key sites and throughout the former range'.

The proposal would result in the clearing of 4.2 ha of potential foraging habitat for the Regent Honeyeater. Although maintaining an enhancing Regent Honeyeater habitat is listed as a Specific Objective in the recovery of the Regent Honeyeater in the plan, the proposed area to be cleared is estimated to be a small percentage (0.01%) of the broader distribution of potential habitat in the locality (36,260 ha). In addition, potential habitat within the Study Area is considered to be of moderate quality and contains no breeding sites. Considering the above, it

is unlikely that the proposal would interfere with the recovery of the Regent Honeyeater.

**Conclusion**

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

## Southern Brown Bandicoot *(Isoodon obesulus obesulus)*

The proposal is likely to directly impact 0.6 ha of potential forest habitat (Coastal Sandstone Gully Forest), 3.6 ha of potential woodland habitat (Coastal Sandstone Ridgetop Woodland) and 1.2 ha of potential Upland Swamp habitat (Coastal Upland Swamp) where there is a heathy understorey on sandy soil.

**Is there a real chance or a possibility that the action will lead to a long-term decrease in the size of a population of a species?**

The Study Area does not contain known breeding sites for this species. Southern Brown Bandicoots inhabit relatively small home ranges but these home ranges are relatively flexible with individuals able to shift their home range depending on resource availability (Broughton and Dickman 1991). This species is unlikely to be wholly dependent upon resources within the Study Area. Additionally, the species has not been recorded within the Study Area or locality. Given the above, it is unlikely that the proposal would lead to a long-term decrease in the size of a population of the Southern Brown Bandicoot.

**Is there a real chance or a possibility that the action will reduce the area of occupancy of the species?**

The proposal is unlikely to impact breeding sites, although foraging habitat for this species may be affected. The total extent of similar foraging habitat types within the locality is 39,575 ha, meaning the area proposed to be cleared/modified represents 0.02 % of the potential habitat for this species within the locality.

Therefore, it is unlikely that the proposal would reduce the area of occupancy of a population of the Southern Brown Bandicoot.

**Is there a real chance or a possibility that the action will fragment an existing population into two or more populations?**

The Study Area is already fragmented by existing roads and powerlines. The boreholes are located in such a way as to not further fragment vegetation stands,

the proposal is unlikely to fragment an existing population of the Southern Brown Bandicoot into two or more populations.

**Is there a real chance or a possibility that the action will adversely affect habitat critical to the survival of a species?**

The Commonwealth Environment Minister may identify and list habitat critical to the survival of a listed threatened species or ecological community. Details of this identified habitat would be recorded in a Register of Critical Habitat. To date no areas of critical habitat have been listed for the Southern Brown Bandicoot.

**Is there a real chance or a possibility that the action will disrupt the breeding cycle of a population?**

There are no records of Southern Brown Bandicoots in the Study Area or locality. There is a possibility of trees being present which could be hosts to the fungal sporocarps which make up part of this species diet. Southern Brown Bandicoots inhabit relatively small home ranges but these home ranges are relatively flexible with individuals able to shift their home range depending on resource availability (Broughton and Dickman 1991). The Study Area does not contain any known breeding sites. Therefore the proposed action is unlikely to disrupt the breeding cycle of a population of the Southern Brown Bandicoot.

**Is there a real chance or a possibility that the action will modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline?**

The Southern Brown Bandicoot has a patchy distribution. It is found in south-eastern NSW, east of the Great Dividing Range south from the Hawkesbury River, southern coastal Victoria and the Grampian Ranges, south-eastern South Australia, south-west Western Australia and the northern tip of Queensland (DECC 2007b).

Potential habitat for this species occurs within the Woodland, Forest and Upland Swamp habitat where trees are hosts to the fungal sporocarps which make up part of this species diet. However, given the lack of these preferred host trees within the Study Area it is unlikely to constitute prime or core habitat for this species. It is possible that the Southern Brown Bandicoot would use the resources within the Study Area, however it is unlikely to be dependant on them for survival.

The proposal is likely to directly impact approximately 5.4 ha of potential foraging habitat which represents 0.01 % of the distribution of similar potential habitat within the locality (39,575 ha). Given the extent of potential habitat within the locality, the moderate quality of the potential habitat to be impacted and lack of breeding sites within the Study Area, it is unlikely that the proposal would decrease the availability or quality of habitat to the extent that the Southern Brown Bandicoot is likely to decline.

**Is there a real chance or a possibility that the action will result in invasive species that are harmful to an endangered species becoming established in the endangered species' habitat?**

Potential habitat within the Study Area has been previously disturbed and is subject to ongoing disturbance, due to adjacent roads and roads including weed invasion. It is possible that the proposal would exacerbate the existing weed invasion in the impacted patches of vegetation, with increased edge effects. However with suitable mitigation measures as outlined in Section 5.2, any impacts on the potential habitat would be minimised.

**Is there a real chance or a possibility that the action will introduce disease that may cause the species to decline?**

Clearing vegetation and the associated actions have the potential to introduce or increase incidence of external diseases into vegetation or fauna populations. However, as the potential habitat for the Southern Brown Bandicoot in the Study Area is already modified and fragmented by existing roads and powerlines, it is unlikely that the proposal would introduce new diseases into the area which could result in the species' decline.

**Is there a real chance or a possibility that the action will interfere with the recovery of the species?**

The Australian Government Minister for the Department of Environment may make or adopt and implement recovery plans for threatened fauna, threatened flora (other than conservation dependent species) and threatened ecological communities listed under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). To date, there is no recovery plan for the Southern Brown Bandicoot.

The proposal would result in the clearing/modifying of 5.4 ha of potential foraging habitat for the Southern Brown Bandicoot. Although clearing of habitat is identified as a threat to the recovery of the Southern Brown Bandicoot, the proposed area to be cleared is estimated to be a small percentage (0.01%) of the broader distribution of potential habitat in the locality (39,575 ha). In addition, potential habitat within the Study Area is considered to be of moderate quality

and contains no recorded breeding sites. For these reasons it is unlikely that the proposal would interfere with the recovery of the Southern Brown Bandicoot.

**Conclusion**

Based on the above assessment, the Southern Brown Bandicoot is **unlikely** to be significantly impacted by the proposal, and as such, a Referral under the provisions of the EPBC Act is not recommended for this species.

## Vulnerable Species

### Flora

Potential habitat occurs within the Study Area for four Vulnerable plant species listed on the EPBC Act: *Acacia bynoeana, Cryptostylis hunteriana, Persoonia acerosa* and *Pultenaea aristata.*

The potential impacts of the proposal on these species are assessed against the Significant Impact Criteria of the EPBC Act below.

#### *Acacia bynoeana*

An 'important population' is defined by DEH (2006) as a population that is necessary for a species' long-term survival and recovery. This may include populations identified as such in recovery plans, and/or that are:

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

*Acacia bynoeana* was not recorded in the Study Area. The species is endemic to central eastern NSW, and is distributed from the Hunter district on the Central Coast south to Berrima and Mittagong in the Southern Highlands (DEC 2005a). The Study Area is not at the limit of the distribution for *Acacia bynoeana*.

The proposal is not likely to impact on an important population of *Acacia bynoeana* since the species was not recorded in the impact area and therefore no individuals would be removed. Potential habitat for this species exists in the Study Area in Coastal Sandstone Ridgetop Woodland, approximately 3.6 ha of which would be impacted by the proposal.

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

*Acacia bynoeana* was not recorded in the Study Area in the current surveys. The proposal is not likely to require the removal of any plants of *Acacia bynoeana,* and is therefore not likely to lead to a long-term decrease in the size of an important population of this species.

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

The proposal is not likely to reduce the area of occupancy of an important population, as no plants of the species are likely to be removed and the area of habitat impacted is small.

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

The proposal is not likely to result in the removal of any plants of *Acacia bynoeana.* The proposal is not likely to fragment an existing important population into two or more populations.

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

'Habitat critical to the survival of a species or ecological community' is defined by DEH (2006) as areas that are necessary:

- for activities such as foraging, breeding, roosting, or dispersal;
- for the long-term maintenance of the species or ecological community (including the maintenance of species essential to the survival of the species or ecological community, such as pollinators);
- to maintain genetic diversity and long term evolutionary development; or
- for the reintroduction of populations or recovery of the species or ecological community.

Such habitat may be, but is not limited to: habitat identified in a recovery plan for the species or ecological community as habitat critical for that species or ecological community; and/or habitat listed on the Register of Critical Habitat maintained by the Minister under the EPBC Act (DEH 2006).

To date, the Register of Critical Habitat does not contain any listing for *Acacia bynoeana* and a recovery plan for the species has not been prepared.

The potential habitat for *Acacia bynoeana* in the Study Area is not likely to be critical habitat. The proposal is not likely to adversely affect habitat critical to the survival of this species.

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

The proposal is not likely to result in the removal of any plants of *Acacia bynoeana.* The proposal is therefore not likely to disrupt the breeding cycle of an important population of the species.

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

The proposal would involve impacts to approximately 3.6 ha of Coastal Sandstone Ridgetop Woodland, which is considered potential habitat for *Acacia bynoeana*. These impacts would include clearing of native vegetation. Approximately 20,800 ha of potential habitat for *Acacia bynoeana* exists within the locality (10 km radius of the Study Area, based on vegetation mapping by Tindall (2004)). The area of habitat in the Study Area to be impacted (directly and indirectly) by the proposal equates to 0.2 % of similar habitat types in the locality and this is not considered to be a significant amount of habitat.

Despite the removal and modification of 3.6 ha of potential habitat for *Acacia bynoeana* within the Study Area, the impact areas for the proposal are generally restricted to the edge of existing tracks and would not require additional fragmentation of habitat for this species. The proposal would not significantly affect habitat connectivity for *Acacia bynoeana.*

The proposal is not likely to have a significant effect on the habitat of the species in the locality.

The proposal is unlikely to modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.

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

The proposal has the potential to introduce weed seed to habitats that are currently relatively free of weed invasion. Mitigation measures listed in Section 5.2 should be undertaken to reduce the potential of the introduction of weed seed.

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

The removal or modification of 3.6 ha of potential habitat for *Acacia bynoeana* is not likely to introduce disease that may cause the species to decline. However as a precaution, vehicles should be washed prior to use on site.

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

The Australian Government Minister for the Environment may make or adopt and implement recovery plans for threatened fauna, threatened flora (other than conservation dependent species) and threatened ecological communities listed under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

To date, there is no recovery plan for *Acacia bynoeana*. The proposal is unlikely to interfere substantially with the recovery of *Acacia bynoeana*.

**Conclusion**

Based on the above assessment, *Acacia bynoeana* is unlikely to be significantly impacted by the proposal and as such a referral under the provisions of the EPBC Act is not recommended for this species.

## *Cryptostylis hunteriana*

An 'important population' is defined by DEH (2006) as a population that is necessary for a species' long-term survival and recovery. This may include populations identified as such in recovery plans, and/or that are:

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

*Cryptostylis hunteriana* was not recorded in the Study Area. The Study Area is therefore unlikely to support an important population of this species. Potential habitat for this species exists in the Study Area in Coastal Sandstone Ridgetop Woodland, which would be impacted by the proposal.

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

This species was not recorded within the Study Area, however, potential habitat within Coastal Sandstone Ridgetop Woodland is considered to be present. Given that no previous records exist for the locality, the relative importance of habitat

within the Study Area for the long-term survival of the species is considered low. In addition to this, there is a large area of similar and potential habitat in the locality which would not be impacted by the proposal. It is therefore considered unlikely that the proposal would lead to a long-term decrease of an important population of the species.

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

This species was not recorded within the Study Area. Approximately 20,800 ha of potential habitats for *C. hunteriana* exist within the locality (10 km radius, based on mapping by Tindall et al. (2004)). The impact of the proposal would involve the loss of 3.6 ha of native vegetation, which is considered potential habitat for *C. hunteriana*. The area to be impacted (directly and indirectly) by the proposal equates to 0.02 % of similar habitat types in the locality. This is not considered likely to lead to reduce the area of occupancy of an important population.

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

No known population of this species exist within the locality. Despite the removal and modification of 3.6 ha of potential habitat for *Cryptostylis hunteriana* within the Study Area, the impact areas for the proposal are generally restricted to the edge of existing tracks and would not require additional fragmentation of habitat for this species. The proposal would not significantly affect habitat connectivity for *Cryptostylis hunteriana.* The proposal is therefore unlikely to fragment an existing population into two or more populations.

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

'Habitat critical to the survival of a species or ecological community' is defined by DEH (2006) as areas that are necessary:

- for activities such as foraging, breeding, roosting, or dispersal;
- for the long-term maintenance of the species or ecological community (including the maintenance of species essential to the survival of the species or ecological community, such as pollinators);
- to maintain genetic diversity and long term evolutionary development; or
- for the reintroduction of populations or recovery of the species or ecological community.

Such habitat may be, but is not limited to: habitat identified in a recovery plan for the species or ecological community as habitat critical for that species or

ecological community; and/or habitat listed on the Register of Critical Habitat maintained by the Minister under the EPBC Act (DEH 2006).

To date, the Register of Critical Habitat does not contain any listing for *Cryptostylis hunteriana* and a recovery plan for the species has not yet been prepared.

The potential habitat for *Cryptostylis hunteriana* in the Study Area is not likely to be critical habitat, as the species was not recorded in the Study Area and is not known to occur in the locality. The area is not likely to be necessary for breeding, dispersal, long-term maintenance of the species, to maintain genetic diversity and long term evolutionary development or for the reintroduction of populations.

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

*Cryptostylis hunteriana* is pollinated by pseudocopulation by the Ichneumid wasp *Lissopimpla excelsa*. The seed 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 often found growing in association with the other *Cryptostylis* species including *C. subulata* and *C. erecta*, neither of which were recorded in the Study Area. It appears likely that each of these *Cryptostylis* species is reliant on symbiotic relationships with the same type of mycorrhizal fungus found in decaying plant matter.

This species was not recorded within the Study Area, however, potential habitat is considered to be present. A large extent of potential habitat for this species is present within the locality (20,800 ha within a 10 km radius), which would not be impacted by the proposal.

Based on the known pollinators for this species it is unlikely that the proposal would significantly reduce the capacity for the pollination of individuals occurring within the locality. The likely dispersal mechanism for the species, wind, is unlikely to be affected by the proposal. On this basis, populations of the species in the locality could reasonably be expected to cross-pollinate with those potentially occurring in the Study Area. The proposal is considered unlikely to disrupt the breeding cycle of a population.

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

This species was not recorded within the Study Area, however, potential habitat within Coastal Sandstone Ridgetop Woodland is present. The proposal would involve the loss or modification of 3.6 ha of native vegetation, which is considered potential habitat for *C. hunteriana*. Approximately 20,800 ha of further potential habitats for *C. hunteriana* exist within the locality (10 km radius). Given the availability of a large areas of potential habitat in the locality, compared to the area to be impacted by the proposal, it is considered unlikely that the proposal would modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.

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

The proposal has the potential to introduce weed seed to habitats that are currently relatively free of weed invasion. Mitigation measures listed in Section 5.2 should be undertaken to reduce the potential of the introduction of weed seed.

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

The removal or modification of 3.6 ha of potential habitat for *Cryptostylis hunteriana* is not likely to introduce disease that may cause the species to decline. However as a precaution, vehicles should be washed prior to use on site.

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

To date, no recovery plan has been written for *Cryptostylis hunteriana.* The proposal is not likely to interfere with the recovery of this species.

**Conclusion**

Based on the above assessment, *Cryptostylis hunteriana* is unlikely to be significantly impacted by the proposal and as such a referral under the provisions of the EPBC Act is not recommended for this species.

## *Persoonia acerosa*

An 'important population' is defined by DEH (2006) as a population that is necessary for a species' long-term survival and recovery. This may include populations identified as such in recovery plans, and/or that are:

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

*Persoonia acerosa* was not recorded in the Study Area. The Study Area is therefore unlikely to support an important population of this species. Potential habitat for this species exists in the Study Area in Coastal Sandstone Ridgetop Woodland, which would be impacted by the proposal.

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

*Persoonia acerosa* was not recorded in the Study Area. Potential habitat within the Study Area is considered to occur within Coastal Sandstone Ridgetop Woodland. The proposal would directly impact approximately 3.6 ha of potential habitat and is not likely to result in the removal of any plants of the species. The proposal is therefore unlikely to lead to a long term decrease in the size of an important population in the Study Area.

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

This species was not recorded within the Study Area. Approximately 20,800 ha of potential habitats for *Persoonia acerosa* exist within the locality (10 km radius, based on mapping by Tindall et al. (2004)). The impact of the proposal would involve the loss of 3.6 ha of native vegetation, which is considered potential habitat for *Persoonia acerosa*. The area to be impacted (directly and indirectly) by the proposal equates to 0.02 % of similar habitat types in the locality. This is not considered likely to lead to reduce the area of occupancy of an important population.

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

Despite the removal and modification of 3.6 ha of potential habitat for *Persoonia acerosa* within the Study Area, the impact areas for the proposal are generally restricted to the edge of existing tracks and would not require additional fragmentation of habitat for this species. The proposal would not significantly

affect habitat connectivity for *Persoonia acerosa.* The proposal is therefore unlikely to fragment an existing population into two or more populations.

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

'Habitat critical to the survival of a species or ecological community' is defined by DEH (2006) as areas that are necessary:

- for activities such as foraging, breeding, roosting, or dispersal;
- for the long-term maintenance of the species or ecological community (including the maintenance of species essential to the survival of the species or ecological community, such as pollinators);
- to maintain genetic diversity and long term evolutionary development; or
- for the reintroduction of populations or recovery of the species or ecological community.

Such habitat may be, but is not limited to: habitat identified in a recovery plan for the species or ecological community as habitat critical for that species or ecological community; and/or habitat listed on the Register of Critical Habitat maintained by the Minister under the EPBC Act (DEH 2006).

To date, the Register of Critical Habitat does not contain any listing for *Persoonia acerosa* and a recovery plan for the species has not yet been prepared.

The potential habitat for *Persoonia acerosa* in the Study Area is not likely to be critical habitat, as the species was not recorded in the Study Area. The area is not likely to be necessary for breeding, dispersal, long-term maintenance of the species, to maintain genetic diversity and long term evolutionary development or for the reintroduction of populations.

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

Pollinators of *Persoonia acerosa* are likely to be native bees (NPWS 2000). Dispersers are likely to be large birds and mammals (Benson and McDougall 2000a). Germination is likely to be triggered by mechanical disturbance and fire (NPWS 2000). Pollination, dispersal and germination are considered important stages of the lifecycle of *P. acerosa.* None of these lifecycle stages are considered likely to be affected by the proposal. The proposal is therefore not likely to disrupt the breeding cycle of an important population of the species.

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

*Persoonia acerosa* was not recorded during the field surveys. However, the proposal would involve impacts to approximately 3.6 ha of Coastal Sandstone Ridgetop Woodland, which is considered potential habitat for *Persoonia acerosa*. These impacts would include clearing of native vegetation. Approximately 20,860 ha of potential habitat for *Persoonia acerosa* exists within the locality (10 km radius of the Study Area). The area of habitat in the Study Area to be impacted (directly and indirectly) by the proposal equates to less than 0.01 % of similar habitat types in the locality and this is not considered to be a significant amount of habitat.

The proposal is not likely to have a significant effect on the habitat of the species in the locality. Therefore, the proposal is unlikely to modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.

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

The proposal has the potential to introduce weed seed to habitats that are currently relatively free of weed invasion. Mitigation measures listed in Section 5.2 should be undertaken to reduce the potential of the introduction of weed seed.

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

The removal or modification of 3.6 ha of potential habitat for *P. acerosa* is not likely to introduce disease that may cause the species to decline. However as a precaution, vehicles should be washed prior to use on site.

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

To date, no recovery plan has been written for *P. acerosa.* The proposal is not likely to interfere with the recovery of this species.

**Conclusion**

Based on the above assessment, *P. acerosa* is unlikely to be significantly impacted by the proposal and as such a referral under the provisions of the EPBC Act is not recommended for this species.

## *Pultenaea aristata*

An 'important population' is defined by DEH (2006) as a population that is necessary for a species' long-term survival and recovery. This may include populations identified as such in recovery plans, and/or that are:

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

*Pultenaea aristata* was not recorded in the Study Area. The Study Area is therefore unlikely to support an important population of this species. Potential habitat for this species exists in the Study Area in Coastal Upland Swamps, which would be impacted by the proposal.

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

*Pultenaea aristata* was not recorded in the Study Area. Potential habitat within the Study Area is considered to occur within Coastal Upland Swamps. The proposal would directly impact approximately 1.2 ha of potential habitat and is not likely to result in the removal of any plants of the species. The proposal is therefore unlikely to lead to a long term decrease in the size of an important population in the Study Area.

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

This species was not recorded within the Study Area. Approximately 3,315 ha of potential habitats for *Pultenaea aristata* exist within the locality (10 km radius, based on mapping by Tindall et al. (2004)). The impact of the proposal would involve the loss of 1.2 ha of native vegetation, which is considered potential habitat for *Pultenaea aristata*. The area to be impacted (directly and indirectly) by the proposal equates to 0.04 % of similar habitat types in the locality. This is not considered likely to lead to reduce the area of occupancy of an important population.

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

Despite the removal and modification of 1.2 ha of potential habitat for *Pultenaea aristata* within the Study Area, the impact areas for the proposal are generally restricted to the edge of existing tracks and would not require additional fragmentation of habitat for this species. The proposal would not significantly

affect habitat connectivity for *Pultenaea aristata.* The proposal is therefore unlikely to fragment an existing population into two or more populations.

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

'Habitat critical to the survival of a species or ecological community' is defined by DEH (2006) as areas that are necessary:

- for activities such as foraging, breeding, roosting, or dispersal;
- for the long-term maintenance of the species or ecological community (including the maintenance of species essential to the survival of the species or ecological community, such as pollinators);
- to maintain genetic diversity and long term evolutionary development; or
- for the reintroduction of populations or recovery of the species or ecological community.

Such habitat may be, but is not limited to: habitat identified in a recovery plan for the species or ecological community as habitat critical for that species or ecological community; and/or habitat listed on the Register of Critical Habitat maintained by the Minister under the EPBC Act (DEH 2006).

To date, the Register of Critical Habitat does not contain any listing for *Pultenaea aristata* and a recovery plan for the species has not yet been prepared.

The potential habitat for *Pultenaea aristata* in the Study Area is not likely to be critical habitat, as the species was not recorded in the Study Area. The area is not likely to be necessary for breeding, dispersal, long-term maintenance of the species, to maintain genetic diversity and long term evolutionary development or for the reintroduction of populations.

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

Pollination and dispersal are considered important stages of the lifecycle of *Pultenaea aristata*. Based on the ecology of the species, pollinators and dispersers are likely to be insects and ants. It is not anticipated that the proposal would be likely to significantly impact the movements, shelter or foraging opportunities of insect vectors. The proposal is therefore not likely to disrupt the breeding cycle of an important population of the species.

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

*Pultenaea aristata* was not recorded during the field surveys. However, the proposal would involve impacts to approximately 1.2 ha of Coastal Upland Swamps, which is considered potential habitat for *Pultenaea aristata*. These impacts would include clearing of native vegetation. Approximately 3,315 ha of potential habitat for *Pultenaea aristata* exists within the locality (10 km radius of the Study Area). The area of habitat in the Study Area to be impacted (directly and indirectly) by the proposal equates to approximately 0.04 % of similar habitat types in the locality and this is not considered to be a significant amount of habitat.

The proposal is not likely to have a significant effect on the habitat of the species in the locality. Therefore, the proposal is unlikely to modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.

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

The proposal has the potential to introduce weed seed to habitats that are currently relatively free of weed invasion. Mitigation measures listed in Section 5.2 should be undertaken to reduce the potential of the introduction of weed seed.

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

The removal or modification of 1.2 ha of potential habitat for *P. aristata* is not likely to introduce disease that may cause the species to decline. However as a precaution, vehicles should be washed prior to use on site.

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

To date, no recovery plan has been written for *P. aristata.* The proposal is not likely to interfere with the recovery of this species.

**Conclusion**

Based on the above assessment, *P. aristata* is unlikely to be significantly impacted by the proposal and as such a referral under the provisions of the EPBC Act is not recommended for this species.

## Fauna

Potential habitat occurs within the Study Area for two Vulnerable animal species listed on the EPBC Act, the Grey-headed Flying-fox and Large-eared Pied Bat. There are three bird species listed as Migratory Species under the EPBC Act, the Black-faced Monarch, Satin Flycatcher and Rainbow Bee-eater. The potential impacts of the proposal on this species are assessed against the Significant Impact Criteria of the EPBC Act below.

### Grey-headed Flying-fox *Pteropus poliocephalus*

Populations of the Grey-headed Flying-fox that may occur within the Study Area are not considered important populations because:

- they are unlikely to be key source populations either for breeding or dispersal, seeing as no camps have been recorded in the Study Area and the nearest camp is approximately 5 km away;
- they are unlikely to be necessary for maintaining genetic diversity, as there is no evidence that the Study Area contains an isolated genetic variant of this species or that the proposal would impact on the overall genetic diversity of the species; and,
- the Study Area is not at or near the limit of the species range which extends along the coast from Bundaberg in Queensland, south to western Victoria.

**Is there a real chance or a possibility that the action will lead to a long-term decrease in the size of an important population of a species?**

The Study Area is not considered to contain an important population of the Grey-headed Flying-fox. Furthermore, as the Study Area contains no camps and given the range and mobility of this species it is unlikely to be wholly dependent upon resources within the Study Area. Therefore the proposal is unlikely to lead to a long-term decrease in the size of an important population.

**Is there a real chance or a possibility that the action will reduce the area of occupancy of an important population?**

The Study Area is not considered to contain an important population of the Grey-headed Flying-fox. Furthermore, the proposal is unlikely to impact potential roost sites (camps), although foraging habitat (flowering eucalypts) for this species may be affected. Therefore, it is unlikely that the proposal would reduce the area of occupancy of an important population of this species.

**Is there a real chance or a possibility that the action will fragment an existing important population into two or more populations?**

The Study Area is not considered to contain an important population of the Grey-headed Flying-fox. The Study Area is already fragmented by existing roads. Given the range and mobility of this species, the proposal is unlikely to fragment an existing important population into two or more populations,.

**Is there a real chance or a possibility that the action will adversely affect habitat critical to the survival of a species?**

The Commonwealth Environment Minister may identify and list habitat critical to the survival of a listed threatened species or ecological community. Details of this identified habitat would be recorded in a Register of Critical Habitat. To date no areas of critical habitat have been listed for Grey-headed Flying Fox.

**Is there a real chance or a possibility that the action will disrupt the breeding cycle of an important population?**

The Grey-headed Flying-fox is a canopy-feeding frugivore, blossom-eater and nectarivore of rainforests, open forests, woodlands, Melaleuca swamps and Banksia woodlands. They have a varied diet, encompassing a wide range of fruits and blossoms from both native and non-native trees (Strahan 1995).

The species congregates in large numbers at roosting sites (camps) in habitats that include rainforest patches, Melaleuca stands, mangroves, riparian woodland or modified vegetation in urban areas. Individuals generally exhibit a high fidelity to traditional camps and return annually to give birth and rear offspring. Grey-headed Flying-foxes are known to travel up to 50 km from their camps to forage (NPWS 2001a).

There is one known Grey-headed Flying-fox camp within the locality in the Illawarra Escarpment near Bulli Pass. There are also two other camps just outside the locality at Mt Kembla and on the Cumberland Plain at Menangle.The Grey-headed Flying-fox was not recorded during the current survey but has been recorded in the past within the Study Area (DECC Atlas of NSW Wildlife).

Potential foraging habitat for this species occurs within the woodland and forest habitat where flowering eucalypts provide potential foraging resources.

The Study Area is not considered to contain an important population of the Grey-headed Flying-fox. Therefore the proposed action is unlikely to disrupt the breeding cycle of an important population. Furthermore, the proposal is unlikely to impact potential roost sites (camps) where breeding occurs (Strahan 1995).

**Is there a real chance or a possibility that the action will modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline?**

The proposal is likely to directly impact 0.6 ha of potential forest habitat (Coastal sandstone Gully Forest) and 3.6 ha of potential woodland habitat (Coastal Sandstone Ridgetop Woodland). The area to be modified or cleared as part of the proposal represents 0.01 % of the broader distribution of these habitat types within the locality (36,260 ha). The impact areas for the proposal are generally restricted to the edge of existing tracks and would not cause major fragmentation of habitat for this species.

Given the range of this species, extent of potential habitat of the same quality within the locality and lack of breeding camps within the Study Area, it is unlikely that the proposal would decrease the availability or quality of habitat to the extent that the species is likely to decline.

**Is there a real chance or a possibility that the action will result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat?**

Potential habitat within the Study Area has been previously disturbed and is subject to ongoing disturbance, due to adjacent roads and powerlines, including weed invasion. It is possible that the proposal would exacerbate the existing weed invasion in the impacted patches of vegetation, with increased edge effects. However with suitable mitigation measures as outlined in Section 5.2 any impacts on the potential habitat would be minimised.

**Is there a real chance or a possibility that the action will introduce disease that may cause the species to decline?**

Diseases have not been identified as a threat to populations of the Grey-headed Flying-fox (NPWS 2001a).

Clearing vegetation and the associated construction works have the potential to introduce or increase incidence of external diseases into vegetation or fauna populations. However, as the potential habitat for the Grey-headed Flying Fox in the Study Area is already modified and fragmented by existing roads, it is unlikely that the proposal would introduce new diseases into the area which could result in the species' decline.

**Is there a real chance or a possibility that the action will interfere substantially with the recovery of the species?**

The Australian Government Minister for the Department of Environment may make or adopt and implement recovery plans for threatened fauna, threatened

flora (other than conservation dependent species) and threatened ecological communities listed under the Commonwealth *Environment Protection and Biodiversity Conservation Act* 1999 (EPBC Act). To date, there is no recovery plan for the Grey-headed Flying-fox.

The proposal would result in the clearing of 4.2 ha of potential foraging habitat for the Grey-headed Flying-fox. Although clearing of habitat is identified as a threat to the recovery of the Grey-headed Flying-fox, the proposed area to be cleared is estimated to be a small percentage (0.01%) of the broader distribution of potential habitat in the locality (36,260 ha). In addition, potential habitat within the Study Area is considered to be of moderate quality and contains no recorded camps/roosting sites. For these reasons it is unlikely that the proposal would interfere with the recovery of the Grey-headed Flying-fox.

**Conclusion**

Based on the above assessment, the Grey-headed Flying-fox is **unlikely** to be significantly impacted by the proposal, and as such, a Referral under the provisions of the EPBC Act is not recommended for this species.

## Large-eared Pied-bat *Chalinolobus dwyeri*

Populations of the Large-eared Pied-bat that may occur within the development footprint are not considered important populations because:

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

This species was not recorded within the study area during the current survey. However, the DECC Atlas of NSW Wildlife has a previous record of this species within a 10 km radius of the Study Area.

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

The Proposal would remove and /or modify approximately 5.4 ha of potential foraging habitat for the Large–eared Pied Bat. These habitats are widely distributed throughout the locality (39,575 ha). The removal and /or modification of potential foraging habitat for this species represents approximately 0.01 % of the available habitat within the locality.

The potential habitat for this species appears to contain no significant roost sites. Given the mobility of this species, lack of potential roost sites and the extent of

potential habitat within the local region, it is unlikely that the proposal would lead to a long-term decrease in the size of an important population.

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

The Study Area is not considered to contain an important population of the Large-eared Pied Bat. Furthermore, the proposed Borehole sites are unlikely to impact potential roosts although foraging habitat (woodland and forest) for this species would be removed. Therefore, it is unlikely that the proposal would reduce the area of occupancy of an important population of this species.

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

The Study Area is not considered to contain an important population of the Large-eared Pied Bat. Therefore, the proposal is unlikely to fragment an existing important population into two or more populations.

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

The Commonwealth Environment Minister may identify and list habitat critical to the survival of a listed threatened species or ecological community. Details of this identified habitat would be recorded in a Register of Critical Habitat. To date no areas of critical habitat have been listed for the Large-eared Pied Bat.

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

This species roosts in caves and mines in groups of between 3 and 37 individuals (Churchill 1998). The Study Area is not considered to contain an important population of the Large-eared Pied Bat and no potential roosting sites were observed in the Study Area. Therefore the proposed action is unlikely to disrupt the breeding cycle of an important population.

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

Potential foraging habitat for this species occurs within the Woodland, Forest and Upland Swamp habitat. The species uses caves for roosting, but may also use abandoned mines. The Large-eared Pied Bat forages for small, flying insects below the tree canopy (DEC 2005w).

Given the lack roosting sites within the Study Area it is unlikely to constitute prime or core habitat for this species. It is possible that the Large-eared Pied Bat would

use the resources within the Study Area, however it is unlikely to be dependant on them for survival. The proposal is likely to directly impact approximately 5.4 ha of potential foraging habitat which represents 0.01 % of the distribution of similar potential habitat within the locality (39,575 ha). Given the extent of potential habitat within the locality, the moderate quality of the potential habitat to be impacted and lack of breeding sites within the Study Area, it is unlikely that the proposal would decrease the availability or quality of habitat to the extent that the Large-eared Pied Bat is likely to decline.

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

Potential habitat within the Study Area has been previously disturbed and is subject to ongoing disturbance, due to adjacent roads and roads including weed invasion. It is possible that the proposal would exacerbate the existing weed invasion in the impacted patches of vegetation, with increased edge effects. However with suitable mitigation measures as outlined in Section 5.2, any impacts on the potential habitat would be minimised.

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

The Australian Government Minister for the Department of Environment may make or adopt and implement recovery plans for threatened fauna, threatened flora (other than conservation dependent species) and threatened ecological communities listed under the EPBC Act. To date, there is no recovery plan for the Large–eared Pied Bat.

The proposal would result in the clearing/modifying of 5.4 ha of potential foraging habitat for the Large–eared Pied Bat. Although clearing of habitat is identified as a threat to the recovery of the Large–eared Pied Bat , the proposed area to be cleared is estimated to be a small percentage (0.01%) of the broader distribution of potential habitat in the locality (39,575 ha). In addition, potential habitat within the Study Area is considered to be of moderate quality and contains no recorded breeding sites. For these reasons it is unlikely that the proposal would interfere with the recovery of the Large–eared Pied Bat.

**Conclusion**

Based on the above assessment, the Large-eared Pied Bat is **unlikely** to be significantly impacted by the proposal, and as such, a Referral under the provisions of the EPBC Act is not recommended for this species.

## Migratory species

The Black-faced Monarch, Satin Flycatcher and Rainbow Bee-eater are listed as Migratory species under the EPBC Act and have been grouped together here based on similar habitat requirements that would be impacted by the Proposal.

These 3 species have not been recorded within the Study Area during the current survey.

For the purposes of the Act, an area of important habitat for migratory species is:

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

The Study Area contains approximately 3.6 ha of Sandstone Ridgetop Woodland and 0.6 ha of Gully Forest habitat for these three migratory species. The Proposal would modify/remove approximately 4.2 ha of potential habitat within the Study Area (which equates to less than 0.1% from the locality; which provides 36,260 ha).

The known and/or potential habitat to be impacted by the Proposal is not considered to be an area of important habitat for the Black-faced Monarch, Satin Flycatcher or Rainbow Bee-eater as it is:

- unlikely to support an ecologically significant proportion of the population of these species;
- unlikely to be critical to particular life cycle stages of these species;
- not located at the limit of distribution for these species; and,
- not located in area where the species is declining (and is also not the preferred habitat of the Rainbow Bee-eater).

Furthermore the impact areas for the proposal are generally restricted to the edge of existing tracks and would not cause major fragmentation of habitat for this species. However borehole AI04B is located in a relatively undisturbed patch of Coastal Sandstone Gully Forest. A clearing for a 5m x 80m access track to the

borehole site is proposed which would increase fragmentation of potential habitat for these species. Given the mobility of these species, and the extent of similar potential foraging habitat in the locality, it is unlikely that the proposal would significantly fragment or isolate any areas of potential foraging habitat or movement corridors for this species.

**Is the action likely to substantially modify (including by fragmenting, altering fire regimes, altering nutrient cycles or altering hydrological cycles), destroy or isolate an area of important habitat for the migratory species?**

The Study Area is not considered to contain an area of important habitat for the Black-faced Monarch, Satin Flycatcher or Rainbow Bee-eater. Therefore, it is unlikely that the Proposal would substantially modify, destroy or isolate area of important habitat for these species.

**Is the action likely to result in an invasive species that is harmful to the migratory species becoming established in an area of important habitat for the migratory species?**

Potential habitat within the Study Area has been previously disturbed and is subject to ongoing disturbance, due to adjacent roads and powerlines, including weed invasion. It is possible that the proposal would exacerbate the existing weed invasion in the impacted patches of vegetation, with increased edge effects. However with suitable mitigation measures as outlined in Section 5.2 any impacts on the potential habitat would be minimised.

The Study Area is not considered to contain an area of important habitat for the Black-faced Monarch, Satin Flycatcher or Rainbow Bee-eater.

**Is the action likely to seriously disrupt the life cycle (breeding, feeding, migration or resting behaviour) of an ecologically significant proportion of the population of the migratory species?**

The Proposal is unlikely to seriously disrupt the life cycle of an ecologically significant proportion of the population of the Black-faced Monarch, Satin Flycatcher or Rainbow Bee-eater.

**Conclusion:**

Based on the above assessment, the Black-faced Monarch, Satin Flycatcher and Rainbow Bee-eater are unlikely to be significantly impacted by the Proposal and as such a Referral under the provisions of the EPBC Act is not recommended for these species.

# REFERENCES

# REFERENCES


Allison FR and Hoye GA (1995) Eastern Freetail-bat. Pp. 484-485 In 'The Mammals of Australia' (Ed. R Strahan). Reed New Holland, Sydney).

Augee M and Ford D (1999) Radio-tracking studies of Grey-headed Flying-foxes, *Pteropus poliocephalus*, from the Gordon colony, Sydney. *Proceedings of the Linnaean Society of New South Wales* 121**,** 61-70.

Barker J *et al.* (1995) 'A Field Guide to Australian Frogs.' (Surrey Beatty and Sons, Sydney).

Benson D and McDougal L (1998) Ecology of Sydney Plant Species Part 6: Myrtaceae. *Cunninghamia* 5**,** 808-984.

Bishop T (1996) 'Field Guide to the Orchids of New South Wales and Victoria.' (UNSW Press, Sydney).

Braithwaite RW (1995) Southern Brown Bandicoot. Pp. 176-177 In 'The Mammals of Australia' (Ed. R Strahan). Reed New Holland, Sydney).

Briggs JD and Leigh JH (1995) 'Rare or Threatened Australian Plants.' (CSIRO Publishing, Collingwood, VIC).

Churchill S (1998) 'Australian Bats.' (Reed New Holland, Sydney).

Cogger HG (1992) 'Reptiles and Amphibians of Australia.' (Reed Books, Sydney).

Daly G (1996) Observations of the Eastern Owl Frog *Helioporous australiacus* (Anura: Myobatrachidae) in Southern NSW. *Herpetofauna* 26**,** 33-42.

Debus S and Chafer C (1994a) The Powerful Owl *Ninox strenua* in New South Wales. *Australian Birds* 28**,** 21-39.

Debus S and Chafer C (1994b) The Sooty Owl, *Tyto tenebricosa* & Powerful Owl, *Ninox strenua* in NSW. *Australian Birds* 28 Supplement**,** 2.

DEC (2004) 'Darwinia biflora Draft Recovery Plan.' NSW Department of Environment and Conservation.

DEC (2005a). *Acacia bynoeana* - Threatened Species Profile, http://www.threatenedspecies.environment.nsw.gov.au/tsprofile/profile.aspx?id=10006, Accessed 19-5-2006a

DEC (2005b). *Caladenia tessellata* - Threatened Species Profile, http://www.threatenedspecies.environment.nsw.gov.au/tsprofile/profile.aspx?id=10124, Accessed 2006b

DEC (2005c). *Callistemon linearifolius*, Threatened Species Profile, http://threatenedspecies.environment.nsw.gov.au/tsprofile/profile.aspx?id=10129, Accessed 16-10-2006c

DEC (2005d). Chorizema parviflorum - Endangered Population Profile, http://www.threatenedspecies.environment.nsw.gov.au/tsprofile/profile.aspx?id=10167, Accessed 2006d

DEC (2005e). *Cryptostylis hunteriana* - Threatened Species Profile, http://www.threatenedspecies.environment.nsw.gov.au/tsprofile/profile.aspx?id=10187, Accessed 19-5-2006e

DEC (2005f). Daphnandra sp. C - Threatened Species Profile, http://www.threatenedspecies.environment.nsw.gov.au/tsprofile/profile.aspx?id=10201, Accessed 2006f

DEC (2005g). Eastern Pygmy-possum: Threatened Species Profile, http://www.threatenedspecies.environment.nsw.gov.au/tsprofile/profile.aspx?id=10155, Accessed

DEC (2005h). *Epacris purpurascens* var. *purpurascens* - Threatened Species Profile, http://www.threatenedspecies.environme

nt.nsw.gov.au/tsprofile/profile.aspx?id=10273, Accessed 19-5-2006h

DEC (2005i). *Eucalyptus camfieldii* - Threatened Species Profile, http://www.threatenedspecies.environment.nsw.gov.au/tsprofile/profile.aspx?id=10287, Accessed 2006i

DEC (2005j). *Genoplesium baueri* - Threatened Species Profile, http://www.threatenedspecies.environment.nsw.gov.au/tsprofile/profile.aspx?id=10875, Accessed 19-5-2006j

DEC (2005k). Grevillea parviflora subsp. parviflora - Threatened Species Profile, http://www.threatenedspecies.environment.nsw.gov.au/tsprofile/profile.aspx?id=10373, Accessed 2006k

DEC (2005l). Koala: Threatened Species Profile, http://www.threatenedspecies.environment.nsw.gov.au/tsprofile/profile.aspx?id=10616, Accessed

DEC (2005m). Lower Hunter Spotted Gum - Ironbark Forest - Threatened Species Profile, http://threatenedspecies.environment.nsw.gov.au/tsprofile/profile.aspx?id=10942, Accessed 2006m

DEC (2005n). *Melaleuca deanei* - Threatened Species Profile, http://www.threatenedspecies.environment.nsw.gov.au/tsprofile/profile.aspx?id=10515, Accessed 19-5-2006n

DEC (2005o). *Persoonia acerosa* - Threatened Species Profile, http://threatenedspecies.environment.nsw.gov.au/tsprofile/profile.aspx?id=10591, Accessed 2006o

DEC (2005p). *Persoonia bargoensis* - Threatened Species Profile, http://www.threatenedspecies.environment.nsw.gov.au/tsprofile/profile.aspx?id=10592, Accessed 2006p

DEC (2005q). *Persoonia hirsuta* - Threatened Species Profile, http://www.threatenedspecies.environment.nsw.gov.au/tsprofile/profile.aspx?id=10595, Accessed 19-5-2006q

DEC (2005r). Pomaderris adnata - Threatened Species Profile, http://threatenedspecies.environment.nsw.gov.au/tsprofile/profile.aspx?id=10646, Accessed 2006r

DEC (2005s). Pomaderris adnata - Threatened Species Profile, http://threatenedspecies.environment.nsw.gov.au/tsprofile/profile.aspx?id=10646, Accessed 2006s

DEC (2005t). Pomaderris brunnea - Threatened Species Profile, http://www.threatenedspecies.environment.nsw.gov.au/tsprofile/profile.aspx?id=10647, Accessed 2006t

DEC (2005u). Prostanthera densa - Threatened Species Profile, http://threatenedspecies.environment.nsw.gov.au/tsprofile/profile.aspx?id=10676, Accessed 2006u

DEC (2005v). Pultenaea aristata - Threatened Species Profile, http://www.threatenedspecies.environment.nsw.gov.au/tsprofile/profile.aspx?id=10710, Accessed 2006v

DEC (2005w). Pultenaea aristata - Threatened Species Profile, http://www.threatenedspecies.environment.nsw.gov.au/tsprofile/profile.aspx?id=10710, Accessed 2006w

DEC (2005x). Regent Honeyeater: Threatened Species Profile, http://www.threatenedspecies.environment.nsw.gov.au/tsprofile/profile.aspx?id=10841, Accessed 2008x

DEC (2005z). Solanum celatum - Threatened Species Profile, http://www.threatenedspecies.environment.nsw.gov.au/tsprofile/profile.aspx?id=10761, Accessed 27-3-2006z

DEC (2005y). Solanum celatum - Threatened Species Profile, http://www.threatenedspecies.environment.nsw.gov.au/tsprofile/profile.aspx?id=10761, Accessed 27-3-2006y

DEC (2005{). Sooty Owl: Threatened Species Profile, http://www.threatenedspecies.environme

nt.nsw.gov.au/tsprofile/profile.aspx?id=10821, Accessed 2007{

DEC (2005|). Square-tailed Kite: Threatened Species Profiles, http://www.threatenedspecies.environment.nsw.gov.au/tsprofile/profile.aspx?id=10495, Accessed

DEC (2005}). *Thesium australe* - Threatened Species Profile, http://www.threatenedspecies.environment.nsw.gov.au/tsprofile/profile.aspx?id=10802, Accessed 2006}

DEC (2005~). Threatened Species Profile, *Cynanchum elegans*, http://threatenedspecies.environment.nsw.gov.au/tsprofile/profile.aspx?id=10196, Accessed

DECC (2007a). Orange-bellied parrot - critically endangered species, http://www.nationalparks.nsw.gov.au/npws.nsf/Content/Psittacidae_critically_endangered_species, Accessed 1911a

DECC (2007b) 'Threatened and pest animals of Greater Southern Sydney.' Department of Environment and Climate Change.

DEH (2005) 'Threat abtement plan for Psittacine Beak and Feather Disease affecting endangered psittacine species.' Department for the Environment and Heritage,Canberra.

Department of Environment, Water Heritage and the Arts (2008). *Epacris limbata* in Species Profile and Threats Database, http://www.environment.gov.au/sprat., Accessed 8-5-0008

DEWHA (2004). Interim Biogeographic Regionalisation for Australia (IBRA), Version 6.1, http://www.environment.gov.au/parks/nrs/science/bioregion-framework/ibra/index.html, Accessed

Dickman CR andRead DG (1992) 'The biology & management of dasyurids of the arid zone in NSW.' NPWS, NSW,No. 11.

Edgar R and Belcher C (1995) Spotted-tailed Quoll. Pp. 67-68 In 'The Mammals of Australia' (Ed. R Strahan). Reed New Holland, Sydney).

Eldridge MDB and Close RL (1995) Brush-tailed Rock-wallaby. Pp. 383-385 In 'The Mammals of Australia' (Ed. R Strahan). Reed New Holland, Sydney).

English TE andPredavec M (2001) 'Mill Stream Bird Assessment.' Biosis Research,Sydney.

Fairley A and Moore P (1995) 'Native Plants of the Sydney District.' (Kangaroo Press, Sydney).

Fairley A and Moore P (2000) 'Native Plants of the Sydney District: An Identification Guide. Revised Edition.' (Kangaroo Press, Sydney).

Forshaw JM and Cooper WT (1981) 'Australian Parrots (2nd Ed).' (Lansdowne Press, Melbourne).

Garnett S (1992) 'Threatened and Extinct Birds of Australia.' (York Press, Richmond).

Gibbons P and Lindenmayer DB (1997) Conserving Hollow-dependent Fauna in Timber Production Forest. *Environmental Heritage Monograph* 3**,** 110.

Harden G (1990) 'Flora of New South Wales Volume 1.' (NSW University Press, Kensington).

Harden G (1991) 'Flora of New South Wales Volume 2.' (NSW University Press, Kensington).

Harden G (1992) 'Flora of New South Wales Volume 3.' (NSW University Press, Kensington).

Harden G (1993) 'Flora of New South Wales Volume 4.' (NSW University Press, Kensington).

Harden G (2002) 'Flora of New South Wales Volume 2 (Revised Edition).' (University of New South Wales Press Ltd., Kensington).

Higgins PJ (1999) 'Handbook of Australian, New Zealand and Antarctic Birds. Volume 4: Parrots to Dollarbird.' (Oxford University Press, Melbourne).

Higgins PJ and Davies SJJF (1996) 'Handbook of Australian, New Zealand and Antarctic Birds. Volume 3: Snipe to Pigeons.' (Oxford University Press, Melbourne).

Higgins PJ *et al.* (2001) 'Handbook of Australian, New Zealand and Antarctic Birds. Volume 5: Tyrant-flycatchers to Chats.' (Oxford University Press, Melbourne).

Hoye GA and Dwyer PD (1995) Large-eared Pied Bat. Pp. 510-511 In 'The Mammals of Australia' (Ed. R Strahan). Reed New Holland, Sydney).

Hoye GA and Richards GC (1995) Greater Broad-nosed Bat. Pp. 527-528 In 'The Mammals of Australia' (Ed. R Strahan). Reed New Holland, Sydney).

James T *et al.* (1999) 'Rare Bushland Plants of Western Sydney.' (Royal Botantical Gardens,

Johnston PG (1995) Long-nosed Potoroo. Pp. 301-302 In 'The Mammals of Australia' (Ed. R Strahan). Reed New Holland, Sydney).

Marchant S and Higgins PJ (1990) 'Handbook of Australian, New Zealand and Antarctic Birds. Volume 1 Ratites to Ducks: Part B Australian Pelican to Ducks.' (Oxford University Press, Melbourne).

Marchant S and Higgins PJ (1993) 'Handbook of Australian, New Zealand and Antactic Birds. Volume 2 Raptors to Lapwings.' (Oxford University Press, Melbourne).

Maxwell S *et al.* (1996) 'The Action Plan for Australian Masupials and Monotremes.' Australian Marsupial and Monotremes Specialist Group, IUCN Survival Commission, Environment Australia Endangered Species Program No. 500, Canberra.

Menkhorst PW and Lumsden LF (1995) Eastern False Pipistrelle.In 'Mammals of Victoria' (Ed. PW Menkhorst). Oxford University Press, Melbourne).

Morris AK (1980) The status and distribution of the Turquoise Parrot in New South Wales. *Australian Birds* 14**,** 57-67.

NPWS. (1998). Vertebrate Fauna Survey of the Northern Illawarra Escarpment. NPWS

NPWS (1999a). Australasian Bittern: Threatened Species Information, http://www.nationalparks.nsw.gov.au/PDFs/tsprofile_australasian_bittern.pdf , Accessed

NPWS (1999b). Black Bittern: Threatened Species Information, http://www.nationalparks.nsw.gov.au/PDFs/tsprofile_black_bittern.pdf, Accessed

NPWS (1999c). Glossy Black Cockatoo: Threatened Species Information, http://www2.nationalparks.nsw.gov.au/PDFs/tsprofile_glossy_black_cockatoo.pdf , Accessed

NPWS (1999d). Green and Golden Bell Frog: Threatened Species Information, http://www.nationalparks.nsw.gov.au/PDFs/tsprofile_green_golden_bell_frog.pdf, Accessed

NPWS (1999e). Regent Honeyeater: Threatened Species Information, http://www.nationalparks.nsw.gov.au/PDFs/tsprofile_regent_honeyeater.pdf, Accessed

NPWS (1999f). Square-tailed Kite: Threatened Species Information, http://www2.nationalparks.nsw.gov.au/PDFs/tsprofile_squaretailed_kite.pdf, Accessed

NPWS (1999g). Yellow-bellied Glider: Threatened Species Information, http://www2.nationalparks.nsw.gov.au/PDFs/tsprofile_yellowbellied_glider.pdf, Accessed

NPWS (2000) 'Persoonia acerosa: Environmental Impact Assessment Guidelines.' NPWS,Hurstville.

NSW Scientific Committee (2001) 'Final determination to list Pomaderris adnata as an endangered species.' NPWS,Hurstville.

NSW Scientific Committee (12-2-2008). Infection by *Psittacine circoviral* (beak and feather) disease affecting endangered psittacine species and populations - key threatening process listing, http://www.environment.nsw.gov.au/determinations/BeakAndFeatherDiseaseKTPListing.htm, Accessed 2008

OBPRT (1998) 'Orange-bellied Parrot Recovery Plan 1998-2002.' Orange-bellied Parrot Recovery Team. Parks and Wildlife Service,Hobart.

Phillips W (1995) Eastern False Pipistrelle. Pp. 520-521 In 'The Mammals of Australia' (Ed. R Strahan). Reed New Holland, Sydney).

Pizzey G and Knight F (1997) 'The Field Guide to the Birds of Australia.' (Angus and Robertson, Sydney).

Pizzey G and Knight F (2007) 'The Field Guide to the Birds of Australia.' (Harper Collins Publishers, Sydney).

Recsei J (1996) Eastern Owl Frog, *Heleioporus australiacus*. Pp. 55-64 In 'Threatened Frogs of New South Wales: Habitats, Status and Conservation.' (Ed. H Ehmann). Frog and Tadpole Study Group of NSW, Sydney South).

Reed P *et al.* (1990) '1986-1987 Survey of the Koala Phascolarctos cinereus (Goldfuss) in New South Wales and an ecological interpretation of its distribution. In Biology of the koala, ed by A. Lee, K. Handasyde and G. Sanson.' Surry Beatty & Sons, Sydney.

Reed PC and Lunney D (1990) Habitat loss: the key problem for the long-term survival of koalas in New South Wales.In 'Koala Summit: Managing Koalas in New South Wales' (Eds D Lunney, CA Urquhart, and PC Reed). NSW NPWS, Hurstville).

Richards GC (1995) Large-footed Myotis. Pp. 521-523 In 'The Mammals of Australia' (Ed. R Strahan). Reed New Holland, Sydney).

Robinson L (1994) 'Field Guide to the Native Plants of Sydney.' (Kangaroo Press, Sydney).

Robinson L (2003) 'Field Guide to the native plants of Sydney - 3rd Edition.' (Kangaroo Press,

Shields J and Crome F (1992) 'Parrots and Pigeons of Australia.' (Angus and Robertson, Sydney).

Strahan R (1995) 'The Mammals of Australia.' (Reed Books, Chatswood).

Thumm K and Mahony M (1997) Red-crowned Toadlet *Pseudophryne australis*. Pp. 125-135 In 'Threatened Frogs of New South Wales: Habitats, Status and Conservation' (Ed. H Ehmann). Frog and Tadpole Study Group of NSW, Sydney South).

Tidemann CR (1995) Grey-headed Flying-fox. Pp. 439-440 In 'The Mammals of Australia' (Ed. R Strahan). Reed New Holland, Sydney).

Tindall D *et al.* (2004) 'Native Vegetation Map Report Series. No. 4: Araluen, Batemans Bay, Braidwood, Burragorang, Goulburn, Jervis Bay, Katoomba, Kiama, Moss vale, Penrith, Port hacking, Sydney, Taralga, Ulladulla and Wollongong 1:100 00 Mapsheets.'.

Traill BJ andDuncan S (2000) 'Status of birds in the New South Wales temperate woodlands region.' Consultancy report to the NSW National Parks and Wildlife Service by the Australian Woodlands Conservancy,Chiltern, Victoria.

Turner V and Ward SJ (1995) Eastern Pygmy-possum. Pp. 217-218 In 'The Mammals of Australia' (Ed. R Strahan). Reed New Holland, Sydney).

Viridans (2003). NSW Flora Information System, 2007

Ward SJ (1990) Life history of the eastern pygmy possum, *Cercartetus nanus* (Burramyidae, Marsupialia) in

south-eastern Australia. *Australian Journal of Zoology* 38**,** 287-304.

Webb JK (1996) Ecology and Conservation of the Threatened Broad-headed Snake *Hoplocephalus bungaroides*.PhD Dissertation,' University of Sydney.

Webb JK and Shine R (1998) Ecological characteristic of an endangered snake species *Hoplocephalus bungeroides* (Sepentes: Elapidae). *Animal Conservation* 1**,** 185-193.

Wellington R andWells R (1985) 'Fauna survey of the Morisset Forestry District, Central Coast NSW. Reptiles and Amphibians.' State Forests of NSW,Pennant Hills.

White AW and Pyke GH (1996) Distribution and conservation status of the Green and Golden Bell Frog *Litoria aurea* in New South Wales. *Australian Zoologist* 30**,** 177-189.